
EUROPEAN COLLEGE of SPORT SCIENCE
ECSS
SPORT & SCIENCE
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BOOK OF ABSTRACTS
Edited by:
Guilhem, G., Rabita, G., Brocherie, F., Tsolakidis, E.,
Ferrauti, A., Helge, J.W., Piacentini, M.F.

28th Annual Congress of the

EUROPEAN COLLEGE OF SPORT SCIENCE

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Welcome

Dear ECSS Paris 2023 Participants,

ECSS returns to its country of birth for its 28th annual congress – 27 years after its first edition in Nice. On behalf of the Paris team, we are honoured to have the opportunity to help you discover or rediscover the City of Light while attending this fantastic event!

We hope you will spare some time before and after the congress to feel the 'Parisii spirit' – a Gallic tribe that dwelt on the banks of the River Seine during the Iron Age and the Roman era. Step into these past times by walking, biking or running along the River Seine to discover the most beautiful monuments of Paris from the cathedral Notre Dame (under reconstruction) to Alexandre III Bridge, the Invalides or even the Eiffel Tower, which you will see during the Bengt Saltin Run. After an enjoyable run, you may want to do your active recovery walking around the quartier latin between the Pantheon and La Sorbonne under the students' eyes. Perhaps you will have your shower or hammam on the rue Geoffroy-Saint-Hilaire.

After visiting the capital's top attractions, why not take a look at some of the favourite spots of Parisians: districts they stroll through on the weekend, parks where they picnic, their famous café terraces for breakfast or an aperitif. Take a green interlude in 24 hectares of the Jardin des Plantes and then cross the river to discover the arrondissement Popincourt, between Bastille and République – one of the most densely populated urban districts of any European city. You may have lunch in the Marais where the United Excellence of Sport Science reception will take place, full of fashionable cafés, restaurants, nightlife, and a range of boutiques and galleries. If you head north-west along the Boulevard Richard-Lenoir, you will reach the romantic Canal St-Martin which was a former route for wood supplies. If you prefer to take the high roads, you can choose one of the hills in the North of Paris (Charonne, Belleville, Bergère, Ménilmontant or of course Montmartre and the Sacré Coeur) where you can admire fantastic viewpoints. In these neighborhoods, you will encounter art at every turn, whether it's street art, buildings with amazing architecture, outdoor works of art and high-profile movie locations – art is everywhere in the French capital.

Together with these unique gifts Paris has to offer, we are looking forward to opening a pre-Olympic and Paralympic forum at INSEP and the Palais des Congrès, both connected by the historical axis and the métro Line 1. You may want to attend the Elite Sport Performance satellite at INSEP on the afternoon of Monday 3 July, which will end with a public lecture from the well-known French athlete and explorer Stéphanie Gicquel, who was designated as the best French athlete in 2022. Please do not miss the ECSS-IOC joint symposium, where high profile researchers will share their work developed in the IOC Research Centres for the Prevention of Injury and Illness. The Masterclasses aimed at students this year will include for the first time a Data Visualisation session led by young scientists and data analysts. In addition, starting from Wednesday, we will have the chance to discover an outstanding scientific programme covering the most exciting areas of sport science. Last but not least, and as a result of our close work with partners and local authorities, we will have a number of exciting social events that will take the congress to unique sites around the city and offer an unforgettable experience for ECSS Participants!

You are warmly invited to enter the doors of the City of Light and be a part of the Olympic and Paralympic journey.

Paris vous attend! / Paris is waiting for you!

Yours in Sport Science,

The ECSS Paris 2023 Organising Team

Gaël Guilhem (Local Congress President)

French Institute of Sport (INSEP)

Laboratory Sport, Expertise and Performance

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Wednesday, July 5, 2023

08:30 - 09:45

Invited symposia

IS-AP01 Recovery and sleep in elite sport

MONITORING SLEEP IN ELITE ATHLETES AND INTERVENTIONS TO ENHANCE SLEEP

HALSON, S.

AUSTRALIAN CATHOLIC UNIVERSITY

Sleep is considered the best recovery strategy available to athletes and has important roles in physical and mental performance, illness and injury prevention, mood, metabolism and cognitive function. Research has established that athletes face numerous sleep challenges and have reduced sleep quality and quantity when compared to the general population. Alongside the rapid increase in research in sleep and athletes is the proliferation of wearable devices to assess sleep. The latest scientific knowledge regarding sleep measurement tools will be provided, including validation research, specific metrics provided by wearables which have sufficient validity and relevance to athletes, and availability, security and access to data. Important caveats for consideration when using these devices with athletes will be presented. Further, is important to understand how to appropriately use metrics derived from wearables and activity monitors to improve sleep. Feedback and behaviour change strategies form essential components of athlete monitoring and education, with scientific evidence developing in this area. Other strategies to increase sleep in athletes, including nutritional and psychological strategies will be outlined.

INFLUENCE OF CHRONOTYPE, TRAINING/COMPETITION SCHEDULES, AND DAYTIME NAPPING ON ELITE ATHLETES SLEEP

VITALE, J.

IRCCS ISTITUTO ORTOPEDICO GALEAZZI

Sleep disturbances in athletes may be explained by their constant exposure to many stressors that impair sleep. Among these variables, also training and competition schedules may influence the sleep response to exercise. Late evening or night competitions, that are very common in team sport disciplines (eg: soccer, basketball or volleyball), can have a negative impact on athletes' sleep onset latency and sleep efficiency. On the contrary, early morning training sessions can reduce total sleep time leading to a sleep debt, especially in athletes of individual sport disciplines (eg. runners, race walkers, triathlon athletes). In addition, athletes have different chronotypes with morning-type athletes displaying early sleep-wake cycles and evening-types athletes showing a strong predisposition toward eveningness. In this context, daytime naps are important tools to offset the adverse impacts of inadequate sleep. Napping during the day can increase the amount of sleep obtained in a 24-hour period and many athletes report including daytime napping in their training program. With the present talk, napping characteristics and the impact of naps on various measures of athletic performance in athletes will be discussed.

EFFECT OF SOCCER CONGESTED SCHEDULE ON PERFORMANCE AND INJURY RISK: THE RELEVANCE OF RECOVERY

DUPONT, G.

CELTIC FC

During periods where the schedule is particularly congested (i.e. two matches per week over several weeks), the recovery time allowed between two successive soccer matches lasts 3-4 days, which may be insufficient to restore homeostasis. Alternating between domestic, continental and international matches during these periods may additionally lead to exhausting travel stress and sleep restriction. As a result, players may experience acute and chronic fatigue potentially leading to injury. There is a lack of scientific data to date examining the specific role of sleep restriction on the risk of acute injury. Available evidence suggests that post-match sleep restriction may result in fatigue, reduction in muscular strength, change in mood and altered cognitive functioning the following days, which may affect attention and decision-making skills during ensuing training sessions and matches, potentially resulting in injury risk increase. With the present lecture, we will discuss the interest of implementing, during a congested schedule, a recovery monitoring protocol including questionnaires, sleep records and physical tests in order to help practitioners preventing injuries.

Oral presentations

OP-BM01 Biomechanics and Motor Control

COMPARING COUNTERMOVEMENT JUMP FORCE PRODUCTION AFTER ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION TO PRE-INJURY PERFORMANCE USING STATISTICAL PARAMETRIC MAPPING

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UNIVERSITY OF PRETORIA, SOUTH AFRICA

INTRODUCTION: Force-time analysis of a bilateral countermovement jump (CMJ) is used to detect neuromuscular deficits after anterior cruciate ligament reconstruction (ACLR). The uninvolved contralateral limb is often used to benchmark recovery along with discrete force and impulse metrics. Both practices may be incomplete indicators of recovery as injury affects strength in the contralateral limb, and discrete variable analysis may exclude force production over the full range of motion in jumping. This study addresses these gaps by investigating changes in CMJ force production after ACLR compared to a pre-injury baseline and inclusion of statistical parametric mapping (SPM) as well as discrete variable analysis.

METHODS: Ground reaction forces were recorded for 12 (male n = 6, female n = 6, age = 21.6 ± 3.7 years) elite multisport athletes on dual force plates (1500Hz) during routine CMJ testing pre-injury (T0), and at 24 ± 3 weeks (T1) after ACLR. Raw force-time data were processed and analysed in the Shiny Vertical Jump Analysis app (https://github.com/mattsams89/shiny-vertical-jump) in Rstudio for the unweighting, braking and propulsive phases of the CMJ. Paired t-tests, asymmetry index and SPM were used to compare the involved limb and uninvolved limb after ACLR, and compared to T0.

RESULTS: At T1, peak force was reduced on the involved limb (T1: 6.4 ± 1.6 N/kg; T0: 7.7 ± 1.4 N/kg, p = 0.002), with greater inter-limb asymmetry for peak force (T1: 7.3 ± 11.1%; T0: -1.1 ± 6.1%, p = 0.039) and propulsive impulse (T1: 12.3 ± 13.3%; T0: -0.2 ± 4.8%, p = 0.011). Propulsive impulse of the uninvolved limb increased from T0 (1.33 ± 0.11 N.s/kg) to T1 (1.58 ± 0.55 N.s/kg, p = 0.037). Propulsive impulse was significantly lower for the involved versus the uninvolved limb at T1 (p = 0.021). SPM showed lower vertical force production for the involved limb when comparing T0 to T1 (p<0.001) from 92% to 99% of the entire CMJ movement; and for the involved versus uninvolved limb (p = 0.009) from 72% to 76% of the entire CMJ movement at T1.

CONCLUSION: Both the discrete variable analysis and SPM revealed a reduction in the involved limb force and impulse production, resulting in elevated inter-limb asymmetry six months after ACLR compared to pre-injury. However, SPM analysis identified additional temporal force-time deficits compared to discrete time point analysis. This highlights the need to consider post-surgery knee function across all phases of centre of mass acceleration and lower limb joint position. Greater propulsive force production of the uninvolved limb post-surgery versus pre-injury may indicate a training effect of the uninvolved limb, or an adjustment in movement strategy. Utilising pre-injury baseline and assessing the shape of the force-time waveform and timing of peak force rather than relying only on discrete or phase-specific metrics may be more useful to assess force production after ACLR to better inform rehabilitative programs and guide return to play.

INFLUENCE OF FATIGUE AND COGNITIVE LOAD ON LANDING BIOMECHANICS IN HEALTHY AND CHRONIC ANKLE INSTABILITY PATIENTS

DURY, J., MICHEL, F., RAVIER, G.

UNIVERSITY OF FRANCHE COMTE

INTRODUCTION: Sports performance implies cognitive and physical load. These constraints impair human movement as jump landing and could increase risk of injury particularly in individuals with injury history. Among sport injuries, ankle sprains are one of the most frequent and imply long term consequences as chronic ankle instability (CAI). The understanding of factors that could predispose to ankle sprain is essential to the development of relevant prevention programs. Nevertheless, there are few studies investigating the impact of both cognitive load and fatigue on a jump landing, particularly in CAI patients. Therefore, the main objective of the study was to determine the influence of fatigue and cognitive load on the landing biomechanics in both CAI and healthy subjects.

METHODS: Twenty-three voluntary males, 13 healthy and 10 presented a CAI participated in this study. They performed single leg landing before and after a fatiguing protocol; with and without adding a cognitive task. The fatiguing protocol consisted of 4 exercises involving jumps and changes of direction performed until a 20% decrease in isometric plantarflexion strength. The cognitive task consisted of tracking a ball on a screen that moved in 2 dimensions among 9 distractor balls. The landing was performed on a force plate that allowed to measure ground reaction force (GRF) and time to stabilization (TTS) in vertical, anteroposterior (ap) and mediolateral (ml) axes. Furthermore, three dimensional movements of the hip, knee and ankle were recorded using infrared cameras system.

RESULTS: CAI group presented a greater GRF (p=0.044) and TTS (p=0.003) in vertical axis and greater GRF in ap axis (p=0.028) than healthy subjects. Fatigue induced a decrease in plantarflexion (p<0.001), ankle supination (p=0.044), hip abduction (p=0.038) and GRF in vertical axis (p=0.004). Furthermore, fatigue conducted to an increase in knee flexion (p=0.001), knee abduction (p=0.047), hip internal rotation (p=0.49), GRF in ml (p=0.016) and TTS in ap (p=0.010). Finally, dual task implied decrease in ankle internal rotation (p=0.006) and increase in knee flexion (p=0.028), knee abduction

(p=0.042), hip flexion (p=0.020), GRF in ml (p=0.019) and TTS in the three axes (p<0.001). There was no interaction between group, fatigue or cognitive factors.

CONCLUSION: The higher GRF and TTS observed in CAI group confirms the existing biomechanical differences between both groups that could predispose CAI subjects to recurrence. Surprisingly, there is no interaction between group, fatigue and cognitive factors. Nevertheless, the increase in the range of motion of knee and hip reveal a more proximal control of jump under constraints conditions as fatigue and cognitive load. In addition, the longer time to stabilization observed in fatigue and dual-task conditions indicates impairments of dynamic postural control. Thus, cognitive and fatigue do not appear to increase specifically the risk of ankle sprains but involve alterations on whole lower limb.

HUMAN FOOT MUSCLES STRENGTH AND ITS ASSOCIATION WITH ACCELERATION SPRINTING, CUTTING AND JUMPING PERFORMANCE KINETICS IN HIGH-LEVEL ATHLETES

TOURILLON, R., MICHEL, A., EDOUARD, P., FOURCHET, F., MORIN, J.B.

UNIVERSITY OF SAINT-ETIENNE, FRANCE

INTRODUCTION: The human foot is composed of intrinsic and extrinsic foot muscles that dissipate and generate net center of mass energy during rapid tasks such as running, jumping or hopping. In addition, it acts also as an efficacious lever during propulsion allowing rapid transfer of ankle plantar flexors forces into the ground. If this energetic and biomechanical role is indisputable, the literature pertaining to the relation between human foot muscles strength and sport performance is not well established. Therefore, the main aim of this study was to understand the relationship between metatarsophalangeal joint (MTPj) flexion strength and sprint acceleration, cutting and jumping performance and kinetics.

METHODS: In fifty-two high-level athletes (n=5 females, 20.1±2.1yrs, body mass index (BMI) 23.2±3.1) we assessed Foot Posture Index, foot passive stiffness using the Arch Height Index Measurement System and MTPj maximal isometric flexion torque using a custom-built dynamometer with a 6-components force sensor. Ankle plantarflexion and knee extension isometric torque were assessed using an isokinetic dynamometer whereas kinetic variables were assessed during sprinting, 90° cutting, foot-ankle hopping and vertical and horizontal jumping using a ~5.4-m force platforms system. Stepwise backward multiple linear regressions were used to understand the relationships between all the aforementioned variables.

RESULTS: During maximal speed phase we found a significant contribution of MTPj flexion strength and foot passive stiffness to explain effective vertical impulse (adjusted r^2=0.28, p=0.008) and a contribution of MTPj flexion strength and foot-ankle reactive strength to explain contact time (r^2=0.35, p=0.003). Interestingly, the association of ankle plantarflexion isometric torque and foot passive stiffness was significantly associated with propulsive impulse during early acceleration (r^2=0.31, p=0.005) whereas ankle plantarflexion isometric torque and foot-ankle reactive strength were associated with cutting performance (r^2=0.35, p<0.001). No other significant relationships were found between MTPj flexion strength and performance or kinetics in cutting and jumping task.

CONCLUSION: These findings show the contribution of MTPj flexion strength and foot passive stiffness (28% and 35% of the variance explained, respectively) to effective vertical impulse and contact time when running speed reach its maximal value. Accordingly, the foot might be a factor to consider for sprinting performance due to the importance of a large ground reaction force production over a short contact time at high maximal speed. Finally, ankle plantar flexors strength and foot-ankle reactive strength seem to explain ~33% of the variance in cutting performance and propulsion during early acceleration. This study highlights that the foot-ankle strength capability has a greater influence on horizontally-oriented explosive movements than overall vertically-oriented ones.

CAUSAL ROLE OF PREFRONTAL CORTEX IN MOTOR LEARNING AND COGNITIVE PROCESSING: A RANDOMIZED, DOUBLE-BLINDED AND SHAM-CONTROLLED BRAIN STIMULATION STUDY

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INTRODUCTION: It is commonly assumed that the positive impact of motor behaviour on cognition is mediated by brain plasticity, but causal evidence for this claim is still missing [1]. Using neuroimaging, we were previously able to observe structural plasticity in the prefrontal cortex (PFC) when participants learned a complex whole-body balance task over six consecutive weeks [2]. However, the exact role of the PFC for balance learning and cognitive performance remains unclear. Here, we tested the hypothesis that non-invasive brain stimulation of the PFC network modulates motor learning [3], performance variability [4] and associated cognitive transfer [5].

METHODS: In a randomized, double-blinded and sham-controlled study, participants (n = 44, 21.8 ± 3.25yrs, 27 females) received cathodal transcranial direct current stimulation (c-tDCS) over the right PFC (20 min of stimulation, intensity: 1mA, current density: 0.028mA/cm2) during training of a complex dynamic balance task (DBT) [2] over three weeks (two sessions/week). Motor learning and performance variability were measured using time in balance (±3 degrees to horizontal) [2] and coefficient of variation, respectively. Before and after the 3-week learning phase, cognition was assessed with PFC-related tests: the trail making test (TMT), a measure of planning, cognitive flexibility and attention [6] and the Eriksen flanker task, a measure of interference resolution [7].

RESULTS: In line with previous findings [2], both groups showed significant DBT performance improvements across the six practice sessions. C-tDCS had no effect on learning (group x time interaction effects: F(5, 18.66) = 1.29, p = .31, d = 0.4;

mixed ANOVA based on trimmed means), but resulted in significantly higher performance variability during learning compared to sham tDCS (group x time interaction effect: F(5, 19.4) = 2.9, p = .04, d = 0.5, medium effect). C-tDCS also tended to induce a larger improvement in TMT-part B performance (t(41.49) = 1.89, p = .07 (Brunner-Munzel test), Cliff's d = 0.3, small effect), and reduced improvement in the accuracy of the Eriksen flanker task compared to sham (t(41.83) = 1.93, p = .06, Cliff's d = 0.3).

CONCLUSION: Our results provide causal evidence for PFC network involvement in long-term DBT practice. We interpret the observed tDCS-effects on motor and cognitive performance as evidence for a potential overlap between the neural substrates for complex motor learning and cognitive processing within the PFC-SMA network.

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[2] Taubert et al., Journal of Neuroscience, 2010

[3] Kaminski et al., Neuroscience Letters, 2013

[4] Herrojo Ruiz et al., Scientific Reports, 2021

[5] Rogge et al., Scientific Reports, 2017

[6] Karimpoor et al., Frontiers in Human Neuroscience, 2017

[7] Isherwood et al., Neuroscience and Biobehavioural Reviews, 2021

A NOVEL FRAMEWORK FOR THE ANALYSIS OF LINEAR ACCELERATION MECHANICS FOCUSSING ON 'SHIN ROLL': HOW TO ROCK N ROLL'?

OEPPERT, T.J., ZEDLER, M., GOLDMANN, J.P., BRAUNSTEIN, B., WILLWACHER, S., ALT, T.

GERMAN SPORTS UNIVERSITY COLOGNE

INTRODUCTION: The generation of horizontal force is essential for sprint acceleration. It requires a precise sequence of joint kinematics and kinetics, which is elicited during swing-stance transition [1]. Thirty years ago, the effectiveness of a 'rotation-extension strategy' has been emphasized: a rotation of the centre of mass (CoM) around the foot in the early stance, followed by a delayed extension of the hip (HJ), knee (KJ) and ankle joint (AJ) [2]. As the rotational component is vital for horizontal acceleration, a deeper understanding is necessary. Therefore, this 'Method and Theoretical Perspective' article aimed to introduce a novel framework which identifies key positions and a temporal sequence of movement strategies contributing to efficient acceleration.

METHODS: A 3D analysis using 16 infrared high-speed cameras (250 Hz, Vicon, Oxford, United Kingdom) was used to study the first three steps of nine female elite sprinters (23±5 years, 172±5 cm, 61.5±5.0 kg, 100 m-PR: 11.4±0.2 s). Combined with a review of existing evidence, this dataset led to the identification of a framework based on the shins' orientation in space [3].

RESULTS: A continuous forward rotation of the shin towards the supporting ground (SG) ('shin roll') was observed from late swing to late stance. Three movement strategies drive the shin's downward tilt and connect four key positions. The 'shin block' defines the instance during late swing at which the shins' rotation direction changes. The athletes then reach the 'touchdown' (initial ground contact), by way of the 'shin alignment' strategy. This is followed by the 'heel lock' when the AJ reaches its lowest position through the 'ankle rocker' strategy. Finally, the 'propulsion pose', defined as the minimum shin angle in relation to the SG, is achieved via the 'shin drop' strategy.

CONCLUSION: The 'shin roll' facilitates rotation of the CoM prior to proximal-to-distal energy transfer. The 'shin alignment' strategy, achieved through a HJ extension with a 'locked' KJ, enables an efficient interaction with the SG after touchdown. Following rapid heel stabilization, the shin continues to rotate forward through a pronounced AJ dorsiflexion ('ankle rocker'). These strategies, as supported by previous research [4] associating foot placement posterior to the vertical projection of the CoM and greater AJ dorsiflexion range of motion during early stance with improved acceleration performance, assist in quickly overcoming the braking impulse. The 'shin drop' ensures a considerable amount of maintained flexion in the AJ and KJ, decreasing excessive vertical acceleration. By combining the ankle rocker and shin roll, the cue 'Rock n Roll' offers a catchy association for practitioners. The framework helps improving the technical understanding of sprint acceleration and can be used as a template for future research.

1) Charalambous et al. (2011) JSportsSci

2) Jacobs & van Ingen Schenau (1992) JBiomech

3) Alt et al. (2022) SportsBiomech

4) King et al. (2023) JSportSci

Oral presentations

OP-AP31 Ageing and Training

EFFECTS OF INSPIRATORY MUSCLE TRAINING AND NORDIC WALKING ON STRENGTH AND BALANCE: A PILOT STUDY

ROLDAN, A.1, FERRARO, F.V.2, MARCO-BARRIGUETE, I.1, MONFERRER-MARIN, J.1, MONTEAGUDO, P.1,3, CORDELLAT, A.1, DIAZ-MARTINEZ, A.S.1, GONZALEZ, R.4, BLASCO-LAFARGA, N.M.1,4, MIR, C.4, NAVARRO-PEREZ, J.5

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Blasco-Lafarga, C.1

INTRODUCTION: Coordination of the diaphragm with abdominal muscles increases intra-abdominal pressure, favoring trunk stabilization, which helps to maintain postural stability in situations of destabilization by external forces or during reactive or dynamic tasks (1). Impaired diaphragm functionality is associated with impaired balance (2), which may increase risk of falls in elderly population, who also tend to have reduced inspiratory muscle strength (IMS) (3). Inspiratory muscle training (IMT) is low cost and has proven to be effective in healthy elderly improving IMS and balance (4) but training proposals focused on this population do not contemplate it. Nordic walking (NW) is a good strategy, not only because of the conditional improvements, but also because it could cause greater adherence since it is done outdoors and can even be combined with other training programs (5). Since both programs improve balance and have never been used together, this study aims to analyse changes in IMS and balance, after 8-weeks of NW+IMT program.

METHODS: Forty-nine elderly were recruited from May to December 2022. Eighteen complete final sample and were divided into two groups:sham (69.24±4.59yr;72.32±11.65Kg,n=9) and experimental (68.43±4.33yr;71.03±9.93Kg,n=9). IMT (unsupervised), specifically inspiratory pressure threshold loading, involved 30 inspirations, twice daily, 7 days/week at 50% (experimental) or 15% (sham) of IMS, while NW (supervised) was 1 hr, 3 days/week. S-Index, mini-BEST test, blood pressure and body composition were assessed before and after intervention. To find out differences between groups after intervention, two-way ANOVA repeated measures or Wilkoxon test were used according to the sample normality.

RESULTS: IMS and balance improved in two groups ($p<0.001$ & $p=0.015$) but analysis considering groups only showed significant differences in experimental (IMS:$F=15.957$;$p=0.001$;$\eta 2=0.499$; OP=0.943 & balance:$p=0.020$;ES=0.081).

CONCLUSION: This is the first study combining NW+IMT. Regardless of inspiratory training load, 8-weeks of NW+IMT program are enough to improve IMS and balance, however, considering groups only experimental group improve significantly. NW is known for improving balance and mobility in elderly, so this was expected in both groups. IMS improvement, although not significant in the control group, could be due to a better recruitment of motor units and better coordination of the inspiratory muscles (6). However, in experimental group they are larger and significant, probably because structural adaptations related to the training load also occur. This confirms that improvement in inspiratory strength enhance the effects of NW on balance. Therefore, this combination should be considered as a strategy in prevention of falls, one of the main causes that lead older adults to hospitalization.

1. Oliveira et al. (2023) 2. Kocjan et al. (2018) 3. Lowery et al. (2013) 4. Ferraro et al. (2019) 5. Bullo et al. (2018) 6. Aren & Maestu (2016)

HIGH-VELOCITY RESISTANCE TRAINING IMPROVES THE FORCE-VELOCITY PROFILE OF MIDDLE-AGED AND OLDER ADULTS WITH AND WITHOUT MOBILITY LIMITATION

SCHAUN, G.Z., CSAPO, R., ANDRADE, L.S., DAVID, G.B., HÄFELE, M.S., MENDES, G.F., ALBERTON, C.L.

UNIVERSITY OF VIENNA

INTRODUCTION: The ability to produce muscle power is reflected by the force-velocity (F-V) relationship. Aging is associated with neuromuscular remodeling processes that result in reduced maximum shortening velocity and impaired muscle force. Regular physical exercise can mitigate these effects, but the impact of high-velocity resistance training (HVRT) on the F-V relationship of older individuals remains poorly understood (1). The goal of the present investigation was to assess whether HVRT can improve the F-V profile of different samples of older adults and evaluate the influence of different baseline F-V profiles on training responses and functional capacity.

METHODS: Middle-aged (n=14, 48±5 yrs) and older adults with (n=15, 69±7 yrs) and without (n=7, 76±8 yrs) mobility limitations were included in this study. The participants F-V profiles were determined both before and after a 12-wk HVRT program (3x/wk, 40-60% 1RM) in the leg press exercise using incremental loads ranging between 30-90% 1RM and a linear position transducer. The resultant F-V data points were fitted using linear regressions to estimate the maximal isometric force (F0), maximal unloaded velocity (V0), maximum power (Pmax), as well as the force (Fopt) and velocity (Vopt) at Pmax. Functional capacity was measured using the maximal gait speed (MGS) test. Timepoint x group repeated measures ANOVAs, t-tests, and linear regression models were used for statistical analyses.

RESULTS: All three groups improved Pmax, F0, and Fopt ($p<0.05$), whereas V0 and Vopt remained unchanged. Notwithstanding this, an inspection of the individual F-V curves revealed two major patterns in response to training: an increase in both V0 and F0 or an increase in F0 without changes in V0. A moderate negative correlation ($r=-0.63$, $p<0.001$) was observed between V0 at pre-training and change in V0, suggesting that the slower participants at baseline achieved greater

gains as compared to the faster individuals. This was also supported by comparisons between groups created based on V0 tertiles, which confirmed greater gains in V0 (11±9% vs. -1±10%; p=0.001) in the lowest V0 tertile. In this group, greater gains in V0 also correlated with changes in MGS (r=0.69, p=0.01).

CONCLUSION: Our results show that HVRT improves maximal force and power output in middle-aged and older adults. On average, the power gains were achieved through an increase in force without a concomitant increase in velocity. However, follow-up analyses of individual F-V profiles showed that the training-induced changes in V0 were contingent upon baseline V0 levels, with originally velocity-deficient subjects showing the largest gains (2). Hence, it can be concluded that HVRT improved power output through improvements in F0 in all subjects and gains in V0 in originally velocity-deficient subjects only. In the latter, improving V0 also seemed to influence the transfer of these improvements to functional capacity.

REFERENCES:

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2. Alcazar et al, Exp Gerontol 2018

EFFECTS OF SPATIALLY EXPLORATIVE COGNITIVE-MOTOR TRAINING INTERVENTIONS IN NURSING HOME RESIDENTS ON LIFE SPACE MOBILITY AND SPATIAL ORIENTATION

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INTRODUCTION: Due to multimorbidity, some older persons need to be hospitalized in nursing homes and consequently encounter an unfamiliar environment. Spatial abilities, including orientation in and navigation through the environment, are known to deteriorate with age, especially for unknown locations. This leads to difficulties in exploring the facilities and their surroundings, which often reduces the experienced radius to ones own room and the way to the dining hall, thus also limiting the physical and social interaction possibilities (Schrempft et al., 2019). Since cognitive-motor training counteracting the decline of spatial orientation abilities has been rarely implemented for nursing home residents a three-armed RCT was conducted in 18 German nursing homes.

METHODS: In each nursing home, one of three different intervention approaches were delivered to participating residents for 12 weeks, twice a week for 45 min each: the PROfit basic group performed functional strength, balance, flexibility, and walking exercises always at the same location, whereas the PROfit plus group changed the location three times while performing similar exercises as the PROfit basic group. The PROfit orientation group received environment-related spatial orientation tasks in addition to the relocation. Physical and cognitive functioning (especially spatial orientation) as well as psychological measures were assessed in all study groups at baseline, post-test (after 12 weeks) and follow-up (after 24 weeks). To capture spatial orientation abilities the sequence of landmarks from the residents room to a relevant everyday life location in the immediate vicinity of the facility (radius 300m) was assessed using photos (landmark sequence task). In addition, the caregivers rated the frequency, radius and independence with which the environment was visited in everyday life by applying the Nursing Home Life Space-Diameter (NHLSD).

RESULTS: N=438 nursing home residents (85.5 ± 8.9 years, 74,7 % female) were included in the PROfit project. Since data collection is expected to be completed by May 2023, preliminary data of a subgroup of the sample is currently available. n=115 participants (living in 4 different nursing homes) received either the PROfit basic or the PROfit plus intervention. Analyses of the NHLSD showed a significantly enlarged life space after the PROfit basic intervention (p= .017), but not for PROfit plus. Comparing pre-and post-training data, a positive trend was also discerned for the landmark sequence task in both groups, but no significant increase.

CONCLUSION: The preliminary data partly indicate positive effects with regard to life space and spatial orientation. If the current trend is confirmed for the overall sample, the most effective training should be implemented widely in nursing homes.

Schrempft, S., Jackowska, M., Hamer, M., & Steptoe, A. (2019). Associations between social isolation, loneliness, and objective physical activity in older men and women. BMC public health, 19(1), 1-10.

CAN WE PREDICT MAXIMAL HEART RATE IN OLDER ADULTS?

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INTRODUCTION: Maximal heart rate (HRmax) is commonly used in exercise physiology to define exercise intensity and as a criterion for achieving maximal exertion. Since direct measurement of HRmax is not always practical, prediction equations were developed. However, validation of equations employing a large sample size of older adults is lacking. To the best of our knowledge, no study to date has used SuperLearner (SL) modeling combining base machine-learning algorithms to predict HRmax (pHRmax) using simple physical and physiological inputs. Our study aimed to validate and compare the accuracy of commonly used equations and a SL model to pHRmax in older men and women.

METHODS: Data from 1390 consecutive cardiorespiratory fitness test in older adults using a metabolic cart (MCD Medgraphics, MGC Diagnostics) were analyzed. All tests were done on cycle ergometer (Corival, Lode). To be considered

maximal, all tests had to be fatigue limited and verified with objective measures of conventional maximal exercise criteria (e.g. a plateau in rate of O2 uptake, plateau in HRmax, respiratory exchange ratio >1.1) [1]. A total of 1208 men (62.7%) and women with an average age 61.6±7.3 years meeting these criteria and were included in the analyses. Measured HRmax was compared to pHRmax using the following equations: Fox, Astrand, Tanaka, Gelish and Gulati [1] and a SL model. Pearson correlation and performance indicators such as R2, root mean squared error (RMSE) and Lin's Concordance Correlation Coefficient (CCC) were performed to assess correlation and compare accuracy between measured and pHRmax, while Bland and Altman analyses were used to assess agreement between measured and pHRmax.

RESULTS: Aerobic capacity was higher (33.7±9 vs 27.3±8.2 mlO2.min-1.kg-1; p<0.01) but no difference was observed for HRmax (156.1±14.7 vs 157±13.7 beats per minute (bpm)) in men and women, respectively. All pHRmax-derived equations were positively associated with measured HRmax (0.41 CONCLUSION: Our findings suggest that currently available equations and even a SL model show insufficient accuracy to pHRmax in older adults. Consequently, the use of predictive equations to estimate the level of physical exertion or intensity of exercise in older adults may be inaccurate and requires further investigation.

1. ACSM's guidelines for exercise testing and prescriptions. 11th edition. 2022.

FIFTEEN YEARS OF NOCTURNAL HEART RATE VARIABILITY, A CASE STUDY OF A FOUR-TIME OLYMPIAN

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INTRODUCTION: Heart rate (HR) and heart rate variability (HRV) measurements are used in monitoring athlete's recovery status [1]. Aging is known to decrease, and good aerobic fitness to increase HRV [2], but what happens to HRV of an endurance athlete during a career of four Olympic Games?

METHODS: Subject of this case study was an elite-level race walker (main event 50 km), who recorded his nocturnal RR-intervals (RRI) regularly during his career to monitor his recovery status. RRI recordings were started when going to bed to sleep and stopped after waking up in the morning. RRI recordings were analyzed by using Firstbeat Sports software (ver. 4.7.3.1) and retrospectively studied on yearly basis. Recordings that had less than four hours of clean data were omitted, and 4 242 recordings were included in this study. Lactate thresholds and maximal oxygen uptake (VO2max) were analyzed 2-4 times per year on an indoor track in 7×1000 m test at gradually increasing speed. Annual average HR and HRV indices as well as annual average lactate thresholds and VO2max were further studied in relation to age of the athlete (23-37 yrs). A repeated measures ANOVA with Tukey post-hoc tests were used to detect changes between the years and Pearson's correlation coefficients were used to detect relationships between variables.

RESULTS: Annual average nocturnal HR was found to stay relatively stable, increasing from 51 ± 3 bpm at the age of 23 yrs to 53 ± 2 bpm (p<0.001) at the age of 37 yrs. Much greater changes were seen in HRV indices over the years, as RMSSD declined from 97 ± 10 ms at the age of 23 yrs to 55 ± 6 ms (p<0.001) at the age of 37 yrs. Age was found to correlate negatively with annual average RMSSD (r=-0.962, p<0.001) and positively with HR (r=0.592, p=0.020). No correlation was found between age and VO2max (r=-0.029, p=0.920), but age was found to correlate positively with the speed at first lactate threshold (r=0.661, p=0.007). Speed at first lactate threshold correlated also negatively with RMSSD (r=-0.609, p=0.016).

CONCLUSION: As shown previously in cross-sectional studies [1], gradual decline in nocturnal HRV was also found in present elite athlete between the age of 23 and 37 suggesting reduced vagal activity. Physical fitness has been found to positively correlate with HRV, but in the studied elite athlete, improvement in the speed at the first lactate threshold suggests improvement in physical fitness over the 15 years of follow-up. It seems that for monitoring athlete´s recovery status [2] the reference values of individual HRV indices should be updated on yearly basis.

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Invited symposia

IS-SH05 Virtual Reality Technologies for understanding and improving sports performance

USING VIRTUAL REALITY TO MEASURE PERCEPTION-ACTION DEFICITS POST-CONCUSSION

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To successfully intercept a moving object, a tight link has to exist between what a person sees (perception) and what a person does in response (action). Previous research has shown how concussion, or mild traumatic brain injury, can disrupt perception-action coupling leading to improper motor execution and increased risk of future injury. This talk will show how Virtual Reality can significantly improve on current concussion tests and protocols by providing dynamic decision-making tasks that can detect significant deficits in sensorimotor control 3 to 5 days post-concussion in players who have

passed standard concussion protocols. In short, this talk will demonstrate how Virtual Reality presents a robust, low-cost, portable solution for capturing deficits in sports performance.

VR FOR VISUO-MOTOR SKILL LEARNING: REVOLUTION OR NEVERLUTION?

VINE, S.
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irtual Reality technology and techniques are increasingly being adopted for motor skill learning in sports environments. VR is proposed to provide a way of learning and practising motor skills that overcomes some of the limitations of traditional methods of learning and practise. For example, VR has been proposed to provide practical benefits, such as flexibility and manoeuvrability; pedagogical benefits such as measurement and variety; perceptual motor benefits such as re-enactment of complex sensori-motor couplings, and generation of perceptually complex environments; and psychological benefits such as exposure to distracting and complex environments that often surround the performance of the motor skills. Research is beginning to emerge in support of some of these features...but this research is in its infancy and limited in several ways. First the breadth and depth of the evidence base provided in this space is growing, but is still limited in its ability to enable firm conclusions about the efficacy of VR to be drawn. Second, the research in this space is still relatively rudimentary in terms of research design, data analysis, and theoretical basis. This means that there is very little consensus among researchers about how VR technology and techniques should be assessed; and as such uncertainty among the sporting community about whether VR is a revolution that they want to join, or a short term trend that will not stand the test of time.

This presentation will briefly describe the existing literature relating to applications of VR for visuomotor skill learning, and explore weaknesses or gaps in the literature that need resolving. Suggestions will be made for ways in which the research area should grow, in order to develop a sound evidence base for the assessment of sports VR. An evidence base that will enable clear recommendations to be made to coaches, teams, and governing bodies of sport.

The findings will be discussed in the context of sports skill learning, but also in terms of other features of sports skill training, such as coaching, tactics, or post-match analysis.

VR FOR TRAINING PERCEPTUAL-MOTOR SKILLS OF BOXERS AND RELAY RUNNERS FOR PARIS 2024 OLYMPIC GAMES

KULPA, R.
UNIVERSITY RENNES 2

The revolution in digital technologies, and in particular Virtual Reality, in the field of sport has opened up new perspectives for the creation of new modalities for analysing and training the skills underlying performance. Virtual Reality allows for the standardisation, control and variation (even beyond real conditions) of stimuli while simultaneously quantifying performance. This provides the opportunity to offer specific training sessions, complementary to traditional training ones. In addition, in order to continuously improve, athletes need to train more and more but they reach their physical limits. Virtual Reality can create new training modalities that allow them to continue training while minimising the risk of injury (for example, due to the repetition of high-intensity work in races for a 4x100m relay or due to the impacts of defensive training in boxing). It may also be relevant for injured athletes who cannot physically practise their discipline but need to continue to train perceptually and cognitively by confronting field situations.

In this talk, we will describe how Virtual Reality is effectively implemented in the French Boxing and Athletics federations to train athletes anticipation skills in their preparation for the Paris 2024 Olympic Games. In the 4x100m relay, the teams performance depends in part on the athletes ability to synchronise their movements and therefore initiate their race at the right moment, before the partner arrives in the relay transmission zone, despite the pressure exerted by the opponents. The Virtual Reality training protocols are therefore designed to train each athlete to initiate his or her race at the right moment, with a tireless and always available avatar, based on the motion capture of real sprinters, whose race characteristics can be configured in terms of speed, lane, curvature, gender, etc. In boxing, the federation wants to improve boxers anticipation skills in defensive situations without making them undergo repetitive blows that could injure them, which is impossible in real training. Virtual Reality training protocols allow boxers to focus on the appropriate information on the opponent, which should enable them to anticipate attacks and adopt the relevant parry. In this talk we will therefore show how these different challenges can be addressed in the REVEA project through the deployment of an interdisciplinary research programme.

Oral presentations

OP-PN01 Molecular Biology and Biochemistry

HISTAMINE ORCHESTRATES AN EXERCISE-INDUCED INFLAMMATORY RESPONSE IN THE HUMAN SKELETAL MUSCLE MICROENVIRONMENT DRIVING GLYCOGEN RESYNTHESIS

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<1> GHENT UNIVERSITY, <2> COPENHAGEN UNIVERSITY, <3> ETH ZURICH, <4> GHENT UNIVERSITY

INTRODUCTION: Histamine, a signalling molecule working via specific histamine receptors, promotes the sustained elevation of muscle blood flow after exercise (1). This hyperperfusion could relate to facilitating training adaptations, since we showed that administration of histamine receptor antagonists blunts exercise-induced adaptations in aerobic capacity, insulin sensitivity and microvascular function (1). To further understand the role of histamine during exercise, we determined which cell types within skeletal muscle express histamine receptors. Next, we performed exercise interventions to measure the secretion of histamine from working muscle, and to assess how this contributes to the acute exercise response, with a focus on muscle glycogen metabolism.

METHODS: A single cell RNA-seq dataset was explored to assess expression of histamine receptors in the cell types present in human skeletal muscle. In two independent cohorts each, we measured histamine secretion during one-leg knee extensor exercise into the interstitial space (vastus lateralis microdialysis, n=12M and n=7M) and circulation (femoral arterial-venous difference, n=20F and n=7M). To study the histamine receptor-mediated exercise response, healthy, young volunteers (12M, 2F) performed a high-intensity interval cycling session on 3 different days: placebo, histamine H1-receptor antagonist (540mg fexofenadine) or histamine H2-receptor antagonist (40mg famotidine). Muscle biopsies of the vastus lateralis were collected before exercise, and after 0 and 3 hours of recovery. Muscle glycogen was determined, combined with whole muscle transcriptomics (Gene Set Enrichment Analysis) and phospho-regulation analysis of the insulin signalling pathway by Western blot. Differences over time or between conditions were analysed using a linear mixed model approach.

RESULTS: Histamine H1-receptors were expressed on macrophages and endothelial cells, whereas H2-receptors were expressed on macrophages, neutrophils and smooth muscle cells. In both cohorts, histamine levels into the muscle interstitial space increased during exercise (3.4 and 9.6-fold), but not in the circulation. During the 3h recovery period, glycogen was significantly resynthesized in placebo (+125 mmol/kg, $p<0.001$) and H2-receptor antagonist (+67 mmol/kg, $p=0.041$), but not with H1-receptor antagonist (+25 mmol/kg, $p=0.625$; different from placebo, $p=0.019$). Western blot and transcriptome results indicate that not muscle insulin signalling, but inflammatory signals were blunted, mainly in H1-receptor blockade.

CONCLUSION: We uncover a cell type-specific expression of histamine receptors in human skeletal muscle. The selective release of histamine into the muscle interstitial space indicates an exercise-induced histamine signalling. Collectively, these data suggest a histamine-mediated intercellular crosstalk in the skeletal muscle microenvironment, contributing to the metabolic recovery, such as glycogen resynthesis, after acute exercise.

(1) Van der Stede et al., Sci Adv, 2021

AMINO ACID TRANSPORTERS IN HUMAN SKELETAL MUSCLE ARE CHANGED WITH REGULAR STRENGTH TRAINING IN YOUNG AND OLD ADULTS

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INTRODUCTION: Increased intracellular amino acid availability in skeletal muscle facilitates muscle protein synthesis (MPS). Postprandial availability is dependent on transmembrane bound amino acid transporters (AAT) transporting amino acids from the blood into the cell and dysfunctional AATs may cause attenuated anabolic muscle response to feeding, termed anabolic resistance, in elderly and in sedentary adults. This study aimed to investigate possible differences in AATs in young and older adults and whether regular strength training changes AAT levels and their regulators.

METHODS: Healthy young (n=24, 20-40 yrs) and old (n=24, 70-80 yrs) adults completed a 12-week whole-body strength training intervention (3/week). Before and after the intervention, an acute study with strength exercise and protein intake was performed, lean leg mass (LLM) was measured by dual-energy X-ray absorptiometry, and strength was tested in leg press as one repetition maximum (1RM). Muscle biopsies were obtained from m. vastus lateralis and fractionated and analyzed with western blots in the cytosolic (C), membrane (M) and nuclear (N) fractions for the AATs: LAT1(C), CD98(C,M,N), SLC38A9(M), LAT3(C); and the regulators eIF2α (C,M,N) and ATF4(C,N). Data was analyzed using a two-way ANOVA, and a Pearson R for correlations.

RESULTS: Training increased LLM by ~1kg in both groups ($p<0.001$). 1RM leg press increased more in the young than old (78±32 kg vs 50±20 kg, $p<0.001$). Before training, the old had higher SLC38A9-M levels ($p<0.05$) and lower LAT1-C levels ($p<0.05$) than young. Training increased CD98-N by 59±97% in the young ($p<0.01$), ATF4-N by 191±362% in the old ($p<0.05$) and eIF2α-N levels in both groups (young: 41±67%, old:65±101%, $p<0.05$) which led to higher eIF2α-N levels in the old than young ($p<0.05$). In untrained state, exercise decreased eIF2α-N ($p<0.01$) and LAT1-C ($p<0.01$) in the young

group. In trained state, exercise increased eIF2α-N ($p<0.01$) and decreased ATF4-N ($p<0.05$) in the old and both groups decreased ATF4-C ($p<0.05$). The protein levels of LAT3-C did not change, and no differences were found between the groups in relative changes for any protein. After training and in relative changes, SLC38A9-M correlated with eIF2α-M ($r=0.57$, $p<0.05$) in the young and with LAT3-C ($r=0.64$, $p<0.05$) in the old. In relative changes, LAT1-C further correlated with ATF4-C in the old ($r=-0.61$, $p<0.05$) after training, and ATF4-N correlated with eIF2α-C ($r=0.76$, $p<0.001$) in the young and with eIF2α-N in both groups (young: $r=0.73$, old: $r=0.77$, $p<0.001$).

CONCLUSION: Strength training increased muscle mass and strength which were accompanied by increased eIF2α-N for both groups, ATF4-N in old and CD98-N in young. The differences between young and old adults in SLC38A9-M and LAT1-C was abolished after the training, but a difference between the groups in eIF2α-N levels emerged after the training. The observed changes in AATs and regulators may influence training adaptations, and regulation of amino acid uptake

INGESTION OF AN ANTI-LIPOLYTIC DRUG ALTERS WHOLE-BODY SUBSTRATE UTILISATION DURING BRISK WALKING EXERCISE IN OBESE INDIVIDUALS, BUT DOES NOT ALTER MUSCLE DIACYLGLYCEROL AND CERAMIDE CONCENTRATIONS

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INTRODUCTION: Exercise increases turnover of the skeletal muscle lipid pool and enhances storage of fatty acids as intramuscular triglycerides (IMTG) in healthy individuals. In contrast, obese individuals have lower rates of IMTG turnover, even during exercise, leading to the accumulation of diacylglycerols (DAGs) and ceramides (Cer) and the development of insulin resistance. Ingestion of an anti-lipolytic drug prior to exercise reduces plasma free fatty acid (FFA) concentrations and increases IMTG utilisation during exercise. The aim of the current study was to investigate whether suppression of plasma FFA concentrations during and in the hours following exercise leads to alterations in muscle Cer and DAG species in obese individuals.

METHODS: Ten obese (BMI >30 kg.m-2) sedentary individuals performed two separate 45-minute treadmill walking trials at 45% VO2max followed by 3 hours recovery. For one trial, participants ingested the anti-lipolytic drug, Acipimox (250 mg), 1-hour before and again immediately post-exercise. During the other trial nothing was ingested. Muscle samples were obtained at baseline, immediately post-exercise, and after 3-hours of recovery. Serial blood samples were taken throughout. Muscle samples were analysed by liquid chromatography tandem mass spectrometry for lipids.

RESULTS: Plasma FFA concentrations were lower in the Acipimox trial compared to control ($P<0.05$). Mean carbohydrate oxidation rates during exercise were greater in the Acipimox trial (1.21 ± 0.46 g.min-1) compared to the control trial (1.01 ± 0.38 g.min-1; $P=0.002$) and mean fat oxidation rates were significantly greater in the control trial (0.38 ± 0.10 g.min-1) compared to the Acipimox trial (0.28 ± 0.07 g.min-1; $P=0.009$). Total DAG or ceramide concentrations did not change during exercise or during recovery ($P=0.34$). No changes in Cer species were observed in either condition. The concentration of glucosylceramides 24:0 and 24:1 were both increased immediately following exercise in both conditions. Total lactosylceramide (LacCer) concentrations were significantly increased by exercise, as were the species LacCer 20:0, LacCer 22:0, and LacCer 24:0. However, no differences between conditions were apparent. Notably, exercise-induced increases in concentration of LacCer species appeared to be sustained following 3 hours of recovery.

CONCLUSION: Here, ingestion of an anti-lipolytic drug suppressed plasma FFA concentrations and altered whole-body substrate utilisation during 45 min of brisk walking in obese individuals. Although no changes in Cer were seen during exercise and recovery in either condition, we speculate that both the rate of synthesis and degradation of Cer and GluCer is being increased by exercise, resulting in greater formation of LacCer. Ongoing transmission electron microscopy analysis to measure subcellular lipid droplet content and morphology will reveal further insight on the effect of Acipimox on turnover of the IMTG pool during exercise.

DICLOFENAC DIFFERENTIALLY REGULATES MUSCLE MRNA EXPRESSION LINKED TO LIPID METABOLISM DURING RESISTANCE EXERCISE TRAINING IN HEALTHY VOLUNTEERS, BUT HAS NO IMPACT ON IMCL CONTENT

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INTRODUCTION: Diclofenac is a non-steroidal anti-inflammatory drug reported to be used off-label to enhance athletic training adaptation [1]. In vitro evidence shows that diclofenac binds to, and activates, peroxisome proliferator-activated receptor gamma (PPAR-gamma). This, alongside the activation of PPAR-gamma Coactivator 1a (encoded by PPARGC1A), upregulates the expression of mRNAs associated with lipid metabolism [2]. The impact of diclofenac administration on in vivo lipid metabolism remains largely unexplored. This study investigated the impact of diclofenac administration on intramyocellular lipid (IMCL) content and the expression levels of muscle mRNAs in healthy volunteers over the course of a 12-week resistance exercise training intervention.

METHODS: Following informed consent and screening, 17 young, healthy, exercise-trained males were allocated to Diclofenac (75mg diclofenac sodium daily; n=9; 25 ± 4 years; 24.8 ± 2.7 kg/m²) or Placebo (n=8; 24 ± 5 years; 23.5 ± 2.5 kg/m²) groups. Groups were matched for isometric leg strength, age, and BMI at baseline. All participants performed 5x30 sets of maximal isokinetic (90 degrees/s) knee extensions, with the non-dominant leg, 3x weekly over 12 weeks. Fasted state Vastus Lateralis muscle biopsies were obtained before and after 1, 7, 28, and 84 days' training, and were analysed for IMCL content (histochemical determination) and the expression levels of 93 targeted muscle mRNAs using

RT-PCR and microfluidic gene cards [3]. Two-way repeated measures ANOVA was used to identify differences in IMCL content between the groups across time points, and Ingenuity Pathway Analysis (IPA) was used to identify gene networks and metabolic predictions related to lipid metabolism.

RESULTS: IMCL content was no different between the groups at baseline (7.4 ± 3.8% Placebo vs. 6.9 ± 2.6% Diclofenac, mean ± SD), and no time/treatment interactions with resistance exercise training were observed (eta²p=0.07). IPA predicted robust activation of cellular events regulating lipid metabolism in both groups over the initial 28 days of training. However, by day 84, this previously predicted activation was no longer evident in the Placebo group. In keeping with this, PPARGC1A mRNA expression at day 84 in the Placebo group was less compared to baseline ($p<0.001$), but conversely greater than baseline in the Diclofenac group ($p<0.001$).

CONCLUSION: Diclofenac administration differentially altered the mRNA expression of genes regulating muscle lipid metabolism following 84 days of resistance exercise training in humans. Furthermore, the increased expression of PPARGC1A mRNA in the Diclofenac group implicates a mechanism by which diclofenac binds to PPAR-gamma in vivo and activates lipid metabolism cellular events. These responses were not associated with changes in IMCL content.

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PHYSICAL CONDITION AND ACTN3 RS1815739 AND TFAM RS1937 POLYMORPHISMS IN SPANISH CHILDREN. THE UP&DOWN STUDY

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INTRODUCTION: Physical condition (muscular strength and power, cardiorespiratory fitness) plays an important role in the health status of individuals and may be genetically determined from childhood. Some genes have been associated with these traits. These include the gene coding for sarcomeric protein alpha actinin 3, ACTN3 gene, and the gene coding for the mitochondrial transcription factor, TFAM gene. Genetic polymorphisms associated with strength and power (ACTN3 rs1815739) and endurance (TFAM rs1937) have been described in both genes in the adult population. The information available regarding the relation between physical condition and genetics in paediatric population is still scarce and poorly understood.

For this reason, the aim of this study was to determine the potential interactions between the ACTN3 rs1815739 and TFAM rs1937 polymorphisms, and the physical condition in Spanish children from the UP&DOWN study (1).

METHODS: 539 children (271 girls) aged between 5 and 12 years (mean=8.25±1.68 years) from the UP&DOWN study were analysed. The following variables were measured in order to collect data of upper- and lower-limb strength, aerobic capacity and motor ability: handgrip strength dynamometry, standing long jump test, 20m track shuttle run, 4x10m shuttle run test. ACTN3 rs1815739 and TFAM rs1937 polymorphisms genotypes were analyzed using Applied Biosystems™ Taqman probe (ID: C_590093_1_ and C_8975662_10 ID, respectively). Physical condition variables were compared to the ACTN3 and TFAM polymorphisms by ANOVA and T test for parametric and Kruskal-Wallis for non-parametric variables.

RESULTS: For ACTN3 rs1815739 analyses, children with TT genotype presented significantly higher results at the standing long jump test than the children with CC and TC genotypes (110.19±19.87 cm vs. 105.22±18.69 cm, p=0.037, Cohen's d= 0.254). We also found significant differences for the TFAM rs1937 genotypes: children with GG genotype showed lower results for 20m track shuttle run compared with children with CG and CC genotypes (2.51±1.46 vs. 3.55±1.42, respectively; p=0.017; Cohen´s d= 0.71).

CONCLUSION: Although calculated effect size was low, the results obtained for ACTN3 rs1815739 polymorphism are contrary to literature, the C allele being generally related to muscular strength and power in adult population. ACTN3 is a protein specific to type II fibers, thus, the differences in muscle fibers proportions and maturation state in children compared to adults, could explain our results. In the case of TFAM rs1937 polymorphism, our results (presenting moderate-high effect size) are consistent with previous knowledge in adult population: C allele is associated with long distance exercise performance and better aerobic capacity. Therefore, it seems genetic factor could play an important role in cardiorespiratory fitness from childhood through the regulation of mitochondrial transcription.

(1) Castro-Piñero J et al. BMC Public Health. 2014;14:400.

Oral presentations

OP-AP32 Running: Training and Testing

EFFECTS OF A 7-DAY HIIT SHOCK MICROCYCLE WITH OR WITHOUT ADDITIONAL LOW-INTENSITY TRAINING ON MAXIMAL OXYGEN UPTAKE AND TIME TRIAL PERFORMANCE – RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: High-intensity interval training (HIIT) shock microcycle (SM, i.e., multiple HIIT sessions in a short period of time) appears effective for improving endurance parameters. However, whether HIIT-SM leads to improvements in maximal oxygen uptake (VO2max) [1, 2], or not [3, 4], is controversial. Further, the effect of additional low-intensity training (LIT) during HIIT-SM on VO2max and the transfer of lab-based effects on time trial (TT) performance has not yet been investigated. Therefore, the aim of this study was to assess the effect of HIIT-SM with or without additional LIT on VO2max and TT performance.

METHODS: Thirty trained endurance athletes (7 women, 23 men) performed a sub-maximal incremental and maximal ramp test running on a treadmill to determine VO2max and maximal heart rate (HRmax) (T1). Participants were then randomly assigned to one of three groups: 1) HIIT-SM=10 running-based HIIT sessions, i.e., 5x4 min at 90-95% HRmax, over 7 days 2) HIIT-SM+LIT=equal to HSM with additional 30-min of LIT after each HIIT 3) CON=regular training. Physiological exercise testing was repeated on 3 days (T2), 7 days (T3), and 14 days (T4) after the intervention. A 5-km TT (5kmTT) was performed 3-4 days before T1 and 10-11 days after the intervention. Between-group differences were analyzed using a linear model (ANCOVA) with pre-test values as the covariate, group as the fixed factor, and each post-test as the dependent variable. Independence of the covariate was tested with ANOVA. Effect sizes (ES) are expressed as partial eta-squared. Within-group comparisons between pre-test and each post-test were done using paired sample T-test. Level of significance was set at $P<0.05$.

RESULTS: VO2max at T1 was 60.3±6.9, 60.3±5.2 and 59.5±2.6 mL/min/kg for HIIT-SM, HIIT-SM+LIT and CON, respectively, with no differences between groups (P=0.92 ES=0.01). No between-group differences in VO2max at T2 (+0.8%, -0.4%, -1.1%; P=0.67; ES=0.03), T3 (+1.6%, +2.0%, -4.6%; P=0.053; ES=0.20), and T4 (+1.5%, +1.9%, -2.6%; P=0.30; ES=0.09) could be observed. There were no within-group changes in VO2max for all three groups. Mean pre-test 5kmTT was 19:31±2:27, 19:14±1:36, and 18:58±1:26 min, respectively, with no difference between groups (P=0.82; ES=0.02). No between-group differences in 5kmTT at the post-test (-2.5%, -2.1%, +0.0%; P=0.14; ES=0.14) could be observed. Within-group improvements were revealed for HIIT-SM (P=0.046) and HIIT-SM+LIT (P=0.03).

CONCLUSION: Both 7-day HIIT-SM with or without additional LIT had no effect on VO2max in endurance trained athletes. No effects in 5kmTT could be observed, despite within-group improvements in both intervention groups. HIIT-SM with or without additional LIT may influence other endurance performance-related parameters.

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LACTATE THRESHOLD IN ELITE RACE WALKERS – DESCRIPTIVE STUDY OF DEVELOPMENT RATES AND ASSOCIATED TRAINING

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INTRODUCTION: The lactate threshold (LT) is one of the most important physiological factors in race walking. However, research concerning the development of this factor and the associated training in elite race walkers is limited [1]. Therefore, the aim of this descriptive study was to determine the development of LT for different training phases of elite race walkers and to describe the realised training.

METHODS: The study is based on retrospective data from 1992 to 2018, collected at the Institute of Applied Training Science in Leipzig. The athletes included in the study were members of the German national team and competed at international level. To determine the LT, athletes completed a step test on the treadmill (4-6x 3000 m, increments: 0.2 m/s, rest duration: 60 s). LT was defined as the velocity where the lactate-velocity-curve crossed 3.0 mmol/l lactate. Furthermore, training data were collected with a standardized diary and processed in an Access database. Male athletes with an age of at least 22 years and a baseline LT of at least 3.6 m/s were included. The development of LT and the average training were investigated for three training phases (P1: preparation phase 1 from Nov/Dec to Jan/Feb, P2: preparation phase 2 from Jan/Feb to Mar/Apr, P3: competition phase from Mar/Apr to June/July). All data are given as mean ± standard deviation.

RESULTS: 33 training phases of 14 athletes with a baseline LT of 3.85 ± 0.12 m/s, an age of 27.2 ± 3.0 years and a duration of 7.4 ± 1.8 weeks were selected for P1. The development of LT within P1 is 0.06 ± 0.10 m/s. The average training includes a training volume of 131.1 ± 43.2 km/week (walking and running), 8.6 ± 1.6 sessions/week (including strength and general endurance training) and an active training time of 12.1 ± 3.4 h/week. The average proportion of training volume near and above the LT (including competitions) is 17.3 ± 14.4 %. Regarding P2, 23 training phases of 9 athletes with a baseline LT of 3.83 ± 0.11 m/s, an age of 27.0 ± 3.0 years and a duration of 9.6 ± 1.4 weeks were analysed. LT increases by 0.04 ± 0.09

m/s. Training consists of 159.5 ± 36.5 km/week, 9.4 ± 1.5 sessions/week, 12.9 ± 2.8 h/week and a proportion of intensity training of 24.8 ± 17.0 %. Finally, 23 training phases of 11 athletes with a baseline LT of 3.92 ± 0.10 m/s, an age of 25.3 ± 1.7 years and a duration of 16.6 ± 2.3 weeks were selected for P3. LT development is 0.04 ± 0.12 m/s. Training includes 122.7 ± 32.4 km/week, 8.1 ± 1.1 sessions/week, 10.5 ± 2.8 h/week and intense walking of 18.9 ± 15.5 %.

CONCLUSION: The mean changes of LT seems small, but individual ranges of -0.17 to 0.31 m/s have to be considered. This study offers coaches a reference for the development of the LT and the associated training in elite race walkers. Further studies should investigate the statistical relation between changes of LT and different training parameters as well as the baseline LT.

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THE EFFECT OF A SLEEP HYGIENE INTERVENTION ON COGNITIVE PERFORMANCE IN A 24H ULTRA-MARATHON RACE

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INTRODUCTION: Ultra-marathons, endurance running events exceeding the 42.2 km distance of a traditional marathon, are increasing in popularity. Of concern, they often involve at least one night of sleep deprivation, which has been demonstrated to impair cognitive performance, particularly reaction time and executive function1. This study aimed to determine if a sleep intervention, implemented in the week prior to a 24h ultra-marathon, would reduce the impairment in cognitive performance after the race.

METHODS: Using a randomised controlled parallel-group design, 16 athletes (14 males, 2 females; mean±SD: age 45±7 years; height 1.77±0.05 m; mass 76.7±11.2 kg) undertook the ContiThunderRun, a continuous 24h race around a 10km loop. Sleep duration and efficiency was recorded at baseline (3-4 weeks prior to the race) and pre-race (7-days prior) using wrist-worn accelerometers (GENEActiv) with validated raw acceleration thresholds. The sleep intervention (INT) group received an online sleep hygiene seminar, aimed at improving the quality of sleep by promoting specific pre-bed behaviours2. The comparison group (COM) were instructed to sleep as they normally would pre-race. After familiarisation, Two Choice Reaction Time (2CRT) and response inhibition (Stroop task) were assessed pre- and post-race. Data were analysed using a repeated measures ANOVA and significance was accepted at $P<0.05$.

RESULTS: Due to drop-out, 14 participants were included in the final analyses [7 INT, 7 COM group; 2 females, 12 males; mean distance covered 123±35 km]. There were no significant effects of the sleep hygiene intervention nor any difference between the baseline and pre-race weeks for sleep duration [mean±SD, 394±22 vs 385±59 min, p=0.59] and efficacy [mean±SD, 89±4 vs 88±5 %, p=0.35]. Similarly, there was no main effect for intervention or intervention*time interaction (all $p > 0.05$) on any aspect of cognitive performance. However, there was a significant deterioration in cognitive performance post-race, with reaction time increasing [462±54 vs 520±108 ms; p=0.02] throughput (number of correct responses per min) reducing in the 2CRT task [124.5±15.4 vs 112.1±20.1; $p<0.01$] and the interference score in the Stroop task reducing [19.9±11.0 vs 15.1±6.2; p=0.02].

CONCLUSION: This study demonstrated that cognitive performance was impaired post-race; however there was no evidence that these effects were ameliorated by the intervention, which had no impact on either sleep duration or efficacy. The lack of effect may be, in part, explained by a summer heatwave (~40oC in London) coinciding with the week preceding the race (i.e. during the intervention), which could have impacted the effectiveness of the intervention. Further research investigating the impact of pre-race sleep strategies on cognitive performance during ultra-marathons is therefore required.

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EFFECTS OF NEUROMUSCULAR ELECTRICAL STIMULATION ON WINGATE TEST AND BLOOD LACTATE ACCUMULATION

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INTRODUCTION: It is well-known that sprint interval training (SIT) can improve aerobic and anaerobic exercise performance [1] and these improvements were associated with changes in lactate kinetics by SIT [2]. Because subtetanic neuromuscular electrical stimulation (NMES) with voluntary exercise (VOLES) does not increase fatigue despite promoting blood lactate accumulation [3], it may be an excellent approach for effective SIT. Elucidating how VOLES affects blood lactate accumulation after sprint training is essential to identify a purposeful application of NMES to SIT. Thus, we hypothesized that NMES with voluntary exercise could maintain 30-sec "all-out" exercise, i.e., Wingate test performance but augment blood lactate accumulation.

METHODS: Fifteen healthy young males (mean ± standard deviation, age: 23 ± 4 yrs, body mass index: 22.0 ± 2.1 kg/m2) volunteered for two trials on a separate day (randomized crossover study). After a 1-min resting baseline, participants performed a 3-min intervention: VOLES (NMES with free-weight cycling) or voluntary cycling alone, which matched oxygen uptake with VOLES (VOL, 43.6 ± 8.0 W). Then, they performed the Wingate test with 30-min free-weight cycling recovery.

The blood lactate concentration ([La]b) was assessed at the end of resting and intervention, and recovery at 1, 3, 5, 10, 20, and 30 min. The paired t-test was used to assess the performance of the Wingate test as well as effect sizes expressed as Cohen's d, and two-way analysis of variance was used to evaluate the [La]b between condition (VOLES vs. VOL) and time (resting vs. intervention vs. recovery) as well as effect sizes expressed as partial eta-squared. Bonferroni-corrected post-hoc procedures were used when applicable. A P-value of < 0.05 was considered significant.

RESULTS: [La]b during intervention was significantly higher in VOLES than in VOL (2.2 ± 0.5 vs. 1.6 ± 0.3 mmol/L, P=0.011, effect size = 0.402). The increase in [La]b after the Wingate test was maintained for longer in VOLES than in VOL at 10- and 20-min recovery (10-min, 14.0 ± 2.1 vs. 13.0 ± 1.5 mmol/L; 20-min, 10.6 ± 2.1 vs. 9.1 ± 1.9 mmol/L. P=0.014 and 0.023, effect size = 0.380 and 0.339, respectively). Based on the Wingate test, performance was similar between VOLES vs. VOL: peak power (686 ± 127 vs. 691 ± 125 W, P=0.184, effect size = 0.040), mean power (529 ± 81 vs. 534 ± 83 W, P=0.201, effect size = 0.061), and the rate of decline (35.6 ± 13.5 vs. 37.4 ± 11.3%, P=0.989, effect size = 0.145).

CONCLUSION: NMES with voluntary exercise did not impair Wingate test performance but sustained blood lactate accumulation for longer than with voluntary exercise alone during recovery. These results set the stage for future research on developing a new strategy for sprint interval training programs that promote more potent physiological stimuli without reducing exercise intensity by employing NMES.

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Invited symposia

IS-MH01 The IOC Consensus Statement of Relative Energy Deficiency in Sports (REDs) - 2023 update

ADVANCES IN THE FIELD OF REDS SCIENCE

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The causal role of low energy availability (LEA) in the aetiology and pathophysiology of REDs is well-established. However, most of the underlying data on the effects of LEA on endocrine and physiological outcomes stem from laboratory experiments involving strict manipulation of dietary energy intake and exercise expenditure. While these seminal studies have contributed immensely to our understanding of human energetics in the context of exercise, they focused largely on outcomes related female reproduction and bone health, were conducted in predominantly sedentary populations, and involved only short-term (<1 week) manipulations of diet and exercise.

However, with the inclusion of additional physiological and psychological outcomes as well as other populations into the REDs model, there has been growing body of laboratory and field studies investigating the effects of LEA on numerous other functions and outcomes related to health and performance. These include, but are not limited to, growth and adaptation, inflammation, substrate storage and utilisation, gastrointestinal issues and haematological aspects as well as potential sex- and age-related differences in the response to LEA, including thresholds for tolerable LEA doses. With growing evidence from observational and intervention studies, a clearer picture has emerged on the time course of physiological and psychological maladaptations in response to LEA, which can range from days to weeks (acute) to months to years (prolonged).

Furthermore, there is also growing evidence that not only LEA but also the pathway to LEA, i.e., whether it is achieved by dietary restriction, increased exercise, or a combination of both, may module a variety of physiological and psychological outcomes. The latter is particular relevant in light of the shared pathways between REDs and overreaching and overtraining syndrome (OTS), which require particular diagnostic attention.

Beyond energy availability, recent studies involving the deliberate manipulation of both energy and macronutrient availability have also highlighted the potentially amplifying role of low carbohydrate availability on specific physiological outcomes, such as bone health, inflammation and iron homeostasis.

THE NEW REDS CONCEPTUAL AND PHYSIOLOGICAL MODELS FOR HEALTH AND PERFORMANCE

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The current evolution of REDs encompasses the principle that although the accommodation of acute and mild LEA is to some extent, normal and advantageous, in some scenarios and individuals, it disrupts health and performance. The new REDs health and performance conceptual models demonstrate the range of body systems for which there is theoretical, empirical and/or clinical evidence of impairments that manifest in different ways. Undoubtedly, these outcomes occur over different timeframes, and with different levels of severity and significance to the individual athlete due to myriad moderating factors. The concept of the LEA threshold (i.e. 30 kcal/kg FFM/d), below which health problems occurred, was

based on elegant but short-term laboratory studies which investigated step-wise changes in EA and perturbation of hormones involved in the female reproductive system. Although this concept was always intended as a guide rather than a diagnostic end-point, more recent information gleaned from real-life clinical observations, as well as theoretical constructs around the frailty of a single, universal threshold, have identified large differences in the EA level apparently associated with health and performance concerns between individuals and between different body systems. Therefore, although EA calculations may inform research interventions or observations, there is danger in setting quantitative definitions of absolute concerns. While the conceptual models provide a simple education message for athletes, coaches and clinicians, the development of a more complex physiological model for the interaction of LEA each body system is encouraged. This should be undertaken with a "systems biology mindset" to enable a more nuanced assessment of the individual athlete and whether their specific exposure to LEA and the presence of secondary moderators (e.g. genetics, training characteristics, other nutritional issues, medication) is likely to be positive, neutral or negative in regard to functional outcomes. The evolution of the science and practice of REDs requires an interdisciplinary field of study, that can integrate complex biological interactions to understand real-life outcomes.

PREVENTION AND TREATMENT OF REDS

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It is undeniable that severe and/or prolonged low energy availability (LEA) and REDs are common among both female and male athletes at different performance levels and may result in serious health (e.g. eating disorders and premature osteoporosis) and performance (e.g. injuries) consequences. Therefore, there is an emerging need to prevent the development of LEA and REDs.

This lecture targeting the athletes' entourage such as sport organisations, coaches and sport medicine clinicians will focus on the IOC recommendations regarding primary and secondary prevention strategies of REDs as well as treatment.

LEA is the underlying etiological factor of REDs, and primary prevention focusing on modifying risk factors for LEA within the sport environment is the best way to preserve health and improve performance among athletes. Primary prevention strategies should target athletes as well as their support team and focus on education of the importance of adequate energy and nutrient availability to ensure optimal health and performance. Furthermore, the educational programs should aim to improve e.g. self-esteem, and acceptance of physical changes related to adolescence, and reduce risk factors, especially de-emphasising the importance of a low body mass and leanness, particularly in young and sub-elite athletes.

Secondary prevention involves identification of REDs symptoms, using early treatment initiatives, prior to development of clinical diagnoses. Secondary prevention therefore includes screening and management of asymptomatic or symptomatic symptoms, including the new REDs Clinical Assessment Tool (CAT2) three-step approach. Self-reported screening instruments, individual health interviews, and objective assessment of REDs markers may be useful in this prevention phase.

The objective of clinical treatment (tertiary prevention) is to promote rehabilitation and to limit long-term, severe health and performance consequences of REDs. Before commencing a treatment program, accurate diagnosis is essential to tailor the treatment to the clinical presentation. Intervention at an early stage in the clinical presentation is desirable to minimise severity of health outcomes of REDs and expedite recovery. The cornerstone of therapy is to treat the underlying cause: LEA. Reversing the LEA can be achieved by decreasing energy output, increasing energy intake, or both in concert. A multidisciplinary treatment team is often required including clinicians specialising in sport medicine, sport dietetics, psychiatry/psychology, exercise physiology, endocrinology and gynaecology.

Oral presentations

OP-MH06 Obesity

EFFECTS OF HIGH INTENSITY INTERVAL TRAINING AND MODERATE INTENSITY CONTINUOUS TRAINING ON CARDIAC FUNCTION IN OBESE YOUNG WOMEN

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INTRODUCTION: Obesity is an independent risk factor for cardiovascular diseases [1]. Both high intensity interval training (HIIT) and moderate intensity continuous training (MICT) have been shown to be equally effective for reducing whole-body fat mass in obese individuals [2]. However, the acute and chronic effects of HIIT and MICT on cardiac function have not yet been properly investigated [3]. Therefore, the aim of this study was to investigate the acute and chronic effects of HIIT and MICT on cardiac function in young obese women.

METHODS: Forty obese women completed this two-phase randomized controlled trial. In the first phase (acute protocol), 15 individuals performed a single bout of HIIT (4x4-min at 85-95% of maximal heart rate (HRmax)), MICT (41-min at 65-75% of HRmax), and control condition (CO). Data were collected at baseline and five (t5) and 35 (t35) minutes after each condition. In the second phase (chronic protocol), 25 individuals completed an eight-week HIIT or MICT protocol, being assessed at

baseline and after the exercise program. Anthropometric, body composition, cardiorespiratory fitness and cardiac function were evaluated.

RESULTS: Acute reductions in global longitudinal strain (GLS) (p=0.010; p=0.002), LV ejection fraction (LVEF) (p=0.017; p=0.010), LV end-diastolic volume (LVEDV) (p=0.001; p=0.048) were observed after HIIT at t5 in relation with baseline values and CO, respectively. GLS also reduced in comparison to MICT at t5 (p=0.013). E/A ratio decreased after HIIT in comparison to baseline (p= 0.001; p=0.001), CO (p<0.001; p=0.001) and MICT (p=0.027; p=0.008) at t5 and t35, respectively. Chronically, HIIT and MICT increased GLS (p=0.016; p=0.023), LVEDV (p=0.005; p<0.001) and stroke volume (p<0.001; p<0.001), respectively. Only HIIT increased LVEF (p=0.012) after the 8-week exercise program.

CONCLUSION: HIIT induced an acute reduction in LV function five minutes after exercise that were almost fully restored 35 minutes after HIIT performance. Chronically, both HIIT and MICT elicited similar improvements in LV function, but only HIIT enhanced LVEF, an important marker of LV systolic function in young obese women.

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SERUM METABOLOME ADAPTATIONS ASSOCIATED WITH MUSCULAR STRENGTH FOLLOWING 12 WEEKS OF HIGH-INTENSITY INTERVAL TRAINING IN OBESE OLDER ADULTS

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INTRODUCTION: One of the major adverse health effects of aging is the loss of muscle strength. As a standard clinical measure, it has been proposed that handgrip strength may be a marker of frailty assessment. The loss of muscle strength becomes much faster than the loss of muscle mass in older individuals, resulting in a decline of muscle quality. In addition to that, age and body fat have been shown to be inversely associated with muscle strength and quality. Therefore, preventing fat gain and preserving lean mass in obese individuals becomes an important issue. High-intensity interval training (HIIT) has been shown as an effective intervention strategy for obese older individuals. Hence, revealing possible mechanisms underlying the changes of muscular strength parameters would be of interest. The aim of this study was to evaluate serum metabolome changes related to muscular strength parameters changes after 12 weeks of HIIT in obese older adults.

METHODS: Twenty-six participants performed HIIT, (67.73 ± 3.87 yrs) three times per week for 12 weeks. Serum metabolome profile as well as clinico-biological parameters were assessed before and after the 12-week intervention. Blood serum samples were subjected to multiple different liquid or gas phase chromatography methods coupled to mass spectrometry.

RESULTS: Among the 364 metabolites and ratio of metabolites identified, 21 metabolites changed significantly following the 12-week HIIT intervention. Out of these metabolites, acyl-alkyl-phosphatidylcholine (PCae) (22:1) delta changes, a metabolite of the fat metabolism, significantly correlated with handgrip strength ($r = 0.52$, $p < 0.01$) delta changes, as well as with handgrip strength relative to arms lean mass delta changes ($r = 0.54$, $p < 0.01$) in the HIIT group.

CONCLUSION: Metabolites of the fat metabolism could play an important role in preserving muscular strength. The metabolite PCae (22:1) could be considered as a metabolite of interest for muscular strength, and hence for a healthy aging. Future studies are needed to confirm our promising results, thus allowing the development of therapeutic interventions for preserving muscular strength, and hence contributing to a healthy aging.

LEFT VENTRICULAR AND HEMODYNAMIC ADAPTATIONS FOLLOWING TWO WORKLOAD-MATCHED HIGH-INTENSITY INTERVAL TRAINING PROGRAMS WITH DIFFERENT BOUT DURATION IN OBESE MEN

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INTRODUCTION: High-intensity interval training (HIIT) is a time-saving training strategy that provides at least similar benefits, in terms of cardiometabolic risk reduction, with moderate-intensity continuous training in the general population [1]. However, studies examining the effectiveness of different HIIT formats on cardiovascular health in obese adults are rather limited. The present study compared the effects of two workload-matched HIIT programs with different bout duration (10 vs. 60 s) on cardiorespiratory fitness and left ventricular structure and function in obese men.

METHODS: Sixteen untrained obese men (aged 38.9 ± 7.3 y) were randomly assigned to either a HIIT10 group, i.e., 48 bouts of 10 s at 100% peak power output (PPO) interspersed with 75 s at 15% PPO, or HIIT60 group, i.e., 10 bouts of 60 s at 100% PPO interspersed with 75 s at 15% PPO. Participants performed eight weeks of supervised training (24 sessions) on an electronically braked cycle ergometer. Before and after the training intervention, peak oxygen uptake (VO2peak) was assessed by an incremental cycle ergometer test and lactate threshold was estimated from a 5-stage submaximal test. Plasma volume changes were calculated from hematocrit and hemoglobin values measured in venous blood collected at rest before the first and last training sessions. Resting left ventricular (LV) function was assessed pre- and post-training using two-dimensional and Doppler echocardiography.

RESULTS: Analysis of variance showed a main effect of time ($p < 0.05$) and no effect of group or interaction ($p > 0.05$) in the examined parameters. Resting systolic and diastolic blood pressure decreased by 2.8 mmHg (90%CI: -4.5 to -1.1 mmHg; $p = 0.009$) and by 2.1 mmHg (90%CI: -3.5 to -0.6 mmHg; $p = 0.019$), respectively. There was an increase in ejection fraction by 3.2% ± 1.3% ($p < 0.001$) from pre- to post-training. This was accompanied by an increase in LV end-diastolic volume by 7.9% (or 8.3 mL, 90%CI: 3.9 to 12.8 mL; $p = 0.003$), and a decrease of LV end-systolic volume by 4.8% (or -2.1 mL, 90%CI: -3.4 to -0.8 mL; $p = 0.007$). Resting stroke volume increased by 10.0 ± 7.4 mL (from 82.3 ± 14.7 to 92.2 ± 14.0 mL, $p < 0.001$). VO2peak increased by 10.9 ± 6.1% on week 4 and by 20.0 ± 7.2% on week 8 ($p < 0.001$). Lactate threshold increased from 55.6 ± 7.4% to 64.8 ± 7.3% VO2peak ($p < 0.001$). Plasma volume at rest remained unchanged after 8 weeks of training.

CONCLUSION: Both HIIT protocols were effective in improving cardiorespiratory fitness, blood pressure and left ventricular morphology and function at rest in untrained obese men. Since metabolic stress and perceptual responses are milder in HIIT of shorter bout duration [2], HIIT10 may be preferable to promote cardiorespiratory health in obese men.

EFFECTS OF TWO ISOENERGETIC HIGH INTENSITY INTERVAL TRAINING PROGRAMS (CYCLING VS RUNNING) ON FAT MASS LOSS AND GUT MICROBIOTA COMPOSITION IN MEN WITH OVERWEIGHT OR OBESITY.

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INTRODUCTION: High-intensity interval training (HIIT) protocols decrease fat mass (FM) deposits, including abdominal and visceral FM. Recent studies performed by our team in rodent models (1,2) and in humans (3) suggest that HIIT could modulate the intestinal microbiota composition and this might contribute to FM loss. To date, FM loss and the possible association between FM reduction and intestinal microbiota composition changes have never been compared using different isoenergetic HIIT modalities, such as cycling and running. Therefore, the aim of this study was to assess these parameters before and after a 12-week cycling (HIIT-BIKE) or running (HIIT-RUN) HIIT program in men with overweight or obesity.

METHODS: Sixteen men (54±10 years; BMI: 30±2 kg/m²) were randomly assigned to the HIIT-BIKE (10 x 45s at 85% of the estimated HRmax, 90s active recovery) or HIIT-RUN (9 x 45s at 85% of the estimated HRmax, 90s active recovery) group (training 3 times per week, for 12 weeks). Dual-energy X-ray absorptiometry was used to measure whole-body, abdominal and visceral FM. Nutritional intake and physical activity level were established with self-report questionnaires. Gut microbiota composition was determined by 16S rRNA gene sequencing at baseline and after the 12-week HIIT program.

RESULTS: Energy intake and physical activity levels did not vary from the beginning to the end of the intervention in both groups. Overall, body weight, and total, abdominal and visceral FM decreased over time. When values were expressed as percentage change, no difference was observed for weight, total and visceral FM between groups. Conversely, abdominal FM loss was greater in the HIIT-RUN than HIIT-BIKE group (-16.1% vs -8.3%; $p < 0.05$). The alpha-diversity (Shannon index) of gut microbiota did not vary over time or between groups, but overall, the alpha-diversity variation was associated with abdominal FM change ($r = 0.74$; $p < 0.05$). The two HIIT programs did not induce specific intestinal microbiota alterations. However, the baseline microbiota profile and gut composition changes were correlated with total, abdominal and visceral FM losses.

CONCLUSION: Whatever the modality, HIIT is an efficient strategy to promote total, abdominal and visceral FM loss in men with overweight or obesity. The mechanisms underlying the higher abdominal FM reduction in the HIIT-RUN compared with the HIIT-BIKE group require additional investigations. No specific intestinal microbiota member changes was observed between groups, but the baseline intestinal microbiota composition and its variation during training were correlated with the FM reduction, reinforcing the possible link between these parameters.

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VERY LOW-VOLUME INTERVAL TRAINING IMPROVES TELOMERE LENGTH IN OBESE METABOLIC SYNDROME PATIENTS

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INTRODUCTION: The metabolic syndrome (MetS) is a cluster of cardiometabolic disorders including excess abdominal fat storage, hypertension, hyperglycemia and dyslipidemia, which jointly pose an increased risk for serious sequelae. Recently, it has been reported that MetS is also linked with an accelerated shortening of telomeres [1]. Telomeres are specific DNA-protein structures located at the end of chromosomes and play a key role in the protection and stabilization of genomes. Telomeres typically shorten with age at each cell division and thus, telomere length (TL) is considered a major biomarker of biological age. Apart from the normal aging process, there are several other factors that have been identified to promote telomere shortening, including diseases associated with chronic low-grade inflammation and oxidative stress like MetS [1]. On the contrary, life-style factors such as regular aerobic training have shown potential to preserve or even increase TL [2]. The aim of the present study was to explore whether very small amounts of exercise in form of low-volume interval training (LOW-HIIT) would have a beneficial impact on TL in in obese MetS patients.

METHODS: Obese individuals with clinical diagnosis of MetS were randomized into a 12 week LOW-HIIT program (2x/week, 5x1 min vigorous exercise intervals interspersed by 1 min recovery phases on cycle ergometers, 14 min total session duration including warm-up and cool-down) or a non-exercising control group (CON). Both groups received standard-care nutritional counseling to support weight loss. Pre- and post-intervention, patients received a comprehensive health examination including blood analysis, body composition measurement and cardiopulmonary exercise testing. TL was determined according to the quantitative PCR method producing a ratio of telomere amount and amount of a single gene copy (T/S-ratio) [3].

RESULTS: Ninety-one patients (52±13 yrs, BMI: 37.6±6.0) completed the intervention (LOW-HIIT: n=57; CON: n=34). Both groups similarly reduced body weight by ~3.3 kg. In the LOW-HIIT group, T/S-ratio increased significantly from 0.78±0.14 to 0.83±0.16 (p=0.002). Additionally, LOW-HIIT group patients experienced improvements in VO2max (+3.5 mL/kg/min, p<0.001), MetS severity score (–1.7, p<0.001) and self-reported quality of life (+11%, p<0.001). None of these outcomes improved in CON.

CONCLUSION: The results of this study indicate that even very low volumes of targeted exercise performed as LOW-HIIT may have a beneficial impact on TL in obese individuals with MetS. Given the similar amount of weight loss in LOW-HIIT and CON, the observed effects appear to be independent of body weight changes and underpin the well-established health benefits of exercise. Further research is required to investigate whether these results can also be transferred to other populations.

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Oral presentations

OP-AP18 Resistance Training Programs

EFFECTS OF TWO PERIODIZATION MODELS (LINEAR VS. NONLINEAR) ON MAXIMAL STRENGTH AND EXPLOSIVE STRENGTH PARAMETERS IN A GROUP OF YOUNG ADULT MALE VOLLEYBALL PLAYERS

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INTRODUCTION: The purpose of this study was to compare the effects of two models of periodization (linear and nonlinear) on maximal strength and explosive strength parameters in a group of young adult male volleyball players.

METHODS: This study included 30 players, between 18 and 23 years old. Stratified sampling was used to divide the athletes into all of the three groups, LIN (n=10), NLIN (n=10), and CON (n=10). All the tests were done using validated protocols. The intervention was carried for 6 weeks; each week included 2 sessions in the gym and 3 volleyball training sessions for the LIN and NLIN groups. The CON group did 5 volleyball trainings per week. The LIN group changed the training program every two weeks, the NLIN group had different intensity every session.

RESULTS: There were no significant differences in all the pre-intervention values among the three groups. As showed by the two-way repeated-measure ANOVA test, there were significant group x time interactions for most of the studied parameters. Also, significant pre-post changes were noted for most of the studied parameters in LIN and NLIN groups. In addition, there were significant differences among the three groups regarding percentage of variation of strength and explosive strength parameters.

CONCLUSION: In conclusion, a 6-week LIN or NLIN periodization program induces significant improvements in the maximal strength and explosive strength parameters of young adult male volleyball players. In addition, the NLIN program presented better results than the LIN in the best vertical jump, block jump, squat jump height and leg curl. In contrast, the

LIN presented better results compared to the NLIN in the 10m sprint. In conclusion, both periodization models (LIN and NLIN) are effective in enhancing maximal strength and explosive strength parameters in amateur volleyball players.

CLUSTER ANALYSIS SHOWS NO SIGNIFICANT VARIATION IN TRAINING VOLUME VARIABLES ACROSS HYPERTROPHIC ADAPTATIONS IN TRAINED INDIVIDUALS

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INTRODUCTION: Resistance training (RT) volume and its impact on muscle size adaptations in resistance-trained individuals are of interest to the scientific community. Previous studies have overlooked important confounding variables, such as participants previous weekly sets number performed per muscle group (PSN), set differences between previous training volume and sets performed during the experimental period (Set-Diff), etc. We aimed to examine if RT volume variables explain muscle growth when individuals are clustered according to hypertrophic adaptations after an RT regimen.

METHODS: Data from 63 resistance-trained individuals (1RM: BM= 2.01□0.26;18 to 30 yrs) who volunteered for previous studies in our lab were analyzed in this project. After an 8-week RT program, a K-means cluster was performed to identify three responder clusters based on the absolute delta change in the sum of medial and distal muscle thickness points (□SMT) and DEXA region of interest for fat-free mass change (□ROI-FFM). Clusters were labeled as HIGH (N=9), MODERATE (N=31), and LOW (N=23) responders. PSN, Set-Diff, weekly sets performed during the study (SPS), total volume load (sets x repetitions times x load) [TVL], and volume load progressions between the first and second training block (□VL) were analyzed with a one-way ANOVA. A Tukey adjustment was implemented for multiple comparisons in the case of significant F values. The significance level was set at P<0.05. Results are expressed as mean and 95% confidence intervals.

RESULTS: □SMT was greater in HIGH when compared to MODERATE and LOW (p<0.05). MODERATE increased more □SMT than LOW (p<0.05), (HIGH: 2.14, 95%-CI: 1.715 to 2.565cm, MODERATE: 0.787, 95%-CI: 0.577 to 0.997cm, and LOW: 0.217, 95%-CI: 0.032 to 0.402cm. □ROI-FFM was higher in HIGH than MODERATE and LOW (p<0.05). MODERATE also increased more □ROI-FFM than LOW (p<0.05), (HIGH:2.722, 95%-CI: 2.178 to 3.267kg, MODERATE: 1.532, 95%-CI: 1.371to 1.693kg, and LOW: 0.147, 95%-CI: -0.043 to 0.338kg). RT volume variables did not differ between clusters (p>0.05): PSN-HIGH: 14.49, 95%-CI: 10.37 to 18.61 sets, MODERATE: 13.32, 95%-CI: 9.86 to 16.77 sets, and LOW: 13.97, 95%-CI: 10.88 to 17.06 sets; Set-Diff-HIGH: 3.73, 95%-CI: -1.311 to 8.778 sets, MODERATE: 5.168, 95%-CI: 1.97 to 8.365 sets, and LOW:4.026, 95%-CI: 0.864 to 7.187 sets; SPS-HIGH: 18.22, 95%-CI: 10.29 to 26.15 sets, MODERATE: 18.48, 95%-CI: 15.30 to 21.66 sets, and LOW: 18, 95%-CI: 15.53 to 20.47 sets; TVL- HIGH: 411560, 95%-CI: 302,757 to 520,3639kg, MODERATE: 544,855, 95%-CI: 444,610 to 645,099kg, and LOW: 562,230, 95%-CI: 466,187 to 658,273kg); □VL- HIGH: 30.521, 95%-CI: -3.882 to 64.932kg, MODERATE: 48.827, 95%-CI: 32.265 to 65.389kg, and LOW: 47.239, 95%-CI: 31.730 to 62.749

CONCLUSION: The present study corroborates Scarpelli et al (2020) and our previous findings (Aube et al.2020), as muscle growth was not affected by SPS and TVL. Intrinsic biological factors still determine the magnitude of RT-induced adaptations in trained individuals.

LOAD-VELOCITY PROFILE ADAPTATIONS IN THE TRAINED AND UNTRAINED LEG AFTER RESISTANCE EXERCISE PROTOCOLS DIFFERING IN SET CONFIGURATION- THE CROSS-EDUCATION PHENOMENON.

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INTRODUCTION: Cross-education phenomenon is a neurological response to a unilateral strength training resulting in a strength gain in the contralateral untrained limb (1). Training parameters are determinant to modulate the strength transfer (2) and individualized load-velocity profiles (LV) are useful to evaluate that gains (3). The aim of this study was to compare the load-velocity changes in trained and untrained limb after two unilateral resistance training programs with equated total volume and work-to-rest ratio but differing in set configuration.

METHODS: 35 active subjects were recruited. After obtaining the individual LV profiles for unilateral knee extension (KE) exercise, subjects were divided in 3 groups: Traditional Training (TT), Cluster Training (CT) and Control (CON) group. Experimental groups completed 10 training sessions (5 weeks) consisting in unilateral KE exercise. Only dominant limb was exercised with the 10-repetition maximum (10RM) load. TT performed 4 sets of 8 reps with 3 min of rest between sets, whereas CT carried out 32 sets of 1 rep with 17.5 seconds of rest. From the LV profile we obtained: the velocity and load axis intercept (V0 and L0) and the area under de line (Aline=V0.L0/2). Additionally, from a load-power polynomic equation, we analyzed: changes in the estimated maximum power (Pmax), the percentage of 1RM where Pmax (%Pmax) occurs and the load associated to Pmax (LPmax).

RESULTS: Regarding the trained limb, higher values of L0 were recorded after training (p=0.009) without group×time interaction. No significant changes were observed for V0 and ALine. Greater values of Pmax were observed in posttest for TT (218.13W vs. 256.10W) (p=0.001) but not for CT nor CON. Similar values were recorded for %Pmax in posttest but higher values of LPmax were observed (p=0.001) without group×time interaction.

No changes were observed in L0 and ALine in posttest for the untrained limb. No changes in V0 were detected for CT and TT whereas lower values were registered in CON (p=0.010). A tendency towards higher V0 values in CT compared to TT in posttest (p=0.085) was detected. Pmax was increased in posttest (p=0.009) without group×time interaction. Similar values of %Pmax and LPmax were observed in posttest.

CONCLUSION: LV profile remained unchanged in the trained limb after intervention but sightly improvements in L0 and LPmax were observed independent of the group. TT intervention promoted an increase in Pmax whereas CT did not. LV profile remained unchanged in the untrained leg for the experimental groups but a tendency towards flatter slopes in the CON group reflect a loss of velocity in the posttest. Set configuration did not modulate the LV changes in the trained nor in the untrained leg. The LV profiles were not sensitive enough to reflect the effect of the cross-education phenomenon.

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IN-SEASON AUTOREGULATION OF ONE WEEKLY STRENGTH TRAINING SESSION MAINTAINS PHYSICAL PERFORMANCE IN PROFESSIONAL MALE FOOTBALL PLAYERS

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INTRODUCTION: While studies have tested different autoregulation methods within the competitive season (1), the use of typical monitoring tools such as GPS-tracking systems and external load performance data, seem to be unexplored. The aim of this study was therefore to compare the effects of autoregulating strength training volume based on an objective (external load match performance) versus a subjective (self-selected) method in professional male football players in-season.

METHODS: Sixteen players were randomly assigned to an external load regulated (EXL: n=7, 24.1±4.7 yrs, 181.4±5.1 cm, 76.6±7.1 kg) or a self-selected (SELF: n=9, 23.7±3.9 yrs, 185.0±6.9 cm, 77.4±8.4 kg) group and completed a 10-week in-season strength intervention period. The EXL-group regulated strength training volume based on their high intensity running (HIR: >19.8 km/h) distance from preceding football matches, and performed 3, 2 or 1 set of each exercise, based on thresholds of <421m, between and >687m, respectively. SELF-group was instructed to reflect on their subjective feeling and readiness to train, and select the number of sets based on their subjective rating of readiness. Physical performance (30-m sprint, countermovement jump, leg-strength) and body composition (DXA) were assessed pre- and post-intervention period.

RESULTS: No significant differences were observed between the groups at baseline. During the 10-week intervention period, both groups performed 1.1±0.1 bout of ~6 sets in leg extensor exercises and Man-Whitney U test revealed no group differences (p>0.05) in training volume (number of strength-training sessions, or number of sets in leg extensor exercises completed). No group differences were detected in physical performance and body composition measures post-intervention. Wilcox signed rank test showed that no significant pre- to post differences were evident in the physical performance measures for either group, or when analyzing all players as one group. For body composition, a statistically higher leg mass and legs lean mass was shown at post- compared to pre-test, for the EXL-group (0.4±0.4kg, p=0.031 and 0.4±0.3, p=0.034) and when analyzing all players as one group (0.3±0.6kg, p=0.039 and 0.2±0.6kg, p=0.024).

CONCLUSION: Our findings demonstrated that an objective autoregulation of strength training volume based on football match HIR distance did not differ from using a self-regulation based on their subjective readiness to train during a 10-week intervention period. This is likely explained by a low, and similar volume in the strength training undertaken. This study demonstrates that one-weekly in-season strength training session with ~6 sets of leg extensor exercises, applied by either an objective or subjective autoregulation method, can maintain professional football players physical performance during a competitive period.

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Oral presentations

OP-MH01 Physical Disabilities

WHEELCHAIR PARA-ATHLETES MAY BE PROTECTED FROM POOR BONE HEALTH BY THE DEGREE OF IMPACT IN THEIR SPORT

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INTRODUCTION: We have previously presented a higher prevalence of low bone mineral density (BMD; osteopenia, Z-score<-1.0) in the lumbar spine and hip in wheelchair-dependent (WC) para-athletes compared to their walking counterparts. Hence, WC non-athletes are assumed to be at an even higher risk of low BMD due to a lack of mechanical loading

from exercise. In this international multi-center study, we aimed to compare the BMD of the lumbar spine and hip between WC para-athletes and WC non-athletes.

METHODS: Lumbar spine, hip, and femoral neck BMD were measured by a dual-energy x-ray densitometry (DXA) scan. All participants filled in a background questionnaire on personal characteristics and training history. Explosive, rotational, and collision sports (WC rugby, tennis and basketball, and alpine sit-ski) were classified as high-impact sports (HIS), and static and one-dimensional sports (cross-country sit-ski, hand cycling, and others) were classified as low-impact sports (LIS). Data are presented as mean±SD. Where suitable, one-way ANOVA, two-sample t-tests, and Pearson correlation analyses were employed. Only valid DXA scans are utilized, as such, analysis n are provided where data are missing.

RESULTS: Of 57 WC users (17-56 yrs; 48% female), 31 were classified as HIS, 13 as LIS, and 13 as non-athletes based on the criteria of sport participation>2 yrs. The overall mean BMD Z-scores were -0.2±1.4 for the lumbar spine (n=45; 31% Z-score<-1.0), -1.3±1.2 for the hip (n=54; 56% Z-score<-1.0), and -1.2±1.4 for the femoral neck (n=49; 51% Z-score<-1.0).

HIS athletes had significantly higher lumbar spine Z-scores (0.5±1.3; n=21) compared to LIS athletes (-1.5±0.9, adjusted P<0.001; n=11) and tended to be higher than non-athletes (-0.3±1.3, adjusted P=0.07). Furthermore, HIS athletes showed a higher hip Z-score (-0.8±1.0; n=28) than LIS athletes (-2.1±1.2, adjusted P<0.01), but not higher than non-athletes (-1.5±0.8, adjusted P=0.11). No significant differences were found between LIS and non-athletes for both lumbar spine and hip Z-scores (both adjusted P>0.05). No group effects were found for the femoral neck (P>0.05).

Overall, lean mass was significantly associated with lumbar spine BMD Z-score (r=0.36, P=0.02), tended to correlate with the femoral neck Z-score (r=0.24, P=0.09), but did not correlate with the hip Z-score (P>0.05). Nor was there any association between any of the BMD Z-scores and years at the national team level or habitual weekly training hours (all P>0.05). Participants with congenital diagnosis (n=26; age: 33±12 yrs) had significantly lower lumbar spine Z-scores (-0.6±1.4) compared to those with acquired diagnosis (n=19; age: 31±10 yrs; 0.3 ±1.5, P=0.04).

CONCLUSION: This study shows that 31-56% of WC users present low BMD, depending on the site measured. The higher BMD seen in HIS athletes may indicate a positive effect of high-impact activities. Exercise programs for preventing and treating low BMD should therefore aim to include such activities achievable for WC users.

THERAPEUTIC BENEFITS OF ANKLE-FOOT PROSTHESES DURING DAILY ACTIVITIES: A SYSTEMATIC REVIEW

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INTRODUCTION: Enhancing the quality of life of people with a lower limb amputation is critical in prosthetic development and rehabilitation. Yet, no overview is available concerning the impact of passive, quasi-passive and active ankle-foot prostheses on quality of life. Therefore, the aim of this study was to systematically review the therapeutic benefits of performing daily activities with passive, quasi-passive and active ankle-foot prostheses in people with a lower limb amputation.

METHODS: We searched the Pubmed, Web of Science, Scopus and Pedro databases and backward citations until November 3, 2021. Only English-written randomised controlled trials, cross-sectional, cross-over and cohort studies were included when the population comprised individuals with a unilateral transfemoral or transtibial amputation, wearing passive, quasi-passive or active ankle-foot prostheses. The intervention and outcome measures had to include any aspect of quality of life assessed while performing daily activities. We synthesised the participants characteristics, type of prosthesis, intervention, outcome and main results and conducted a risk of bias assessment using the Cochrane risk of bias tool. This study is registered on PROSPERO, number CRD42021290189.

RESULTS: We identified 4281 records and included 34 studies in total. Results indicate that quasi-passive and active prostheses are favoured over passive prostheses in the short-term. None of the included studies investigated the long-term effects of the prostheses, and none of the studies compared active with quasi-passive prostheses. Among the included studies, quality of life has been evaluated in the short term using biomechanical (n = 26), physiological (n = 10), performance-related (n = 19) or subjective measures (n = 10). These measures were collected during level walking (n = 34), slope walking (n = 9), standing (n = 2), circuit walking (n = 1), stair climbing (n = 1), standardized clinical tests (n = 1) and rock climbing (n = 1). All studies had a moderate or high risk of bias.

CONCLUSION: Compared to passive ankle-foot prostheses, quasi-passive and active prostheses significantly enhance the quality of life during the performance of daily activities. Although short-term therapeutic benefits have been established favouring more advanced prostheses, outcome measures discrepancies prevail, and the long-term benefits remain unknown. Investigating these aspects within prosthetic evaluations may improve the quality of life of people with a lower limb amputation.

PREDICTION OF INJURIES, TRAUMAS AND MUSCULOSKELETAL PAIN IN ELITE PARALYMPIC VOLLEYBALL PLAYERS

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INTRODUCTION: Volleyball is believed not to be a particularly dangerous sport. Nevertheless, the previous research conducted by the authors of the present study suggests that the rates of musculoskeletal pain and injuries among elite sitting volleyball players are high and may be intensified by compensatory mechanisms(Gaweł et al., 2021, Zwierzchowska et al. 2022abc). However, there is still lack of research that evaluated this issue in case of initial playing position i.e. sitting vs.

standing and type of impairment. Thus, the study aimed to identify the prevalence and location of injuries, traumas and musculoskeletal pain in Paralympic and Olympic volleyball players based on an impairment and initial playing position (sitting/standing) and to identify the predictors of the abovementioned variables using a classification and regression tree (CRT)

METHODS: 75 male and female(age=34.1±;11.1;BH=1.83±0.1;BM=82.3±15.2)elite Paralympic and Olympic volleyball players from 7 countries took part in the study. They were divided into SG1 of lateral amputee Paralympic players, SG2 of able-bodied Paralympic volleyball players and SG3 of able-bodied Olympic volleyball players. A direct-participatory observation method was used in the study including a modified injuries and traumas survey questionnaire from Zwierzchowska et al.(2020) and NMQ-7 questionnaire. The CRT analysis was used to predict which training-related (sitting/standing playing position) and body-related (lateral amputation/no amputation) variables better classified the risk of the prevalence of injuries and theirs effect on athlete's health and sports performance.

RESULTS: Both SG1 and SG3 were characterized by similar prevalence of musculoskeletal pain (60/62) and injuries (55/53), while the lowest prevalence was identified in SG2. Both humeral and knee joint were the most frequent locations of the musculoskeletal pain and/or injuries in all studied groups, excepting low back pain that occurred mostly in SG1 and SG3. In SG1 musculoskeletal pain and injuries located mostly in the upper limbs, what is in the contrary to SG3, in whom they occurred in lower segments of the body.For SG1 the CRT analysis showed 7 significant influencing factors on a five-stage tree, while in SG2 and SG3 9 significant factors were identified. Eighteen nodes were mainly established by injury – ankle(level 1), break in training for 2 weeks(level 2), surgical treatment after injury and injury during trainings(level 3), overload injuries(level 4), fraction and low back pain(level 5) in both studied groups, while in SG2 and SG3 additional influencing factors were identified including injury – fingers(level 2) , injury – elbow joint(level 3).

CONCLUSION: 1.Extrinsic compensatory mechanism (initial playing position - sitting/standing) may be a crucial variable for prediction of musculoskeletal pain, injuries and traumas in volleyball players.

2.Lower limb amputation seems to impact on the prevalence of musculoskeletal complaints.

3.Training volume may predict LBP.

VALIDATION AND CROSS-SECTIONAL EXPLORATION OF A TEST PROTOCOL TO MEASURE ANAEROBIC AND AEROBIC POWER IN WHEELCHAIR ATHLETES

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INTRODUCTION: Wheelchair athletes currently lack standardized wheelchair-specific tools for an objective monitoring of their anaerobic and aerobic power production. Therefore, the aim of this study was to evaluate the validity of an individualized and standardized test protocol to measure the wheelchair-specific anaerobic and aerobic capacity in any individual wheelchair athlete and to provide a cross-sectional exploration of their performance capacities.

METHODS: Wheelchair athletes from basketball, rugby, tennis, triathlon and track & field performed an isometric strength test, a 10 s sprint test, a 30 s Wingate anaerobic test (WAnT) and a 1 min stepwise aerobic graded exercise test (GXT) on an instrumented roller ergometer. Using previously developed regression equations [1], the measured isometric strength was used to estimate the WAnT result (R2 = 0.75) and set an individual WAnT resistance. The measured WAnT result was used to estimate the GXT result (R2 = 0.81) and scaled the individual GXT resistance steps. The WAnT was considered valid when peak rim velocity stayed below 3 m/s. The GXT was considered valid when two out of three criteria were met: respiratory exchange ratio ≥ 1.10, heart rate ≥ 95% of predicted heart rate and rate of perceived exertion ≥ 8.

RESULTS: The test battery was completed by 38 wheelchair athletes of different sport disciplines in their own sports wheelchair. The five strongest athletes turned out to be too strong for the isometric strength test on the ergometer. Consequently, their WAnT resistance was underestimated, giving them the highest peak rim velocities (between 2.8 and 3.0 m/s). Instead, the sprint test was feasible for every athlete and showed the best estimate of the WAnT (R2 = 0.85). The resistance settings for the GXT were valid for every athlete. Isometric strength ranged from 140 N (tennis player) to 445 N (track and field athlete). Anaerobic power ranged from 72 W (rugby player) to 251 W (track and field athlete). Aerobic power ranged from 53 W (rugby player) to 156 W (tennis player).

CONCLUSION: The WAnT resistance was accurately estimated from the isometric strength for most athletes but was not feasible for the stronger athletes. The sprint test outperformed the isometric test as an estimator for the WAnT resistance and can instead be used as estimator for the WAnT resistance. The WAnT scaled the protocol for the GXT accurate and led to valid tests. The wide range in isometric strength, anaerobic power and aerobic power showed that this test protocol can be used in a diverse group of wheelchair athletes. The wider use of this individualized and standardized test protocol will lead to a more uniform way of wheelchair-specific exercise capacity testing and improved comparability of different studies.

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IMPACT OF USING A RACKET DURING WHEELCHAIR BADMINTON PROPULSION.

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INTRODUCTION: Wheelchair badminton is a recent sport, and its peculiarity lies in the use of a badminton racket (BR) during wheelchair propulsion. To our knowledge, this particularity has not been studied in the field of wheelchair badminton but more widely studied in the context of wheelchair tennis, a discipline close to wheelchair badminton in which we find the same peculiarity. Prior studies found that using a racket during wheelchair propulsion have a negative impact on the performance and efficiency of wheelchair propulsion and on the risk of injury to athletes [1-3]. In view of these studies, it would be interesting to see if the use of a BR induces similar changes. The objective of our study is therefore to compare wheelchair propulsion with and without a BR to understand its impact on the performance. We hypothesized that the athletes maximum velocity, mean acceleration and mean deceleration would decrease when using BR.

METHODS: 18 French wheelchair badminton experimented players (41.4±9.3 years; 64.9±11.1kg; 169.7±13.7cm) were recruited in our study. They performed a consecutive forward (FP) and backward propulsion (BP) test for 1 min on a 3m straight line on a badminton court with and without BR. The athletes used their own wheelchairs equipped with inertial measurement units (IMU) on the wheels. These tools allowed us to collect the kinematic data on all forward and backward propulsion passages. We compare the dominant hand with and without BR.

RESULTS: In FP, maximum velocity decreased significantly with the use of a BR (4.57 ± 0.69 m/s vs 4.68 ± 0.65 m/s). Similar results were obtained for the mean deceleration which significantly decreased while using a BR (10.19 ± 4.26 m/s2 vs 11.12 ± 4.49 m/s2). In the same way, similar results were found comparing results with and without a BR in BP: the maximum velocity was higher without the use of a BR (4.21 ± 0.54 m/s vs 4.08 ± 0.65 m/s) and it is the same for the mean deceleration (10.22 ± 4.15 m/s2 vs 9.52 ± 3.45 m/s2). In contrast, no significant differences were found for mean acceleration but it tends to decrease for both propulsion.

CONCLUSION: Our hypothesis was partially verified since the maximum velocity and the mean deceleration decreased with the use of the BR in FP and BP without a significant decrease in the mean acceleration. But it tends to decrease. Thus, BR does have an impact on athletes and especially their performance. Future studies should focus on the risk of injury induced using BR.

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Oral presentations

OP-AP42 Wearables and Apps

ASSESSING REAL-WORLD MOVEMENT WITH CONSUMER-GRADE WEARABLE SENSORS: MEASURING SEGMENT ORIENTATIONS AND MOVEMENT QUALITY

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INTRODUCTION: In recent years, there has been increasing interest in the quantity as well as the quality of human movement and its impact on health and wellbeing. However, the ability to assess movement quality in the real-world remains a major limiting factor beyond a controlled laboratory environment. Therefore, the purpose of this study was to investigate the ability of consumer-grade wearables to assess movement quality and to consider the optimal sensor location for such assessments.

METHODS: Twenty participants (28.2 ± 7.4 years; 14 males) performed three sets of 10 repetitions of squats, good mornings, push-ups, and chair dips in a stratified randomised order whilst wearing seven Polar Verity Sense sensors, positioned on the chest, wrists, thighs, and ankles. A sensor-fusion algorithm was subsequently applied to the raw data to obtain three-dimensional orientations (pitch, roll, and yaw). Following synchronisation, sensor performance was validated against the criterion measure (Vicon) by determining the root-mean-square error (RMSE) for the decoupled Euler parameters.

RESULTS: For the squat, dip, and good morning, the mean global RMSE (i.e. the mean RMSE of the pitch, roll and yaw) for the chest-worn sensor was 5.0-6.9°. The ankle sensors generated a mean global RMSE of 4.1° and 12.9° for the good

morning and the squat, respectively, with mean global RMSE > 27.6° for the dip and push-up. The thigh sensors were most accurate for the good morning (mean global RMSE = 7.5°), with the remaining movements generating a mean global RMSE > 15.3°. Irrespective of movement, the global RMSE for the wrist sensors was consistently higher than all other placements (mean global RMSE > 15.3°; U = 655; p = 0.004).

CONCLUSION: Consumer-grade devices could support real-world movement analysis through the measurement of segment orientations. Accuracies comparable to previous research were observed under static conditions and when measuring uniplanar motion. The most accurate location for the assessment of movement quality was the chest, with soft tissue artifact and the proximity to a joint likely reducing movement-specific measurement accuracies. The findings of this study demonstrate the plausibility of using accessible consumer-grade wearable sensors to determine segment orientations, particularly when measuring uniplanar movements. However, this study also emphasises the importance of sensor placement when assessing movement quality to mitigate measurement errors. Future research should consider the integration of multiple sensor placements and continue to investigate calibration and post-processing data techniques.

PARAMETERS INFLUENCING THE ACCURACY OF A WRIST-PHOTOPLETHYSMOGRAPHY HEART RATE MONITOR (POLAR UNITE) DURING EXERCISE

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INTRODUCTION: Heart rate (HR) at rest, during exercise and/or after exercise cessation is a key measure in the monitoring of athletes, whether it is used to control exercise intensity or to monitor physiological adaptations to training load. However, assessing HR with a gold-standard electrocardiographic (ECG) system is not accessible, and wearing a chest strap is not without problems, notably in terms of user acceptance. To overcome these limitations, manufacturers have extended the range of their technological solutions by developing devices that measure HR at the wrist using a photoplethysmographic signal. However, the accuracy of this technique can be influenced by the tightening of the wristband, the movement of arms or the kinetics of the signal (e.g. steady-state exercise vs on- and off-transients). To test these hypotheses, photoplethysmographic and ECG signals were compared.

METHODS: 30 participants (50% females) randomly performed two 13' sequences (3' rest, 5' submaximal-intensity exercise, 5' passive recovery), on a motorized treadmill and a bicycle ergometer. HR was measured concomitantly with a 10-lead ECG and two wrist-photoplethysmography monitors (Polar Unite) with different tightening (free vs imposed at the maximum tolerable).

RESULTS: The level of association (r) and the error of measurement (CV) of the Polar Unite vs the 10-lead ECG is affected by the tightening of the wristband (normal vs high; r=0.83 and 0.96, CV=16.1 and 8.1% for the treadmill, respectively; r=0.71 and 0.97, CV=20.3 and 6.2% for the bicycle, respectively), by the phase of the signal (transition vs steady-state; r=0.90 and 0.97, CV= 9.0 and 7.6% for the treadmill, respectively; r=0.93 and 0.99, CV=7.5 and 3.1% for the bicycle, respectively) and by the movement of arms (treadmill vs bicycle; r=0.90 and 0.93, CV=9.0 and 7.5% during the transition phase, respectively; r=0.97 and 0.99, CV=7.6 and 3.1% during the steady-state phase, respectively). As compared with ECG, the decrease in HR at the end of the exercise began almost always later with the tightened Unite (97% of cases). For Δ60 (i.e. the decrease in HR during the first minute following the end of the exercise), r=0.73 and CV=27.47% for the treadmill, and r=0.93 and CV=11.71% for the ergocycle. By starting the analysis as soon as the HR begins to decrease, r=0.67 and CV=27.45% for the treadmill and r=0.94 and CV=9.74% for the ergocycle.

CONCLUSION: The accuracy of HR measured with a wrist-photoplethysmography monitor is affected by the wristbands tightening and the signals phase. A high tightening is required when high accuracy is expected. If the aim is to assess the reactivation of the parasympathetic system during the recovery phase, starting the analysis as soon as the HR begins to decrease may be relevant, especially when the exercise is performed on ergocycle.

VALIDITY OF A WEARABLE SENSOR FOR STROKE DETECTION IN YOUTH TENNIS PLAYERS

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INTRODUCTION: The practice of athlete monitoring in tennis used to be done via notational analysis, so that coaches or analysts manually count the stroke and empirically estimate the load player may experience. The advancement of in micro-sensors and intelligent algorithms allow for the automatic and more tennis-specific quantification of the load, which enables the monitoring of multiple players in real-time. The aim of the study was to validate a commercially available trunk-mounted wearable sensor in detecting the strokes of different techniques in youth tennis player.

METHODS: Fifteen youth tennis male players (International Tennis Number: 3 to 8) were recruited in the study and wore a GNSS and IMU based wearable device (Catapult Vector S7) between the scapulae using specific harness to collect the data of each stroke. During the experiment, players were required to perform 30 strokes of the following stroke in sequence with an interval of rest: forehand stroke, backhand stroke, volley, smash, serve, and shadow swings. The device manufacturer has developed a prototype algorithm to classify the recorded stroke into one of the following category: Forehand, Backhand, Serve and Other stroke. The Kappa statistic was used to measure the consistency between detected strokes by the device and the actual strokes.

RESULTS: For strokes with presence of the ball, a total of 1391 correct strokes were identified, 187 incorrect stroke numbers were identified, and 843 incorrect stroke types were identified. While during for shadow swings, a total of 1216 correct

strokes were identified; 58 incorrect stroke numbers were identified, and 1049 incorrect stroke types were identified. Higher Kappa coefficients were shown for forehand and backhand strokes detection (0.919 & 0.910 for ball strokes; and 0.904 & 0.959 for shadow swings), followed by that of serves (0.533 and 0.361). The device turned out to have poor to fair agreement with the actual counts in volley and smash (0.104 & 0.390; and 0.066, 0.316).

CONCLUSION: The wearable device tennis stroke detection algorithm presented good results with excellent consistency in detecting forehand and backhand strokes. However, younger players may not produce the aspects of stroke strength and turn amplitude that met the inclusion criteria of the algorithm, so that the smash and serve showed a fair to moderate consistency. Moreover, as the turn amplitude of the volley and stroke strength are comparatively slighter, and youth players showed more variance during stroke execution, it is possible that few strokes could be correctly classified using a single sensor placed between scapulae. The device should be applied with caution to quantify player's stroke load and adding wrist-mounted sensors could potentially improve detection accuracy.

SMART SWIM GOGGLES WITH AR DISPLAY ACCURATELY AND RELIABLY MEASURE SWIM PERFORMANCE METRICS IN RECREATIONAL SWIMMERS

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INTRODUCTION: Swimmers commonly access performance metrics such as lap splits, distance and pacing information between work bouts while they rest. Recently, a new category of tracking devices for swimming was introduced with the FORM Smart Swim Goggles (FORM Goggles). The goggles have a built-in see-through display and are capable of tracking and displaying distance, time splits, stroke, and pace metrics in real time using machine learning and augmented reality through a heads-up display. The purpose of this study was to assess the validity and reliability of the FORM Goggles compared to video analysis for stroke type, length count, length time, stroke rate and stroke count in recreational swimmers and triathletes.

METHODS: Thirty-six participants performed mixed swimming intervals in a 25-meter pool across two identical 900-meter swim sessions performed at comparable intensities one week apart. Participants wore FORM Goggles during their swims, which detected the following five swim metrics: stroke type, length time, length count, stroke count and stroke rate. Four video cameras were positioned on the pool edges to capture ground-truth video footage, which was then manually labeled by three trained individuals. Mean (SD) differences between FORM Goggles and ground truth were calculated for the selected metrics for both sessions. Absolute Mean Difference and Mean Absolute Percentage Error were used to assess the differences of the FORM Goggles relative to ground truth. Test-retest reliability of the goggles were assessed using both relative and absolute reliability metrics.

RESULTS: Compared to video analysis, the FORM Goggles identified the correct stroke type at a rate of 99.7% (N = 2354 lengths, $p < 0.001$), length count accuracy of 99.8%, and mean differences (FORM Goggles – ground-truth) for length time: -0.10s (1.49); stroke count: -0.63 (1.82), and stroke rate: 0.19 strokes/min (3.23). The test-retest ICC values between the two test days were 0.793 for length time, 0.797 for stroke count, and 0.883 for stroke rate. Overall, for length time the residuals were within ±1.0s for 65.3% of total lengths, for stroke count within ±1 stroke for 62.6% of total lengths, and for stroke rate within ±2 strokes/min for 66.40% of total lengths.

CONCLUSION: The FORM Goggles were found valid and reliable for tracking of length time, length count, stroke count, stroke rate, and stroke type during freestyle, backstroke, and breaststroke swimming in recreational swimmers and triathletes when compared to video analysis. This opens perspectives for receiving real-time information on performance metrics during swimming.

Oral presentations

OP-SH01 Mentoring and Coaching: Talent

APPROACHING THE COACH'S EYE – AN INTERVIEW STUDY ON EXPERT COACHES' BELIEFS AND EXPERIENCES REGARDING 'TALENT' AND PLAYER SELECTION IN TABLE TENNIS

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Athlete identification and development programs are crucial for the development of young 'talented' children into world-class athletes (e.g., De Bosscher et al., 2008). Particularly in early starting sports and those with highly limited resources, systems personified by coaches often select athletes into programs already at a young age, aiming to use resources efficiently on those athletes with the highest potential. For example, the German table tennis system starts selecting players to national player development programs at age 10. However, the coaches' decision-making processes in the context of player selection (often referred to as coach's eye; Lath et al., 2021) and their specific criteria used are widely unknown. To address this gap, we conducted in-depth semi-structured interviews with fifteen coaches (five female, ten male; age: 32-78 years, M = 55, SD = 12.96) with high expertise in the identification and development of young talented table tennis players (10-60 years of experience, M = 28.80, SD = 13.94 years). Analysis reveals that the concept of 'talent' and the

process of player selection in table tennis are highly complex phenomena. In the interviews (duration: 41-79 min, M = 54.67, SD = 9.75 min), three main areas of importance were identified: 1) coaches' general beliefs regarding 'talent', 2) coaches' specific selection criteria including individual as well as environmental aspects, and 3) the system's implementation of player selection processes. One main finding is that coaches see 'talent' as dependent on various surrounding factors including (relative) age, maturation as well as previous (practice) experience. To their understanding, all these factors must be incorporated into selection decisions. Furthermore, coaches appreciate the multidimensionality of 'talent' and include both individual (e.g., technical skills) and environmental criteria (e.g., parents' support) in their decision-making process. Also, our interviews revealed that selection decisions are usually not made by a single but by multiple coaches during group meetings. This suggests that group processes and dynamics may play an important role. In summary, our work helps to further unravel the high complexity of 'talent' and player selection (in table tennis). With that, we provide new insights and avenues for practitioners and researchers in athlete selection. Future research should further investigate the coach's eye including the relevance of both individual and environmental as well as surrounding factors within athlete selection contexts.

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WHAT DOES IT TAKE TO MAKE THE TEAM ? ANALYZING THE TALENT IDENTIFICATION PROCESS IN COMPETITIVE ICE HOCKEY

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INTRODUCTION: In ice hockey, off-season evaluation camps are crucial steps in the preparation and training of national teams. Traditionally, such camps allow for a look at the evolution of different components of athletic talent such as 1) physical fitness, 2) technical skills, 3) psychological aspects and 4) performance in a game context. However, little is known about the real contribution of these camps in the team selection process. The objective of this study is to take a look at a talent identification process by analyzing the contribution of each talent determinant in competitive hockey.

METHODS: A 2-yr prospective design was conducted among two cohorts of highly competitive adolescent players (initial n = 160, 50 % male, 14 years old; 50% female, 16 years old) based in the province of Quebec (Canada). Players were informed about the process and accepted to participate in the project. The selection process was developed over a series of three evaluation camps (Camp 1: 80 male-100 females; Camp 2: 45 males-45 females; Camp 3: n = 25 males-25 females). At each camp, measures included off-ice fitness tests, on-ice skating tests, psychological measures and game performance throughout the full hockey season. All data was used in the team selection process, which was based on two-phases (Phase 1: from 2 x 80 to 2 x 45 players; Phase 2: from 2 x 45 to 2 x 20 players), which led to two team selections. Descriptive statistics, and discriminant analyses (selected versus non-selected players at each phase) were performed. The selection process according to each variable was compared according to each team (gender).

RESULTS: In phase 1, descriptive statistics revealed no differences were comparing males in which selected players were similar to non-selected. Results from discriminant analyses also showed no discriminant function for male players. For females, selected players displayed higher off-ice fitness, on-ice agility and psychological characteristics. Nine performance markers were significantly discriminant, in favour of selected players. By integrating additional variables at Camps 2 and 3, Phase 2 analyses led to a deeper understanding of the selection process for both teams. In fact, some psychological characteristics and game performance indicators (2022-2023) were identified as discriminant variables to be retain in the selection process.

CONCLUSION: This study contributed to refine our understanding of talent identification in youth sport. Talent identification is a long-term process in which coaches and stakeholders need to consider the developmental aspects that contribute to attain high performance level in ice hockey. In this regard, evaluation camps should consider to assess the multiple components of sport talent. In addition, they should take account of players evolution in regard to these components. Further research is needed in terms of how the talent at this stage of development can be transposed for the next competition levels.

A COMPARISON OF SELF-REPORTED AND HEART RATE-BASED TRAINING IN JUNIOR ENDURANCE ATHLETES.

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INTRODUCTION: Analysis of training characteristics provides valuable information to understand the relationship between training stimulus and consequent (mal)adaptations. A common method for training analysis is the use of training diaries, where athletes usually self-report their training duration and intensity by manually allocating time to different intensity zones based on a combination of perceived exertion, heart rate (HR) and goal of the session (1). A nearly perfect correlation between self-reported (SR) and HR-based training duration was observed in senior elite endurance athletes, although athletes consistently SR a lower total training duration (2). However, the association between these two methods has not

been assessed among young less experienced endurance athletes. The purpose of the present study was therefore to compare SR and HR-based training data among junior endurance athletes.

METHODS: SR and HR-based training data of 24 (11 female, 13 male) competitive cross-country skiers and biathletes (17.2 ± 0.9yrs) were collected for all endurance sessions for two weeks during the preparation period. Training duration for HR-based data was calculated both as the total training duration recorded by each athlete's HR-device and the duration performed >55% of HRmax. HR-based data were allocated to intensity zones based on the intensity scale developed by the Norwegian Top Sport Centre: low intensity training (LIT), 55%–82% of HRmax, moderate intensity training (MIT), 82%–87% of HRmax and high intensity training (HIT), >87% of HRmax (3). The SR training duration and intensity distribution were collected from athletes' training diaries and categorized in a 3-zone intensity distribution. The association between SR and HR-based training data was tested using mixed model analysis.

RESULTS: Total training duration was significantly lower using the SR method (-10.74min, P<.001) compared to HR-based, whereas the opposite (7.62min, P<.001) was observed when training duration >55% of HRmax was analysed. LIT duration was significantly higher using the SR method (6.20min, P<.001) compared to HR-based and the same was observed for HIT (3.09min, P<.001), whereas MIT duration was lower using the SR method (-1.61min, P=.02) compared to HR-based.

CONCLUSION: These results confirmed previous findings in senior elite athletes (2) with regards to systematically self-reporting a lower total training duration and a higher training duration >55% HRmax. SR and HR-based methods were not concordant in terms of intensity distribution, which indicates they cannot be used interchangeably. The HR-based method likely does not capture the full picture of metabolic and perceptual events during training at different intensities, which might be better represented by the SR method.

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SPORT-SPECIFIC TASKS AND GAME PERFORMANCE IN RELATION TO RELATIVE AGE AND BIOLOGICAL MATURITY IN TALENT SELECTION AMONG ADOLESCENT FEMALE HANDBALL PLAYERS

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INTRODUCTION: It has been proposed that technical and tactical sport-specific tasks are not affected by maturity status and therefore can be considered for talent selection purposes. In this study, we examined in-game performance and sport- and position-specific tasks in relation to relative age and biological maturity during a talent selection process in handball. We tested the hypothesis that relative age and/or maturation have limited impact on talent selection.

METHODS: The participants (N=225) were adolescent female handball field players participating in the national handball selection (backcourts N=99, wings N=55, pivots N=21, center backcourts N=50). The selection included handball-specific generic skills, position-specific technical drills and the players performance in game situations. We grouped the players into eight categories in quarter-year intervals (from Q1-Q8). Biological maturity was estimated with an ultrasound-based device (Sunlight BoneAge). Differences between bone age (BA) and chronological age (CA) were used to estimate maturity status (delayed/average/advanced). Inter-group differences were examined by one-way analysis of variance.

RESULTS: Relative age groups differed in bone age in favour of relative older, but not in body size. Regarding selection criteria, differences between relative age groups were found only for in-game performance (Q1: 6.0±2.0 vs. Q8: 3.4±3.4 points; p<.002) and total score (Q1: 21.7±6.7 vs. Q8: 13.9±7.0 points; p<.003), but not for the technical tasks. When divided based on their maturity status, delayed maturing players had significantly lower performance in the slalom dribbling-shooting task than average maturing players (29.1±1.6 sec vs 27.7±1.7 sec respectively, p<.014) and also in the defensive footwork task than advanced maturing players (16.3±1.3 sec vs 15.5±0.8 sec respectively, p<.001).

CONCLUSION: The results confirm the disadvantage of the delayed maturing players in selection, primarily in those generic tasks where the relative contribution of physical abilities (force, speed, agility) is important for success. Maturation did not affect position-specific tasks and game performance. It seems that relative age has no effects on most tasks, despite that relative older players were older also in biological age. This may be explained by the similar variability in maturity status observed in all relative age groups likely resulting in homogenizing their performance. The significant differences in in-game performance scores between the relative age groups can be explained by the assumption that relatively older players have more training and competition possibilities developing in this way their game intelligence. In summary, it is not the relative age itself that affects the selection, but mostly advanced biological maturation of presumably above one-year differences between the players.

Oral presentations

OP-AP05 Machine Learning (sponsored by Boost Innovation)

ILLNESS PREDICTION OF ELITE YOUTH SOCCER PLAYERS BASED ON BLOOD-BASED BIOMARKER DATA AND MACHINE LEARNING MODELS

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INTRODUCTION: Minimizing the risk of illness is of great interest in sport, e.g. soccer, as illnesses can lead to long absences during the season. The risk for developing illness has already been explained in studies by low fitness, high training load, or subjectively reported factors [1, 2]. The aim of our work was to investigate whether an emerging illness in soccer players can be predicted by a comprehensive panel of blood-based biomarkers collected on the days preceding the onset of illness using machine learning models.

METHODS: Data were collected from 23 soccer players of an elite European youth soccer team over a three-month period during the 2021/2022 regular season. In addition to 40 blood parameters (covering aspects of e.g., muscle damage, iron status, inflammation and immune response), information on the illness status of the players was regularly collected. To predict illness, five players were randomly selected as the training dataset and the remaining players were used as the test dataset for validation. The training dataset contained 10 illness and the test dataset contained two illness data points. To increase the number of illness cases in the training dataset, we used ADASYN [3] for oversampling. For prediction, we compared three machine learning models: random forest, linear support vector machines and a naïve Bayes classifier. To investigate the important variables for classification, we use the Receiving Operating Curve.

RESULTS: Linear supported vector machine achieved the best classification results. With this model one of the two illnesses present in the test data could be explained, which resulted in an accuracy value of 85%, recall of 50% and a Cohens Kappa of 0.10. Analysing the most important variables for classification reveals that illness is best predicted by Eosinophil, Ferritin, Glucose and C-reactive protein.

CONCLUSION: Although it is possible to predict illness of soccer players by using blood-based biomarker data and applying a linear support vector machine, the number of wrongly predicted illnesses is high. Nevertheless, when having more illnesses to train a model, machine learning approaches could help to detect illness signs in advance and thus react early if needed.

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DIFFERENCES IN FUTURE SUCCESS AMONG PROFILES OF YOUTH ELITE SOCCER PLAYERS IN MULTIDIMENSIONAL PERFORMANCE ASSESSMENTS: A PERSON-ORIENTED APPROACH BASED ON DEEP LEARNING FACTOR AND CLUSTER ANALYSES

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INTRODUCTION: Over the last decades, the prognostic relevance of performance assessments in talent identification and development (TID) programs in soccer is critically discussed in talent research. While a major part of studies deals with variable-centered approaches investigating the predictive value of single tests and/or their combination, also person-oriented analyses focusing on the player holistically, e.g., by examining player profiles, seem promising [1;2]. Therefore, the aims of the present study were (a) to explore different player profiles based on multidimensional performance assessments, and (b) to examine differences among those profiles regarding players' future success in youth elite soccer.

METHODS: The study sample consisted of N=6523 male U12 players participating in nationwide conducted multidimensional assessments (12 outcome variables) in the German TID program [3]. To address (a), a deep learning factor analysis identified four underlying latent factors behind the assessments: (1) subjective coach evaluations of players' tactical, technical, and psychosocial skills; (2) age-related and anthropometric measurements, (3) technical skills; and (4) speed abilities. Those were used to discover player profiles via a k-means-cluster analysis. Regarding (b), it was assessed, whether players transitioned into a U15 at a German youth academy three years after the assessment. 570 players (8.7%) met the criterion. Chi-square tests examined differences between identified profiles and success rates. Odds ratios for being selected (for each profile) served as effect size.

RESULTS: (a) The cluster analysis revealed six different player profiles: "Anthropometrically advanced high performers" (n=788), "Subjectively low rated, anthropometrically advantaged" (n=604), "Subjectively high rated and technically skilled" (n=1189), "Average performers" (n=1344), "Subjectively low rated players with low technical skills" (n=1157), and "Anthropometrically and technically below average" (n=1440). (b) Significantly different proportions of successful players among profiles were detected (p<.001). "Anthropometrically advanced high performers" obtained the highest chances for future

success (22.6%, OR=2.6, p<.05), while the lowest chances occurred for the profile "Anthropometrically and technically below average" (1.7%, OR=0.2, p<.05).

CONCLUSION: The results indicate differences in future success among the identified performance profiles of players. Similar to former variable-centered approaches, the person-oriented analyses confirmed the predictive value of the multi-dimensional performance assessments. Whether and to what extent benefits of the person-oriented approach (e.g., the potential to discover compensation effects) may provide valuable information for research and applied practice of TID processes needs to be examined in future studies.

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PREDICTING FOOTBALL MATCH RESULT IN REAL-TIME BASED ON MACHINE LEARNING APPROACH

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INTRODUCTION: Recent advances in sports technology have provided massive data on professional football matches that facilitates the investigation of competitive performance, which further allows for the generation of research aiming to predict the outcome of matches. However, it seems more practically useful and challenging if the real-time win probability of a team is objectively predicted when it comes to the analysis of match behavior and fan engagement. Therefore, the purpose of the study was to build an interpretable machine learning framework that enables in-game football match result prediction.

METHODS: The event data from 380 matches of the 2017-2018 English Premier League (EPL) and 64 matches of the 2018 World Cup were used. A total of 52 features from 9 categories were extracted every five minutes: offensive behaviors (shots, attacking passes, etc.), defensive behaviors (tackles, interceptions, etc.), playing styles (tempos, average team position, etc.), opponent attack behaviors (opponent shots, etc.), game situations (home goals, yellows, etc.), ball possessions, team ratings, historical game outcome, and team strength (ELO ratings, etc.). The current match status (win, lose and draw) for home team was used as the result label. The Light Gradient Boosting Machine (LGBM) was applied to model the match result of different periods, with the training set being 7953 observations from all EPL games and the test set being 1352 observations from all World Cup games (ratio of the training set to the test set: 8 to 2).

RESULTS: Within all result labels, home team was winning 44.8%, drawing 24.5% and losing 30.6% of all games. The statistics of the AUC, F1 and prediction accuracy of the model were 0.73, 0.50 and 0.64 respectively after training and validating. Specifically, the model successfully classified 471 out of 572 home wins (82.3%), 390 out of 590 home loses (66.1%) and only 11 out of 190 draws (5.8%) during the 2018 World Cup. Team strength and historical game results demonstrated higher feature importance. The game situation showed a moderate influence on the model, while the shots, clearance and ratings had the least contribution to the prediction of the model.

CONCLUSION: The study introduced an in-game football match result prediction framework that combines domain knowledge and data-driven model. In general, the proposed model showed decent prediction accuracy expect for the drawn matches where margin of victory for both teams is relatively low. In line with previous research, the score advantage in the game mainly depends on its own strength and the goals in previous games and will also be affected by the home court and penalty cards. The model could be applied into the real-time win probability during match broadcast or providing coaching teams with reference for decision-making.

EXPLORING THE EFFECT OF ARM SWING ON COUNTERMOVEMENT JUMP PERFORMANCE USING MACHINE LEARNING AND GROUND REACTION FORCE ANALYSIS

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INTRODUCTION: Jump performance is a requirement for many physical activities. The ability to accurately classify different jumping styles can provide valuable insights into an athletes performance and aid in the development of training programs. This study aimed to investigate the impact of arm swing on the observed pattern of ground reaction forces during a countermovement jump (CMJ) and determine if it can be used to improve the classification accuracy of jumping styles. Our hypothesis was that the presence of arm swing would result in different ground reaction force patterns compared to a countermovement jump without arm swing.

METHODS: Three hundred and thirty-two male adult high-level athletes from various sports performed a series of CMJ and CMJ with arm swing (CMJas) on a 1D force platform. A machine learning approach was adopted to analyze the force-time data recorded for each participant, using a random forest classifier [1]. The data were interpolated to 101 points and then transposed so that each force-time point represents a feature. SHapley Additive exPlanations (SHAP) analysis [2] was used to provide explanations about the models' predictions and insights about the most important features that best described each class force pattern. Also, to describe, interpret, and further explore the derived classification predictions, kinetic energy was calculated and statistically compared across the two jumps using the SPM1D paired t-test.

RESULTS: The classification accuracy was 0.895 (CI 95%: 0.869 - 0.921). The SHAP-based variable importance ranked all the features (time points) according to their value for the model, to predict the class (CMJ or CMJas). The model showed that all features (time points) from 83 – 94% of the total jump duration were the most important in distinguishing between the CMJ and CMJas. Also, the model pointed out that vGRF is highly informative in separating the two jumps after 65% of the total jump duration. Further statistical analysis of the data revealed a significant difference in the produced kinetic energy with the CMJas prevailing from CMJ at ~90-100% ($t = 3.249$, $p < 0.05$) of jump duration.

CONCLUSION: These findings confirmed that arm swing discriminates countermovement jumps, especially in the last part of the task. They also support the efficacy of the machine learning modeling approach for understanding the complexities of vGRF patterns in a laboratory setting. Overall, the work produced during the late phase of CMJ with arm swing produces a very distinct peak, which the classifier can capture and separate into two classes. Contrary to previous reports, no informative features were found before 65% of the jump duration, likely linked to the inconsistency due to the high variance of the force patterns during the unweighing and braking phases of both jumping techniques.

1. Breiman L. Mach Learn 2001

2. Lundberg et al. Adv Neural Inf Process Syst. 2017

Oral presentations

OP-PN27 Energy Restriction and Weight Loss

RAPID WEIGHT LOSS BEHAVIOR IN JUDO ATHLETES: PREVALENCE, MAGNITUDE, AND METHODS.

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INTRODUCTION: Rapid weight loss (RWL) is characterized as a reduction of body mass equal to or above 3% in up to 7 days. The typical magnitude of reduction is about 5% of body mass, although some athletes may reduce up to 10% before competition [1]. There is limited information about the prevalence, magnitude, and methods of RWL since the judo weigh-in was changed to the day before competition, and it is believed that athletes altered their behaviors due to the extended recovery time.

METHODS: This study involved 223 judo athletes who were over 18 years of age and actively competing. Participants were required to complete a validated RWL Questionnaire (RWLQ)[2] that included questions about personal information, competitive level, weight and diet history, and RWL behaviors. The questionnaire had a scoring system where a higher score indicated more aggressive weight management behavior. Participants were recruited through online forms and during official competitions. The Mann-Whitney U-test was used to compare scores between the sexes, and a one-way ANOVA was used to compare scores between athletes who started cutting weight at different ages and levels of competition.

RESULTS: The prevalence of RWL was 90% when all athletes were included and 93% when heavyweights were excluded. On average, athletes lost 4.94% (range: 0-24%) of their body mass 3-5 days before competition. A significant number of athletes (40%) reduced more than 5%. When asked about their greatest weight loss, athletes reported a mean reduction of 8% (range: 0-24%) of their body mass. Approximately 50% of athletes regained 2-3kg (2-6%) in the week after the competition, and about 37% regained more than 3 kg (3-13%). The most common methods used were increased exercise, training with plastic or rubberized suits, and decreased fluid intake. The athletes weight management behavior was most influenced by the judo coach, dietitians, and training colleagues. When separated by age, athletes who started cutting weight earlier had a higher score on the RWLQ ($P=0.002$), but no significant differences were found between males and females ($P=0.285$) or between competitive levels ($P=0.378$).

CONCLUSION: The prevalence of RWL in judo athletes is slightly higher than previously reported before the weigh-in rule changed [1]. However, the magnitude of RWL is similar for most athletes, and a growing number of athletes are reducing more than 5% of their body mass.

1. Artioli et al. (2010) 2. Artioli et al. (2010)

EFFECTS OF THE FUEL INTERVENTION ON MENSTRUAL FUNCTION IN COMPETITIVE FEMALE ENDURANCE ATHLETES WITH RISK OF RELATIVE ENERGY DEFICIENCY IN SPORT

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INTRODUCTION: Female endurance athletes are at high risk of menstrual dysfunction (MD) due to problematic (long-term/severe) low energy availability (LEA). MD has been associated with reduced bone health and performance in female endurance athletes, emphasizing the need for management of problematic LEA and associated conditions such as MD.

METHODS: Female competitive endurance athletes from Norway (n=60), Sweden (n=84), Ireland (n=17), and Germany (n=47) were recruited to the Food and nUtrition for Endurance athletes – a Learning (FUEL) program consisting of 16 weekly

online lectures and individual athlete-centered nutrition counseling every other week. Fifty athletes with symptoms of REDs [LEA in Females Questionnaire (LEAF-Q) score ≥ 8] and with low risk of eating disorders, with no use of hormonal contraceptives and no chronic diseases, were allocated to either the 16-week FUEL-intervention (n=32) (FUEL) or a 16-week control period (n=18) (CON). All but one completed the FUEL-intervention, while n=3 dropped out during CON. Athletes completed the LEAF-Q with menstrual function questions, at pre- and post-intervention/control period, and also at 6- and 12-months follow-up for the FUEL group. Menstrual function was analyzed in a descriptive manner, while group comparisons of LEAF-Q menstrual score from pre- to post, as well as within FUEL group comparisons for the four measurement time points, were conducted using a Bayesian mixed factor analysis of variance.

RESULTS: Self-reported eumenorrhea increased from 10% (n=9 athletes) at pretest to 67% (20 athletes) at posttest in FUEL and decreased in CON from 73% (n=11) to 53% (n=8). Five of the 14 (36%) FUEL athletes, who reported MD at pretest, reported eumenorrhea at posttest. Seven (23%) FUEL athletes and three (20%) CON athletes were unaware whether they had normal menstruation at pretest. All FUEL athletes were able to define whether they had normal menstruation at posttest, while the number was unchanged for CON athletes. The number of athletes who reported reduced or absence of menstrual bleedings with increased training load decrease from 70% (n=21) to 47% (n=14) in FUEL while the number 73% (n=14) was unchanged in CON.

Changes in the LEAF-Q menstrual score from pre- to post did not differ between groups, as indicated by the lack of an interaction effect (FUEL: 6.6 ± 2.5 at pre- and 5.3 ± 3.0 at posttest versus CON: 5.1 ± 2.7 at pre- and 4.7 ± 2.3 at posttest, BFincl = 0.664). Six- and 12-months follow-up revealed strong evidence (BFincl = 860) for improvement in LEAF-Q menstrual score for FUEL athletes comparing all four measuring points (4.6 ± 2.6 at 6- and 5.1 ± 3.1 at 12-months follow-up).

CONCLUSION: In this group of endurance athletes, participating in the FUEL intervention implies long-term improvement of menstrual function. The lack of long-term follow-up for the CON condition indicates, however, that the results should be interpreted with caution.

ANALYSIS OF FOOD INTAKE DURING A 20-DAY EXPEDITION IN THE COLD

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INTRODUCTION: To achieve neutral energy balance and avoid body mass loss during a period with high and sustained physical activities might be hard even in comfortable ecological conditions and/or with easy access to food with an energy content exceeding the energy demands. The reasons of this under consumption are multiple and mostly contextual but are rarely studied. The aim of this study was to identify these reasons using a military 20-day ski expedition in Greenland.

METHODS: Twelve French soldiers realized a 20-d ski expedition in Greenland (-5 to -25°C) during which they were fed with 3750-kcal lyophilized rations (7 different menus composed of easy-to-use, highly palatable and familiar foods) insufficient to cover their expected energy expenditure (~4500 kcal). Each day, in a paper notebook, they had to report foods and beverages intake in order to calculate energy intake. They also had to indicate the time of intake, the palatability of each consumed items (from 1 to 10) and the reason(s) they did not consume some items. Appetite was assessed using visual analog scales before breakfast and dinner. A body mass and composition measurement was done just before and the day after the expedition. The 20 days were cut in 3 parts (D1-D7; D8-D14 and D15-D20) and the food items were separated in breakfast, day sweet, day savory, and dinner items for analyses.

RESULTS: Participants experienced a mean negative energy balance of -975 ± 550 kcal during the expedition leading to a 4.2 ± 1.9 kg ($p < 0.001$) body mass loss. A temporal analysis revealed that energy intake ($p = 0.033$) and hunger levels ($p < 0.001$) were higher during the last week compared to first one during the expedition. The percentage of consumed items rose from 86 to 90% between the first and third weeks, this increase concerning mostly savory day and dinner foods (87 to 91, and 81 to 91%, respectively). In agreement, palatability increased only in savory day ($p < 0.001$) and dinner ($p = 0.048$) foods. The reasons for not consuming an item were: 1) the food being not sufficiently good and/or practical (33%) and the lack of appetite (33%), 3) their conservation in case of needs (15%), 4) the lack of time (13%), and 5) the weariness (6%).

CONCLUSION: Despite experiencing large body mass loss, these participants only slightly and very insufficiently adapted their food intake. Interestingly, the lack of appetite and the lack of palatability came as the main reasons for not consuming foods suggesting that body mass loss does not transpose well into an increase in food flexibility. Moreover, the increase of palatability and frequency of consumption was mostly targeted towards savory foods (during the day and dinner) pointing point out means to improve rations compositions and limit body mass loss.

POSITIVE ASSOCIATION BETWEEN T3 AND RESTING ENERGY EXPENDITURE IN FEMALE CROSSFIT PRACTITIONERS: DOES IT PRECEDE THE FEMALE ATHLETE TRIAD? PRELIMINARY DATA FROM AN EXPLORATORY CROSS-SECTIONAL STUDY.

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INTRODUCTION: CrossFit® (CF) is characterized as a constantly varied, high-intensity, functional movement training program, performed with little or no rest between bouts, combining strength and endurance exercises, such as running, cycling, rowing, Olympic weightlifting, power weightlifting, and gymnastic-type exercises. Due to CF characteristics, female CF practitioners may be at risk to experience low energy availability (LEA), which is the etiological process underpinning

the development of the Female Athlete Triad (FAT). The aim of this study is to verify if female CF practitioners are at risk for the FAT.

METHODS: This is a cross-sectional study with nonprobability sampling. Inclusion criteria: healthy female CF practitioners aged 18-39 years, minimum of 5 training sessions per week for at least 6 months; minimum CF training experience of 1 year. Exclusion criteria: women taking any substance that interferes with the menstrual cycle. Subjects visited the laboratory once. They initially answered a health and sociodemographic questionnaire. Resting energy expenditure (REE) via indirect calorimetry (K5, COSMED®) and body composition (Bioelectrical impedance analysis; model 450®, Biodynamics) were assessed in a fasting state, followed by a blood test (levels of IGF-1, T3, and leptin) and the Low Energy Availability in Females Questionnaire (LEAF-Q). Data were analyzed using Jamovi® 2.3.21 version. A sample size of 42 subjects was calculated.

RESULTS: Subject characteristics (mean (DP); n = 14): Age: 32.1 (5.45) y; IMC: 23.7 (1.57) kg/m2; % body fat: 22.6 (3.45); REE: 1589 (146) kcal; IGF-1: 164 (54.8) ng/mL; Leptin: 12.8 (10.1) ng/mL; T3: 1.05 (0.319) ng/mL; LEAF-Q score: 3.86 (2.80). More than 70% REE variability is explained by multiple regression model (R2: 0.77; p = 0.040). After controlling for age, IGF-1, and leptin, the linear regression model showed T3 was positively associated with REE (B = 254.32 kcal; 95% IC: 12.14 - 486.52; p = 0.042). On the order hand, this model was not associated with the LEAF-Q score.

CONCLUSION: Our preliminary data showed a positive association between T3 levels and REE, even with our small sample size. It is well known that thyroid hormones are of central importance for energy homeostasis and metabolism. They directly stimulate energy expenditure, which means that low levels of thyroid hormone decrease REE and high levels increase REE. So far, LEAF-Q results did not show risk of FAT among female CF practitioners. Low T3 levels may be an important predictor of low REE among CFP and consequent low REE might precede other perceived disturbances associated with FAT in this population. Our results are preliminary, and more data is required for a better comprehension of this important topic, especially in CF practitioners.

Oral presentations

OP-SH24 Physical education and health

MODELING SPORTS-RELATED HEALTH COMPETENCE FOR PHYSICAL EDUCATION

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INTRODUCTION: Health promotion has always been of particular interest in physical education research. Especially in the course of competence orientation in didactics, there is currently a shift in Germany towards the goal of promoting students sports-related health competence. Although the tripartite nature of the competence dimensions is largely consensual at a theoretical level ("knowledge, ability and willingness"), there is however a strong focus on knowledge tests when it comes to competence assessment (e.g. Töpfer & Sygusch, 2022). The following research question is addressed: How can the dimensions of ability and willingness be captured in addition to knowledge testing to enable a comprehensive investigation of sports-related health competence?

METHOD:

With the overall aim to develop a holistic survey method for the sports-related health competence of students, a multimethod validation procedure is used (Jenßen et al., 2015). In a first step, a draft of an adapted model of sports-related health competence for physical education (based on Blömeke et al., 2015) was put up for discussion in qualitative expert interviews with scientists in the field of sports pedagogy, educational and health science (N=10). Important prerequisites for holistic competence assessment have been discussed. Qualitative content analysis is used for the evaluation. The presentation focuses on these interview results, which shall be used in a second step to develop the survey methodology.

RESULTS: Based on the findings of the content analysis, the adapted model was revised. Individual dimensions of the model of sports-related health competence (e.g. body awareness) and their function for health-related action of students have been identified. The experts stressed the importance to link the contents of knowledge and ability testing closely when aiming to test the sports-related health competence in a holistic way. Motivational-volitional dimensions were attributed different importance by the experts. Another finding is that the capability to act, as a potential goal of promoting sports-related health competence in physical education, has to be distinguished from the actual actions of the students in everyday life (performance).

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DIFFERENCES BETWEEN YOUNG CHILDREN'S ACTUAL AND PERCEIVED MOTOR COMPETENCE REGARDING SKILL PERFORMANCES ON LAND VERSUS IN WATER: A CROSS-SECTIONAL STUDY

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INTRODUCTION: Both actual motor competence (AMC) and perceived motor competence (PMC) are positively associated with physical activity in children [1]. Despite the importance of accurate estimates of aquatic skills in view of water safety from an early age onwards, research has mainly focused on children's self-perceiving ability in relation to their AMC regarding land-based skill performances. Therefore, the purpose of this cross-sectional study was to simultaneously document and compare young children's AMC and PMC in different movement contexts (i.e., on land vs. in water).

METHODS: Data were collected from 92 children (42 girls, 50 boys; aged 6.8 ± 0.4 years) attending primary schools for regular education near Brussels (Belgium). All participants' AMC and PMC in terms of skill performances on land versus in water were assessed using aligned instruments per movement context. Children's land-based AMC was evaluated by means of the third version of the Test of Gross Motor Development (TGMD-3) [2], whereas their land-based PMC was examined using the updated version of the Pictorial Scale of Perceived Movement Skill Competence for Young Children (PMSC) [3] matching the 13 TGMD-3 test items. Children's water-based AMC was evaluated by means of the Actual Aquatic Skills Test (AAST) [4,5], during which they performed exactly the same 17 aquatic skills as presented in the Pictorial Scale of Perceived Water Competence (PSPWC) [6] used to examine their water-based PMC. All raw total test scores were re-scaled to achieve a comparable score range of 0-100 across the different assessment tools. A three-way Repeated Measures ANOVA compared children's AMC and PMC (i.e., skill assessment type) according to movement context, also taking their sex into account.

RESULTS: There was a significant interaction between skill assessment type and movement context as within-subjects factors ($p < .001$), indicating significantly higher PMC as compared to AMC scores with a greater extent of disagreement between these outcomes on land ($p < .001$; land-based AMC = 73.96 ± 10.83; land-based PMC = 89.99 ± 12.18) versus in water ($p = .044$; water-based AMC = 72.95 ± 19.93; water-based PMC = 77.53 ± 12.14). Children's land-based PMC was also significantly higher than their water-based PMC score ($p < .001$), whilst this equally directed difference according to movement context was not significant for AMC scores ($p = .679$). No sex effects were found.

CONCLUSION: Young children proved to overestimate their actual skill performances in both movement contexts. This perceptual error or extent of disagreement between AMC and PMC was more pronounced on land than in the aquatic environment. A promising research avenue is to apply a person-centered approach using cluster analysis to gain more insight in divergent/convergent MC-based profiles within and perhaps across contexts.

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ASSOCIATIONS OF REGULAR PHYSICAL ACTIVITY WITH PHYSIOLOGICAL AND PSYCHOLOGICAL STRESS REACTIVITY IN CHILDREN AGED 10-13 YEARS

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INTRODUCTION: High stress reactivity can be detrimental for physiological and psychological health. According to the cross-stressor-adaptation hypothesis, physical activity has health-beneficial effects on psychosocial stress reactivity. However, studies investigating such effects in children are scarce. Therefore, our study aimed to investigate the association of regular physical activity with physiological and psychological stress reactivity in children.

METHODS: One hundred and ten (62 male) right handed children aged 10-13 years were recruited from schools and through distribution of flyers in public places. On two different laboratory appointments, scheduled in randomized order, the Trier Social Stress Test for Children (TSST-C) and a non-stressful control task were performed. Heart rate variability (RMSSD, measured via chest belt) and salivary cortisol (samples taken directly before and 0 min, 15 min and 30 min after the task) represented physiological stress reactivity. State anxiety was measured before and after the task with an 8-item questionnaire based on the state scale of the State-Trait Anxiety Inventory. Actigraphs worn over the course of 7 days were used to quantify moderate-to-vigorous physical activity (MVPA).

RESULTS: A median split was performed on MVPA, and separate analyses of variance were calculated with MVPA group and sex as between subject factors. For all stress parameters, significant main effects of condition indicated higher stress reactivity in the TSST-C compared to the control task ($p<.001$). A significant between subject effect of MVPA group ($F(1, 105) = 3.98$, $p = .049$, partial eta^2 = 0.037) indicated lower cortisol reactivity in children with higher MVPA. A similar tendency was observed for heart rate variability ($F(1, 99) = 3.42$, $p = .067$, partial eta^2 = 0.033). All other associations and interactions with MVPA were not significant. Significant sex differences were observed for cortisol and anxiety, with boys reacting more to the control task and less to the TSST-C compared to girls.

Discussion/CONCLUSION: The results of our study indicate a health-beneficial association of higher levels of MVPA with children's physiological response to a psychosocial stressor. Programs targeting stress reduction in children should take potential sex differences in stress reactivity into account. Further longitudinal and intervention studies are necessary to confirm potential causal relationships.

EXPLORING LINGUISTIC DIMENSIONS THROUGH EXPLORATORY CIRCUS ASSIGNMENTS IN PHYSICAL EDUCATION

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Introduction

Limited language skills are problematic for learning to occur. Teachers should carry out literacy teaching that enhances pupils' language development but consider themselves too busy with teaching subject content (Moje 2008). According to physical education (PE) teachers, the primary goal is to physically activate the pupils. Research shows that language integrated PE can assist children's language development (Derri et al. 2010). However, language integrated PE lowers the time for physical activity (Coral et al. 2020). This is problematic since youth's physical inactivity is a growing problem. This study examines how disciplinary literacy in a multilingual PE context can be emphasized and the pupils' use of verbal language stimulated to enhancing learning in PE and to understand how it can steer teaching and learning processes in certain directions.

Methods

Multilingual 10-year-old pupils and their PE teacher participated with a research teacher in 10 PE lessons focusing on language integrated exploratory circus assignments. Data was collected through participant observation, video observation, interviews, and field diary. The data analysis was abductive, which meant an oscillating backwards and forwards between the theory and the data. A thematic analysis was carried out.

Results

The tentative results show that there were both opportunities and challenges when emphasizing disciplinary literacy in PE. Time focused on language was needed for all pupils to partake and develop knowledge, but it happened on the expense of physical active time. Such endangering was bridged through additional time for anchoring the language and creating pre-understanding beforehand the PE lesson.

Discussion

The PE subject's focus on physical activity can be considered a "free zone" from the theorizing ambition to emphasize language learning. This study question whether there is a paradox embedded in such a thought, namely: only when you do not try to force PE and language together, language does come into its own. Physical doing is also learning, and the reflection of the action makes pupils reach new levels in doing things in PE. This study highlights that involvement of language is important in PE – not for the language itself, but because it enables learning and enhances knowledge development in PE.

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PHYSICAL LITERACY IN GERMAN CHILDREN

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Introduction

Physical literacy (PL) is a concept attracting worldwide attention in the context of Physical Education (PE), sport and health. It is described as the motivation, confidence, physical competence, knowledge and understanding to be physically active for life. The Canadian Assessment of Physical Literacy, second edition (CAPL-2) (Longmuir et al., 2018) is a valid and reliable instrument to assess physical literacy in children. The aim of our study is a gender-and age-stratified analysis of PL in German primary school children.

Method

332 (172 girls, 160 boys) German primary school children aged 8-12 years old (M=11.05 SD=0.98) participated in the study. PL was measured using the German version of the Canadian Assessment of Physical Literacy, second edition (CAPL-2-G). CAPL-2-G consists of a questionnaire to assess the Knowledge and Understanding and Motivation and Confidence domains. The Daily Behavior domain was assessed from one self-report item of weekly physical activity and step counts during one week. To study the Physical Competence domain three physical tests were applied.

Results

The results for the overall physical literacy score (maximum 100 points) demonstrate significant differences (U=2452; z=-2.068; p= .039; r=.17) between girls (n=82; M=66.32; SD=11.94) and boys ((n=74; M=70.99: SD=14.57). No significant age-specific differences were found. According to the four domains the results show significant gender-differences in the

Physical Competence (girls n=150; M=19.15; SD=5.64; boys n=142; M=21.38; SD=6.26; U=8036; z=-3.625; p=.000; r=.2; maximum score 30 points) and Daily Behaviour domain (girls n=83; M=14.86; SD=6.58; boys n=74; M=17.27; SD=6.82; U=24888; z=-2.052; p=.040; r=.16; 30 points maximal score). Only in the domain of Knowledge and Understanding (N=332) the data reveal significant differences within the age groups (F=2.72 p=.045) with the highest mean value in the 11-year-old age group (n=132; M=6.7; SD=1.86; maximum score 10 points).

Discussion

The gender-and age-stratified analysis of PL in German primary school children illustrates gender differences. The boys overall level of PL was higher than that of the girls and the 11-year old boys reached the highest PL overall score. The results show that the boys are more physical active than the girls and their level of physical competence is higher. This is also found in many international studies recently. The holistic concept and the assessment of PL in German primary school children provide a useful approach for structuring learning processes in PE class to improve a physically active lifestyle. And, our results can be the background for a discussion about co-or mono-educational teaching in PE class.

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10:00 - 11:15

Invited symposia

IS-PN05 Movement as Mitochondrial Medicine: new insights from traditional mitochondrial measures and the latest 'omic' techniques

MOLECULAR REGULATION OF MITOCHONDRIAL ADAPTATIONS TO EXERCISE

ZIERATH, J.

KAROLINSKA INSTITUTE SWEDEN, CBMR, UNIVERSITY OF COPENHAGEN, DENMARK

It is well established that endurance exercise training induces mitochondrial biogenesis in skeletal muscle, with a concomitant increased skeletal muscle mitochondrial capacity. These adaptations are mediated by a complex interplay between a myriad of signalling pathways coupled to downstream regulators of gene transcription and translation. On a regulatory level, a single session of exercise alters the DNA binding activity of a variety of important transcription factors. Protein stability and subcellular localisation of transcriptional factor complexes within the nucleus and mitochondrion are also affected. Transient DNA hypomethylation of gene-specific promoter regions also precedes some of the increases in mRNA expression in response to acute exercise. In turn, these pulses of elevated mRNA during the recovery from acute exercise facilitate the synthesis of respective proteins, and provoke gradual structural remodelling and long-term functional adjustments of the mitochondria. This presentation, by one of the leading experts in the world, will provide an up-to-date review of the molecular mechanisms that underpin the adaptation of skeletal muscle mitochondria to a single session of exercise and exercise training. The target audience will be both exercise and sport scientists with an interest in the mechanisms that underlie adaptations to exercise training.

THE EFFECTS OF DIFFERENT TYPES OF EXERCISE ON MITOCHONDRIAL ADAPTATIONS

DAUSSIN, F.

UNIVERSITY OF LILLE

Mitochondria are living, dynamic, energy-producing and signalling organelles that actively adapt to environmental inputs such as exercise. Mitochondrial biogenesis is defined as the process leading to the production of new mitochondrial components, and it is possible to evaluate the effects of exercise training on mitochondrial biogenesis by assessing changes in mitochondrial content and respiratory function. The effects of exercise training on mitochondria are controversial; some studies have observed changes in mitochondrial respiratory function without changes in mitochondrial content, other studies have reported the opposite effect, and some studies have observed an increase in both parameters. It has been suggested that the exercise modality used may partially explain these divergent adaptations to different training programs. This presentation will summarise how the following exercise modalities influence mitochondrial adaptations: i) high-intensity interval exercise (HIIE) - defined as efforts performed at an intensity between 80 and 100% of power/velocity associated with VO2max, ii) moderate-intensity continuous exercise - characterised by exercise performed in a continuous manner and at a lower intensity than HIIE, and iii) sprint interval exercise - repeated efforts performed at an intensity greater than power/velocity associated with VO2max. The current literature suggests that training volume will mainly improve mitochondrial content, while the training intensity will be the major determinant of changes in mitochondrial respiratory function. In this talk, Dr Daussin will summarise our understanding of the effects of different exercise modalities on mitochondrial adaptations. In addition, he will highlight some considerations, such as the training organisation, the role of sex, and fibre-type recruitment during exercise, that may influence mitochondrial adaptations to exercise. The

target audience will be both exercise and sport scientists with an interest in the prescription of exercise to improve health and performance.

USING OMICS TO UNDERSTAND MITOCHONDRIAL ADAPTATIONS TO DIFFERENT TYPES OF EXERCISE

BISHOP, D.
VICTORIA UNIVERSITY

Given the importance of mitochondrial biogenesis for skeletal muscle performance, considerable attention has been given to understanding the molecular changes that help to determine mitochondrial adaptations to exercise. In this session, Prof. Bishop will present published and unpublished 'omics data that provide new and exciting insights into the many molecular changes that contribute to exercise-induced mitochondrial adaptations. The results of RNA sequencing (RNA-seq) based transcriptomics highlight how different mitochondria-related gene transcripts respond following different types of exercise, and how this may help to explain divergent mitochondrial adaptations to different types of exercise training. These RNAseq results also indicate that there are transcriptional responses that are shared across different exercise prescriptions. Of particular interest is how exercise-induced mitochondrial damage activates transcriptional pathways associated with mitochondrial stress and how this may help to explain the powerful effects of very high-intensity exercise to improve mitochondrial respiratory function. The results of training studies incorporating whole-muscle proteomics will then be used to highlight an intricate and previously undemonstrated network of differentially prioritised mitochondrial adaptations that occur in response to different types of training. It will be shown that changes in hundreds of transcripts, proteins, and lipids are not stoichiometrically linked to the overall increase in mitochondrial content. Finally, the results of single-fibre proteomics show how exercise intensity influences fibre recruitment and ultimately induces fibre-specific changes in mitochondrial proteins that can help to explain how different types of exercise induce divergent mitochondrial adaptations. Finally, this presentation will highlight how these exciting new tools can help exercise and sport scientists to better understand how best to prescribe exercise to achieve specific mitochondrial adaptations. The target audience will be both exercise and sport scientists with an interest in the mechanisms that underlie adaptations to exercise training.

Oral presentations

OP-AP43 Paralympics

PACING PROFILE BY CLASSIFICATION IN ELITE PARACYCLING

LE TOQUIN, B., SCHIPMAN, J., HAMRI, I., FORSTMANN, N., BACONNAIS, M., WEISSLAND, T., TOUSSAINT, J.F.
INSEP

INTRODUCTION: Pacing profile in cycling and paracycling studies can provide insight into the underlying physiological processes during specific events. In elite paracycling, it can also give insight into the effect of classification (thus disabilities) on cycling performance. Furthermore, analysis of the pacing strategies employed by successful athletes can provide information on optimal pacing strategy for a given event, and suggest opportunities for performance enhancement. This study aims to 1/ investigated the effect of classification on the pacing profile used in paracycling track events. 2/ analyze the pacing strategy of world championship medalists.

METHODS: All the results and split times (every 125m) of male (525 performances) and female (261 performances) paracyclists in 6 world championships from 2014 to 2022 have been collected on the RSStiming website. Data are based on the 1km Time Trial (TT), 500m TT and Individual Pursuit (IP) events. Analysis of variance with repeated measures was used to examine differences in 250m split times during IP events and differences in 125m split times during the 1km TT and 500m TT. Post-hoc analysis was performed using Student's t test for paired data, with alpha adjusted by the Bonferroni method. In order to analyse the decay kinetics of the speed over the course of an event, a speed decrease index (SPI) was calculated for each performance. Finally, to investigate if there were any differences in the pacing strategies between medalists and non medalist. The performance data from each world championships was split into 3 groups (Top 3; Top 8; Top 20) in each classification. A pairwise Wilcoxon test with Bonferroni adjustment to identify differences between each performance group was used.

RESULTS: First lap mean speed (0-250m split) and second lap (375-500m) was significantly different between classification ($p<0.05$) in each male and female event. In 1km TT, each classification reaches mean top speed in 375-500m before losing speed suggesting an identical pacing strategy. Pacing profile in each event suggest an «all-out» strategy and was not different between classifications. No significative difference between classification was found in SPI in each event ($p > 0.05$). However, a significative difference was found between the Top 3 and Top 8 SPI ($p<0.05$) in male and female individual pursuit events in C5 and C4 classification.

CONCLUSION: This study provides insights into the impact of paracycling classification system in para-cycling. In C5 and C4 classification, this study suggests that the best performers seem to be differentiated by their ability to not lose velocity during the race. The significant differences between each category during the first 2 laps indicate an impact of the classification (and thus of the disability) on the start.

HOW TO BE A FINALIST IN THE 3-POSITION RIFLE EVENT IN PARA-SHOOTING?

SCHIPMAN, J., BACONNAIS, M., SAUVEPLANE, V., CHAUSSÉ, M., FORSTMANN, N., TOUSSAINT, J.F.

INSEP

INTRODUCTION: The Paralympic mens 50m 3-position rifle event (R7) is performed in the following order: kneeling, prone and standing. In the prone position, both elbows are placed on a support, which offers stability. On the contrary, in the standing position, neither elbow is supported. 120 shots are fired in the qualification round (12 series of 10 shots), i.e. 40 shots per position. The maximum value per shot is 10.9 points, that is a theoretical maximum of 436 points per position for a total of 1308 points at the end. Following the qualification phase, the 8-best para-shooters advance to the final. The objective of this study is to analyze if one position among the three is discriminating between the para-shooters who reach the final (finalists) and those eliminated in the qualification phase (non-finalists).

METHODS: 29 competitions between 2014 and 2022 were collected on the international competition results website (SIUS Shooting), representing 716 performances by 76 para-shooters. The number of points obtained per position was added up to create three performance indicators for each position.

To analyze and quantify the difference in profiles between finalists and non-finalists, a Bayesian Inference via Markov Chain Monte Carlo was used from estimates of the posteriori distribution of θ (θ = (θ1, θ2, ..., θn), i.e., all parameters) and credibility intervals (θ be in the interval [a; b] with probability (1 -α)). Differences in mean scores were investigated between each sample pair for the finalist and not finalist groups (kneeling vs. standing, prone vs. kneeling, prone vs. standing).

RESULTS: Among the finalists, the mean differences in scores between the kneeling vs. standing and prone vs. kneeling positions are 7,7 and 7,2 respectively. Between the prone vs. standing positions, the difference in means is higher, at 14,8.

Among the non-finalists, the mean differences in scores between the kneeling vs. standing positions is 13,9, between the prone vs. kneeling positions is 11,5 and between the prone and standing positions is 26.0.

Between finalists and non-finalists, in the kneeling position, the difference in mean scores is 10,7. In the prone position, the difference in mean scores is 6,3. In standing position, the difference in mean score is 16,7. From the first 4 heats (kneeling), the finalists start to stand out. The next 4 heats (prone) maintain the gap between the para without increasing it. Finally, the last 4 heats (standing) widen the gap between the finalists and the non-finalists.

CONCLUSION: Bayesian analysis showed that there is a significant difference in profiles between para-shooters. The non-finalists show significant differences between the three positions. Finalist para-shooters shot better in the prone position than in the standing position, better in the kneeling position than in the standing position, and better in the prone position than in the kneeling position. Conversely, although there was a significant difference between the prone and standing positions,

KATA SELECTION OF INTELLECTUALLY IMPAIRED ATHLETES AT THE TOP-LEVEL PARA-KARATE COMPETITIONS

AUGUSTOVICOVA, D., STYRIAK, R.

COMENIUS UNIVERSITY

INTRODUCTION: Para-karate made its debut at the World Championships in Linz 2012 and since then it has been an integral part of the WKF Senior World Championships, which take place every two years. The top-level kata performance analysis is common [1,2], but there is limited knowledge of performance structure in top-level para-karate kata competitions for intellectually impaired (II) athletes. Repetition of the same kata is allowed for II athletes [3].

The main goal of the study is to describe the type and frequency of performed katas at the three consecutive World (2016, 2018, 2021) and four European (2018, 2019, 2021, 2022) para-karate championships. Then, investigate if there is a relationship between the sport class (II athletes and II athletes with Down syndrome) and the kata selection.

METHODS: All performed katas during seven top-level events were recorded. Competitors gender, name of the performed kata, and sport class were recorded. A chi-square test and descriptive statistics were conducted. A total of 245 kata were performed (153 in the male and 92 in the female category).

RESULTS: The most performed katas were Gojushiho Sho (29%), the same as in able-bodied kata competition, followed by Jion (9%), Suparinpei (9%), Chatanyara Kushanku (8%), and Sansai (7%). There is a significant relationship between sport class and choice of katas ($p \leq 0.05$). The Jion kata is not found in able-bodied competition. Athletes with Down syndrome select for the competition katas with lower athletic and technical levels, with a lower fast-slow movement ratio [4]. Only 5 athletes perform two different katas during one competition.

CONCLUSION: Top-level II athletes have a similar kata selection as the no-impaired karate athletes. The WKF Para-karate rules allow the repetition of the same kata during all rounds of the competition. Therefore, II athletes and their coaches prefer to use only the one and the most challenging kata to succeed with a lower rate of fast-slow movement ratio.

This abstract is a part of the VEGA project (number 1/0611/23).

References

1. Novosad A, Argajova J, Augustovicova D., New kata evaluation in top-level karate: Analysis of frequency and score of katas in k1 premier league. Archives of Budo. 2020;16:153–60.

2. Augustovicova DC, Argajova J, García MS, Rodríguez MM, Arriaza R., Top-level karate : analysis of frequency and successfulness of katas in K1 Premiere League. IDO MOVEMENT FOR CULTURE Journal of Martial Arts Anthropology. 2018;18(4):46–53.

3. World Karate Federation. World Karate Federation (WKF). 2023;1–52. Available from: www.wkf.net

4. Argajova J., Time-motion analysis of the most performed katas at the top-level karate competition. In: European Col-Book of Abstracts. Seville: European Colledge of Sport Sciences; 2020.

IMPACT OF CAMBER ON REAR WHEEL KINETICS FOR MWC SPORTS

FRITSCH, C., ALTAMIRANO, A., BASCOU, J., THOREUX, P., SAURET, C.

INSTITUTION NATIONALE DES INVALIDES - ARTS ET MÉTIERS INSTITUTE OF TECHNOLOGY

INTRODUCTION: Manual wheelchair (MWC) sports require athletes to apply strong repetitive forces on the handrims to accelerate, turn or stop. For many MWC sports, manoeuvrability is critical to performance and, to this extent, the MWC configuration is usually modified by adding camber to the rear wheels. However, rolling resistance was observed to increase with camber (1). Besides, if the interest of camber on shoulder load was already shown, questions remain on the resulting power output at the wheel. This study aims to evaluate the maximum power produced by the user during propulsion for two MWC configurations, with and without camber, using a wheelchair ergometer.

METHODS: Five able-bodied participants were tested on a fully adjustable wheelchair ergometer equipped with 6-axis sensors on the handrims and velocity-controlled wheels. Seat height and fore-aft position were set as recommended for each subject (2,3). Camber angle was tested at 0 and 15° while keeping the other configuration parameters - and thus the joint configuration with the hand at the top dead centre of the handrim - strictly identical between the two configurations. For each configuration, participants were asked to apply maximum force on the handrims (x5) while wheels were turning at equivalent linear velocities of the MWC of 0.15, 1.0, 1.5 and 2.75 m/s, performed in a randomized order. The maximal propulsive moment was identified for each velocity in each configuration, and a linear regression was performed to identify the moment-velocity profile (4). Finally, the maximal theoretical power was derived from the power-velocity profile for each participant in each configuration (4). Results were compared between configurations with a Wilcoxon signed rank test.

RESULTS: Maximal propulsive moment was higher for all tested velocities in the configuration with camber (from 39.3±11.1 N.m at 0.15 m/s to 12.2±2.7 N.m at 2.75 m/s) than without (from 38.0±13.3 N.m at 0.15 m/s to 10.5±2.3 N.m at 2.75 m/s) but with no significative difference between the two ($p>0.1$). The maximal theoretical power was different between configurations (160.6±8.6 W with camber, 142.8±23.3 W without) with a 10% significance level ($p=0.06$).

CONCLUSION: Despite a higher rolling resistance with increasing camber, power output seems to be greater with camber than without. Indeed, the significance level of the difference in maximal power between configurations is above but close to 5%, which could be due to the small number of participants. Therefore, performance should not be impacted by adding camber to the wheels, especially linear acceleration. Moreover, these first results have proven the feasibility of testing and evaluating different configurations in similar velocity conditions, which could lead in the future to further tests with more modifications on the configuration and more velocity conditions.

REFERENCES:

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4) Hintzy et al., J. Sports Sci., 2003

Oral presentations

OP-AP01 Training and Testing: Running

SAME-DAY RECOVERY FOLLOWING MODERATE INTENSITY EXERCISE IS NOT IMPACTED BY HOT- OR COLD-WATER IMMERSION POST EXERCISE IN TRAINED RUNNERS

MENZIES, C.

COVENTRY UNIVERSITY

INTRODUCTION: Post-exercise body temperature manipulation is a popular recovery strategy [1, 2], with both heating and cooling suggested to enhance recovery through alterations in tissue temperature and blood flow [3, 4]. However, post-exercise sauna-bathing has been shown to decrease next day performance [5], with biomarkers associated with fatigue (e.g. Interleukin-6 (IL-6), cortisol) increasing following passive heating [6, 7]. Therefore, this study aimed to assess same-day recovery following post-exercise hot (HWI) or cold (CWI) water immersion.

METHODS: Trained runners (n = 14. 11 males, VO2max: 3.4 ± 0.6 L/min) performed three trials consisting of two 45-min moderate intensity treadmill runs (Run 1, Run 2) separated by six hours. Following each Run 1, participants completed HWI (30 min, 40 °C), CWI (15 min, 14 °C), or control (CON; ambient rest) in a randomised order. Perceived effort and recovery were measured using Ratings of Perceived Exertion (RPE) and the Acute Recovery and Stress Scale (ARSS). Venous concentrations of adrenaline, noradrenaline, cortisol, IL-6, and its soluble receptor were measured. Femoral blood flow and rectal temperature were measured after the intervention following Run 1. Main effects were determined using linear

mixed-effects modelling with significance set as $p < 0.05$, with effect sizes compared to CON calculated as the mean difference divided by the square root of the sum of the random variance.

RESULTS: There was no difference between conditions in perceptions of recovery, as measured by RPE, during Run 2 (12 ± 2 AU, $p = 0.68$. HWI: $d = 0.1$, CWI: $d = 0.2$) or any of the ARSS subscales ($p > 0.05$), despite a significant effect of time for overall recovery, mental performance capacity, physical performance capability, and emotional balance ($p < 0.05$). Similarly, there was no effect of condition on any of the measured circulating biomarkers ($p > 0.05$). Adrenaline (0.3 ± 0.2 ng/mL) and noradrenaline (3.3 ± 1.4 ng/mL) peaked immediately post Run 1, whilst IL-6 peaked following the intervention period (2.1 ± 1.1 pg/mL). Femoral blood flow was significantly different between conditions post intervention ($p < 0.001$), being highest in the HWI condition (HWI: 661 ± 180 ml/min, $d = 4.5$, CWI: 67 ± 23 ml/min, $d = 1.1$. CON: 181 ± 56ml/min). Rectal temperature also differed between conditions post intervention ($p < 0.001$. HWI: 38.3 ± 0.4 °C, $d = 2.7$. CWI: 36.9 ± 0.3 °C, $d = 0.5$. CON: 37.1 ± 0.2 °C).

CONCLUSION: These data demonstrate limited effects of post-exercise HWI or CWI on perceptions of recovery and associated biomarkers, despite large differences in femoral blood flow and rectal temperature. Further work is required to investigate the effects of repeated post-exercise temperature manipulation on recovery, fatigue, adaptation, and improvements in performance.

References:

1. Menzies et al. (2022). 2. Allan et al. (2021). 3. Kim et al. (2020). 4. Ihsan et al. (2016). 5. Skorski et al. (2019). 6. Faulkner et al. (2017). 7. Ježova et al. (1994).

STRENGTH TRAINING IMPROVES TIME TO EXHAUSTION SUBSEQUENT TO A PROLONGED RUN IN WELL-TRAINED MALE ENDURANCE RUNNERS: A RANDOMISED CONTROL TRIAL

ZANINI, M.1, FOLLAND, J.P.1, BLAGROVE, R.C.1

1. LOUGHBOROUGH UNIVERSITY

INTRODUCTION: Strength training has been shown to improve time trial performance and running economy (RE) when unfatigued in endurance runners (1). However, RE increases as runners fatigue (2) and consequently, the ability to produce high-intensity efforts, that often determines a race outcome, is reduced. Whether strength training improves RE over a strenuous prolonged run and alters the capacity to produce a high-intensity effort at the end of it, has not been investigated. This study aimed to examine the effect of strength training on the energy cost of running over 90 min and subsequent time to exhaustion (TTE) at a high-intensity in endurance runners.

METHODS: Thirty-eight well-trained male endurance runners (maximal oxygen uptake (VO2max) 58.6±7.0 ml/kg/min) were performance-matched and randomly assigned to a control (CG) and a strength training group (SG). The CG continued their regular training, while the SG added maximal strength and plyometric training twice weekly for 10 weeks. Before the training, participants completed an incremental test to determine lactate threshold 1 and 2 (LT1 and LT2) and VO2max, and on a separate day a 90min run at 10% delta between LT1 and LT2 (13.1±1.5 km/h, 80.7±4.0% VO2max). RE quantified as energy cost and rate of perceived exertion (RPE) were recorded at 15, 60, 75, and 90 min during the run. Following the 90 min run, participants completed a TTE run at 95% VO2max (16.1±1.6 km/h). A two-way repeated measures ANOVA with Bonferroni post-hoc correction was used to detect changes between groups, in TTE and pre-post delta in RE and RPE. Significance was defined as $p<0.05$ and effect size (ES) was calculated as partial-eta squared.

RESULTS: Twenty-eight subjects completed the study (14 SG, 14 CG). A significant and large group x time effect was detected for TTE ($p<0.01$, ES=0.48), with SG improving by 42±35% (251s vs 352s; $p<0.01$, ES=0.50), and CG worsening by 8±52% ($p>0.05$). There was a significant and large effect of trial time x group in RE ($p=0.04$, ES=0.21). Pre-post RE did not change between SG and CG at 15min, it was significantly better at 60 min (-0.2% vs 2.5%; $p=0.02$, ES=0.37), but not at 75 (-1.0% vs +2.2%; $p=0.06$, ES=0.26) or 90 min (-1.5% vs +2.1%; $p=0.10$, ES=0.21). Pre-post RPE was significantly lower in SG at 90min ($p=0.03$, ES=0.31), and decreased more (-7.8%, 15.8±2.0 vs 14.5±2.2) than CG (+5.8%, 16.6±1.6 vs 17.4±1.7) at the same time-point ($p=0.04$, ES=0.28).

CONCLUSION: Ten weeks of strength training in well-trained male endurance runners significantly improved TTE and reduced RPE following a prolonged run. RE changes between SG and CG were not different at 15, 75 and 90 min, but SG improved significantly at 60 min. These findings are in line with previous research on strength training in elite cyclists (3). Further research is warranted to clarify the adaptations to strength training contributing to TTE improvement and RPE reduction in a fatigued state.

1. Blagrove et al. (2018), 2. Brueckner et al. (1991), 3. Ronnestad et al. (2011)

THE EFFECT OF XC-RUNNING RACE LIDINGÖLOPPET ON RUNNING ECONOMY AND DETERMINANTS OF PERFORMANCE

RAPP, E.1, SUNDQVIST, C.2, CARDINALE, D.1,2

1.SWEDISH SCHOOL OF SPORT AND HEALTH SCIENCES, STOCKHOLM, SWEDEN 2.ELITE PERFORMANCE CENTRE, BOSÖN, SWEDISH SPORTS CONFEDERATION, LIDINGÖ, SWEDEN

INTRODUCTION: Determinants of running performance on flat terrain are known to be; running economy (RE), maximal oxygen consumption (VO2max) and fractional utilization (FU) (1). Off-road running performance is seldom studied with varying results between studies (2). Furthermore there is not an agreement between studies on how RE is influenced by fatigue induced by off-road running events, some indicating increased cost of running (3) whereas some showing de-

creased cost of running (4). The aim of this study was therefore to investigate determinants of performance in a 30 km cross-country (XC) running race with 522 m elevation gain and to investigate how RE is affected by the race.

METHODS: Thirteen runners (age 35±4 yr; VO2max 62.3±5.8 ml/kg/min) performed three testing sessions: 1. Laboratory testing of oxygen cost of running (CrOx), respiratory exchange ratio (RER), substrate utilization (fat% and carb%) during 5-min treadmill running at 14km/h as well as measurements of estimated lactate threshold (θLT), respiratory compensation point (RCP), VO2max (ml/kg/min) and speed at VO2max (vVO2max) during a graded exercise test (GXT). 2. Measurement of body composition using dual-energy X-ray absorptiometry. 3. Performing the race followed directly by measurements measurement of CrOx, Cr, fat%, carb% and RER running at 14km/h for 5 min. Analysis of CrOx, Cr and RER were performed using the last minute in the 5-min submaximal segments. For changes between pre- and post-race students t.test was performed. Determinants of performance was investigated using Pearsons correlation between race time and pre-test variables and performing multiple linear regression with race time as dependant variable.

RESULTS: CrOx (201.6±13.8 vs 208.4±9.3 ml/kg/km, p=0.041) and fat% (29±12 vs 48±18 %, p<0.01) increased post-race whereas carb% (71±12 vs 53±18 %, p<0.01) and RER (0.85±0.05 vs 0.91±0.04, p<0.01) decreased. Variance in race performance was best explained (R2=0.813, adjusted R2=0.743) by RER, CrOx and ml/kg/min at θLT. Race performance was significantly correlated to RER (r=0.645, p=0.017), CrOx (r=0.682, p=0.01), vVO2max (r=-0.757, p=0.004), speed θLT (r=-0.777, p=0.003) , ml/kg/min at θLT (r=-0.593, p=0.042) and speed at RCP (r=-0.722, p=0.012). VO2max (r=-0.575, p=0.051), ml/kg/min at RCP (r=-0.5, p=0.118), body fat % (r=0.51, p=0.109) did not correlate significantly with performance.

CONCLUSION: RE, CrOx, together with FU, θLT and RCP, and RER are strong determinants of 30 km XC-running race performance as shown by their capability to explain variance in performance time and by the relationship between performance time and CrOx, Cr, θLT, RCP and RER. However, weak determinants were VO2max and body composition as neither did relate to performance. The increase in CrOx with race-induced fatigue showed changes in RE, likely explained by the increase in fat% and decrease in carb%.

1. Basset & Howley (2000) 2. de Waal et al. (2021) 3. Sabater Pastor et al. (2021) 4. Vernillo et al. (2017)

"WHY I MONITOR": WORLD-CLASS ENDURANCE COACHES' PERSPECTIVES OF ATHLETE MONITORING

TIMMERMAN, W., STANLEY, M., ABBISS, C., LAWLER, N., RAYNOR, A.

EDITH COWAN UNIVERSITY

INTRODUCTION: Athlete monitoring literature tends to focus on the tools and techniques of data collection and analysis, however there is a current lack of understanding as to why coaches implement these tools in their coaching. Therefore, the purpose of this research project was to elicit insights into why world-class endurance coaches conduct athlete monitoring practices.

METHODS: A qualitative descriptive research design was employed, using semi-structured interviews (Sandelowski, 2010). Twelve male coaches across canoeing, road and track cycling, rowing, triathlon, and swimming from Australia, Canada, Italy, South Africa, Spain, the USA, and the UK with 16.8 ± 6.4 years of experience were recruited. Eligible participants coached at least one endurance athlete to a top-3 performance in Major Games, World Championship, or cycling Grand Tour. The interview transcripts were analysed inductively using the iterative process of reflexive thematic analysis (Braun & Clarke, 2022). Rigour has been addressed through prolonged engagement with the data, peer examination where co-authors acted as critical friends, dense descriptions of the participants and research methods, and a documented audit trail of the research decisions.

RESULTS: The analysis generated five themes "Athlete involvement", "Tracking progress", "Learning and understanding", "Decision making", and "Achieving athletic potential". Tracking athletes' progress provides information to improve the coaches' understanding of their athletes and lead to more informed and contextualised decisions. The coaches perceive that athlete monitoring improves their decision-making to drive and adjust the training program while reducing negative training consequences, such as injury or illness, which is expected to contribute to athletes achieving their potential. Athlete monitoring is also used as a strategy to keep the athletes more closely engaged with their training process.

CONCLUSION: The in-depth insights gained from this study indicate that athlete monitoring has various important roles for world-class endurance coaches. For sports scientists, understanding the various purposes and nuances of athlete monitoring can assist them in providing suitable information at the right time to the coach, thus impacting the decision process and athlete's performance. Future research can explore how world-class coaches use athlete monitoring information to make decisions to refine the training program for the individual athlete and assess the impact coach background, coach-athlete relationship, and athlete information availability and presentation have on coaches' decision-making process and outcomes.

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SEX INFLUENCE ON MUSCLE INFLAMMATION AND FUNCTIONAL RECOVERY AFTER RUNNING-INDUCED MUSCLE DAMAGE

MACCHI, R.1,2, KUNIMASA, Y.3, CORCELLE, B.4, FAZZARI, C.1, POMPORTES, L.1, CHAVET, P.1, VERCRUYSSEN, F.5, BENDAHAN, D.6, NICOL, C.1

1 AIX-MARSEILLE UNIVERSITY; 2 INSEP; 3 NIIGATA UNIVERSITY; 4 UNIVERSITY OF CÔTE DAZUR; 5 UNIVERSITY OF TOULON; 6 CNRS

INTRODUCTION: The repeated ground impacts and stretches involved during the active braking phase of a prolonged running task can induce muscle damage [1]. The resulting inflammatory process leads to functional alterations that peak 1 to 2 days after the exercise. Based on the expected protective effects of oestrogen [2], previous studies have suggested that women would show lower muscle damage and functional decline than men after eccentric exercise. However, results after running exercise in humans are lacking. The purpose of this study was to quantify muscle oedema (based on the cross-sectional area (CSA)) resulting from a 20-km graded running race and to assess the potential relationships with functional and neural changes.

METHODS: Two experimental groups (13 women (28±6 yrs); 14 men (36±9 yrs)) performed the race. The testing protocol included one session before (PRE) and two after the race, either on days 1 or 2 (D1-2) and days 3 or 4 (D3-4). This study included a control group (11 healthy participants, 24±4 yrs) who did not take part in the race and who completed two sessions. CSA and EMG activity were measured in 10 lower-limb muscles. Two functional tests, a squat jump (SJ) and a drop jump (DJ), were performed on a sledge ergometer. A Bayesian multilevel modelling approach allowed to assess the probability (pd) that the changes in participant involved in the race were different from those in the control group. Correlations and a self-organizing map (SOM) were used to assess the relationships between structural, functional and neural changes.

RESULTS: Men ran faster than women (1:44±0:09 h vs. 1:58±0:15 h, $p<0.01$). Regardless of sex, VL, SM, GL and TA showed a CSA increase up to D3-4 (pd=0.99). The SM CSA increase was higher in women than in men at D3-4 (+5.7 %). SJ performance decreased up to D3-4 for both sexes (pd=1). DJ performance decreased for women at D1-2 only (βD1-2 = -4.6±1.1 %; pd=0.99), but for men until D3-4 (βD1-2 = -6.1±1.1 %; βD3-4 = -6.2±1.4 %, pd=1). At D1-2, the increased gastrocnemius CSA was associated with an increased braking force in women whereas men decreased their lower-limb stiffness. Other structural-functional relationships were not always intuitive, but the SOM analysis revealed the combined influence of neural adjustments that did not depend on sex.

CONCLUSION: As previously reported [3], functional recovery is both sex- and test-dependent, and lasts longer in men in the DJ test. However, challenging the protective oestrogen effect, women showed more signs of inflammation in the SM muscle. The correlations highlight that structural alterations do not induce similar functional changes as function of sex and even opposite behaviours in DJ. The SOM analysis illustrates the complexity of neural adjustments related to dynamic multi-joint tests under fatiguing conditions.

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Oral presentations

OP-PN02 Physiology: Fatigue

WHICH FEATURES INFLUENCE MENTAL FATIGUE RESISTANCE? A PRELIMINARY ANALYSIS USING PERFORMANCE DETERMINING FACTORS

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INTRODUCTION: Mental fatigue (MF) is known to negatively impact physical and cognitive performance. These effects seem to diminish based on the training level of participants, essentially creating a resistance to MF. However, not only are results on this resistance inconsistent across studies, it is still unclear which features might be responsible for it. Therefore, the goal of the present experiment was to assess the influence of different performance defining features on the MF response.

METHODS: Forty nine participants (26 men; 23 women; age = 31± 9 y; BMI = 22.79 ± 2.36 kg/m2 ; VO2Max = 46.92 ± 8.03 ml/min/kg) were included in this randomized counterbalanced crossover trial. At familiarization, researchers assessed features of participants that determine both physical and cognitive performance: VO2max (maximal incremental exercise test), sport expertise (questionnaire), response inhibition (cognitive task) and mental toughness (questionnaire). During subsequent visits, participants were either subjected to a 45 min Stroop task or a documentary before performing a cognitive (i.e. Go-NoGo task) and physical (i.e. time trial) performance test. The subjective level of MF was determined via M-VAS.

RESULTS: Statistical analysis showed a significant increase over time in subjective MF in the intervention condition (F = 89.25; p < 0.001; effect size (ES) = 0.65) and a significant increase in the intervention compared to the control condition at relevant time points (after the Stroop task (MF = 65.6 ± 20.3; CON = 28.0 ± 20.5): t = 10,37; p < 0.001; ES = 1.48). This subjective increase in MF translated to a significant negative effect on almost all aspects of cognitive performance (Go reaction time (MF = 385.10 ± 32.78 ms; CON = 368.80 ± 33.90 ms): t = 5.42; p < 0.001; ES = 0.77; Go accuracy (MF = 98 ± 2%; CON = 99 ± 1%): t = -2.20; p = 0.032; ES = -0.32; NoGo accuracy (MF = 89 ± 1%; CON = 91 ± 1%): t = -1.27; p = 0.211; ES = -0.18). There was no significant effect of MF on the distance parameter of the time trial (MF = 12.07 ± 1.56 km; CON = 12.34 ± 1.42 km; t = -1.85; p = 0.071; ES = -0.27). A multiple regression analysis incorporating the mentioned variables provided no significant prediction of the difference in cognitive and physical performance between the intervention and control group. Adjusted R square values of the predictions ranged between 0 and 8%.

CONCLUSION: The present study confirms a negative effect of mental fatigue on cognitive performance, while a trend to significance was found for the effect on physical performance. However, the most novel finding of the trial is that different aspects that determine an individual's performance level did not significantly predict the response to mental fatigue. The present analysis therefore primarily shows that the interindividual differences in mental fatigue resistance in the general population are influenced by an abundance of unknown and, most of the times, neglected internal and external factors.

EFFECTS OF INSPIRATORY MUSCLE FATIGUE ON EXERCISE PERFORMANCE IN YOUNG AND MASTER ATHLETES

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INTRODUCTION: An increase in ventilatory work and associated respiratory muscle fatigue can compromise exercise performance by reducing blood flow and accelerating the development of fatigue in working muscles. Old individuals have a greater work of breathing during exercise, mainly because of reduced lung elastic recoil and/or increased airway resistance, suggesting that aged athletes (i.e. master athletes) may be especially susceptible to locomotor muscle fatigue with the increase in respiratory muscle fatigue. We tested this hypothesis by modulating the level of inspiratory muscle fatigue prior to intense exercise in young and master endurance athletes.

METHODS: Eight young (YA; age, 26.3±4.2 years; VO2MAX, 65.8±4.8 mL.min-1.kg-1) and eight master (MA; age, 64.7±5.3 years; VO2MAX, 48.3±5.8 mL.min-1.kg-1) endurance athletes performed, on separate visits, on a cycle ergometer, 1 maximal and graded test and 2 constant workload tests at 90% of peak power output to the limit of tolerance following an inspiratory resistive breathing task at 60% (CWT60%) or at 2% (CWT2%) of maximal inspiratory pressure (PIMAX) determined at rest. CWT60% and CWT2% were performed until failure and for 10 minutes, respectively. During the last visit, participants reproduced CWT2% but exercise was stopped when the same amount of work than CWT60% was reached (CWT2% ISOWORK). Quadriceps fatigue was assessed via pre- to postexercise (15s to 15min recovery) changes in maximal voluntary isometric contraction (MViC) and potentiated twitch force evoked by single electrical stimulation of the femoral nerve (QTsingle). Inspiratory muscle fatigue was assessed via pre- to post resistive breathing task changes in PIMAX.

RESULTS: PIMAX significantly decreased after CWT60% (ΔCWT60% = -19.3±7.4 cmH2O, p=0.002) but not after CWT2% (ΔCWT2%= -5.1±7.4 cmH2O, p>0.05) indicating inspiratory muscles fatigue prior exercise in CWT60%. Time to exhaustion significantly decreased in CWT60% (YA: 6.4±3.2 min; MA: 4.9±3.2 min) compared to CWT2% (YA: 7.7±2.9 min; MA: 7.9±4.5 min). This reduction in performance was 2.5 times greater (p <0.05) in MA (-35.2±20.1%) vs. YA (-14.3±16.7%). Despite the difference in exercise performance, reduction in MViC and QTsingle were similar following CWT60% (MVC, YA: -14.8%, MA: -13.3%; QTsingle, YA: -30.1%, MA: -26.8%) and CWT2% (MVC, YA: -15.7%, MA: -12.5%; QTsingle, YA: -28.8%, MA: -25.9%). In contrast, fatigue was less following CWT2 ISOWORK (MVC, YA: -9.7%; MA: -9.2%; QTsingle, YA: -23.9%; MA: -22.2%).

CONCLUSION: These findings suggest that inspiratory muscle fatigue accelerates the development rather than accentuates the severity of locomotor muscle fatigue and impairs exercise performance in endurance trained men. Despite similar levels of locomotor muscle fatigue, exercise performance impairment was more pronounced in master than in young athletes. With aging, inspiratory muscle fatigue thus increases the rate of locomotor muscle fatigue development during exercise.

IMPACT OF SINGLE AND INTERMITTENT/PROLONGED HOT-WATER IMMERSIONS ON SKELETAL MUSCLE FORCE AND FATIGABILITY IN YOUNG MALES

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INTRODUCTION: Passive heating such as hot-water immersion (HWI) increases rectal (Tre) and muscle (Tmu) temperatures, which could affect central and peripheral factors associated with neuromuscular function, respectively. Although HWI may influence maximal voluntary force and voluntary activation, as well as involuntary force and fatigue resistance, it is unknown whether the duration of HWI could have an impact on muscle function. Therefore, the aim of this study was to investigate the effect of single and intermittent/prolonged HWI on muscle torque, voluntary activation, and muscle fatiguability during electrically induced contractions.

METHODS: Twelve active males (27.2 ± 6.6 years old) were recruited for this study, including 2 phases: the phase "single exposure", (single phase, SP), followed by the phase "intermittent/prolonged exposure" (intermittent/prolonged phase,

IPP). Each phase consisted of 2 conditions performed randomly: HWI (44.5 °C water bath up to the iliac crest) or control sitting (CON). HWI was either continuous for 45 min (SP-HWI) or intermittent/prolonged for 300 min (IPP-HWI: initial 45 min followed by 8 x 15 min). Tmu (3 cm depth), Trec and physiological strain index (PSI) were determined. Neuromuscular testing was performed at baseline (BL) and 60 min after BL during SP, and at BL, 60, 90, 150 and 300 min after BL during IPP. Quadriceps muscle was electrically stimulated during these tests to determine torques at low (20 Hz: P20) and high (100 Hz: P100) frequencies, and P20/P100 ratio. Maximal voluntary isometric torque of the knee extensors (MVIC) and central activation ratio (CAR) were also determined. A fatiguing protocol (100 x 250-ms test train stimulation at 100 Hz of the knee extensors) was performed after the last neuromuscular testing (i.e., after 60 min in SP, and after 300 min in IPP) and torque fatigue index was calculated.

RESULTS: Compared to BL, similar increases after SP-HWI and IPP-HWI were found for Trec, Tmu and PSI ($p<0.001$). P20 and P100 were not significantly affected by HWI, while P20/P100 was slightly lower after SP-HWI and IPP-HWI compared to CON conditions ($p<0.05$). The reduction of MVIC (compared to BL) was larger after IPP-HWI than SP-HWI (-37.4 ± 39.4 Nm vs. -3.0 ± 10.9 Nm, $p=0.01$), and the reduction of CAR (compared to BL) tended to be higher after IPP-HWI than SP-HWI ($p=0.08$). Torque fatigue index was higher in HWI than in CON conditions, irrespective of the duration of HWI (condition effect, $p=0.001$).

CONCLUSION: HWI does not affect involuntary force but elicits a shift towards a faster contractile profile (i.e., decreased P20/P100) independent of the duration of heating. A larger reduction of MVIC (compared to BL) is found after IPP-HWI than SP-HWI, despite similar increases in Trec, Tmu and PSI. This result might be partly explained by the larger reduction of voluntary activation (although not significant) found after IPP-HWI than SP-HWI. Finally, HWI increases muscle fatigability regardless of the duration of exposure.

EFFECTS OF REPEATED CRYOSTIMULATION ON SLEEP QUALITY OF ELITE SWIMMERS DURING AN INTENSE TRAINING PERIOD.

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LABORATOIRE MOVE

INTRODUCTION: Elite athletes and swimmers in particular are subject to intense training (IT) loads many times during their season. IT may lead to fatigue accumulation, and requires proper recovery to optimize physiological adaptations. Among the large variety of recovery techniques, cryostimulation appears as an effective tool triggering various beneficial physiological effects for athletes' recovery. This technique consists in a short exposure (3 min) to very cold air (-110°) and is recognized to induce an improvement of physical and psychological wellness, a decreased inflammatory response, an activation of the parasympathetic cardiac tone, as well as beneficial effects on sleep, one of the key components of recovery.

This study aimed to evaluate the effects of daily partial body cryostimulation (PBC) exposure on sleep and recovery, in elite swimmers undergoing an intense training (IT) period.

METHODS: Twenty three elite French swimmers (7 females ; 16 males) were involved in this controlled cross-over protocol. The experiment took place during two weeks of IT load. Each week (5 days and 5 nights) represented one of the two experimental conditions: CRYO or CONT. A daily PBC exposure of 3 min at -110° was conducted - or not - during 5 consecutive days after the evening training. During the experiment, perceived anxiety, tiredness and depression, sleep quality (via actimetry and cerebral recording), and nocturnal heart rate variability (HRV), were evaluated. Salivary collection also permitted the measurement of anti-inflammatory markers. Salivary melatonin and CRP were measured in specimen collected at 10 p.m. and 6 a.m., respectively.

RESULTS: Perceived anxiety, tiredness and depression were reduced after the CRYO week, concomitant with an improved mood profile. Recordings of cerebral activity during the night highlighted an increased slow wave sleep duration of the first sleep cycle, during the CRYO condition. The other sleep parameters including total sleep time, sleep latency, efficiency or movements during the night remained unchanged. Whatever the condition was, salivary melatonin concentrations were higher before the fifth night of the protocol, whereas the mean C-reactive protein concentrations were lower in the CRYO week compared to the CONT one. Moreover, sleep analysis differed between good and bad sleepers. Nocturnal LF/HF ratio was higher in bad sleepers compared to good sleepers, whatever the condition was, suggesting a lower parasympathetic activity in swimmers subjected to lower sleep quality.

CONCLUSION: Repeated cryostimulation exposures during one week of IT improved perceived wellness of elite swimmers. It reduced inflammation and modulated sleep architecture by increasing SWS duration. Nocturnal HRV exhibited distinct patterns among swimmers depending on their sleep quality.

EXPLORING THE NEUROPHYSIOLOGICAL IMPACT OF MENTAL FATIGUE ON STRENGTH ENDURANCE: UNCOVERING THE ROLE OF MOVEMENT-RELATED CORTICAL POTENTIALS

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INTRODUCTION: Mental fatigue has become a significant area of focus within sports science due to its potential to decrease cognitive and physical performance. This psychobiological state has been shown to reduce accuracy, increase response time, and impair several physical performances, primarily endurance performances such as running and cy-

cling, mostly by increasing the ratings of perceived effort (RPE) without affecting physiological measures. The processing of neural signals in the brain is affected by mental fatigue, potentially providing further clues to unravel the link between mental fatigue and RPE. This study aimed to investigate whether performing a submaximal endurance leg extension task in a mentally fatigued state would lead to higher RPE than in a non-mentally fatigued state, and if so, whether the central motor command would be increased and reflected as an increased movement-related cortical potential-amplitude measured with electroencephalography (EEG).

METHODS: Fourteen healthy subjects (age: 23 ± 2 y, 5 females, 9 males) came to our lab for one familiarization trial and two experimental trials in this randomized, blinded, cross-over study. Participants had to complete a submaximal leg extension task after a mentally fatiguing task (an individualized 60 minutes Stroop task) or control task (documentary). The leg extension task consisted of performing 100 extensions at 35% of their 1RM, during which multiple physiological (heart rate, EEG, RPE) and psychological measures (MF, cognitive load, motivation) were assessed. These variables were also assessed throughout the rest of the protocol.

RESULTS: The subjective level of mental fatigue, measured by the M-VAS, was significantly higher in the intervention trials (71.71 ± 17.65 after intervention) compared to the control trial (36.64 ± 16.57) ($p<0.001$). Behaviourally, a decrease in accuracy on the Flanker task was detected in the intervention trial (from 0.96 ± 0.03 to 0.94 ± 0.03) ($p<0.05$). During the leg extension task, RPE was slightly higher in the mental fatigue trial than in the control group. Preliminary results of the movement-related cortical potential show no significant differences in amplitudes between both conditions. However, there seem to be individual differences between participants.

CONCLUSION: These results imply that mental fatigue was successfully induced. Preliminary results show that, depending on the individual response to mental fatigue, the amplitude of the movement-related cortical potential might be affected where the first analyses show an elevated or non-affected amplitude. This would support the hypothesis that mental fatigue plays a role in the processing of neural signals in the brain and, as such, affects the performance of an athlete. Further research regarding the individual response to mental fatigue while measuring brain activity is required.

Oral presentations

OP-BM15 Neuromuscular Physiology: Central and/or spinal drive I

IPSI- AND CONTRALATERAL EFFECTS OF AN ACUTE BOUT OF LOCAL TENDON VIBRATION ON BILATERAL H-REFLEX EXCITABILITY

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INTRODUCTION: Vibration via external devices has been frequently used as a training modality for improving athletes' performance and in rehabilitation. Tools providing local vibration (LV) have seen a recent trend in recreational use and physiological and clinical research identifying potential applications. The acute effects of a unilaterally LV on spinal excitability assessed by H-reflexes have only been investigated in the ipsilateral limb. However, there is evidence suggesting a bilateral change in performance after unilateral LV. Thus, it is important to understand the neurophysiology behind bilateral effects of unilateral LV.

METHODS: In 14 subjects (30 ± 5y, 7 females), bilateral soleus H-reflex excitability was tested before and after 20min of unilateral Achilles tendon LV at 45Hz. Initially, an H/M recruitment curve was measured followed by two baseline H-reflex measurements. Before the first H-reflex test, H-reflex amplitude was adjusted to 20% of Mmax. Then, 20 H-reflexes were applied. This was followed by 20min unilateral Achilles tendon vibration to either the left or right leg. Immediately after (0min), 5min, 10min and 15min, H-reflex recordings were repeated in both legs in a counterbalanced order. For analyses, peak to peak H-reflex amplitudes were normalized to Mmax and a repeated measures Anova was performed.

RESULTS: The results show that unilateral Achilles tendon vibration causes a significant suppression of the ipsilateral H-reflexes ($p < 0.0001$). Post-hoc test showed that H-reflex were significantly suppressed at 0min ($p = 0.0004$), 5min ($p = 0.0006$), 10min ($p = 0.0007$) as well as 15min ($p = 0.0009$). For the contralateral side, H-reflexes were significantly reduced ($p = 0.0002$), too. Post-hoc tests showed that H-reflexes were significantly suppressed at 0min ($p = 0.03$), 5min ($p = 0.03$), 10min ($p = 0.01$) as well as 15min ($p = 0.008$).

CONCLUSION: The present study shows that 20min of local unilateral Achilles tendon vibration resulted in a significant reduction of the H-reflex not only in the vibrated ipsilateral, but also the non-vibrated contralateral limb. Even though speculative, the reduced H-reflexes in both limbs might be caused by an increase in bilateral inhibition either caused at the spinal or supraspinal level. For the first time, we have shown immediate bilateral neurophysiological adaptations to LV. These bilateral neural adaptations may be – at least partly – be responsible for the bilateral changes in performance after unilateral LV.

IMPAIRED NEUROMUSCULAR JUNCTION TRANSMISSION AND MOTOR UNITS LOSS PRECEDE SARCOPENIA AND CONTRIBUTE TO THE LOSS OF MUSCLE FUNCTION IN OLD AGE

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INTRODUCTION: Mounting evidence suggests that motoneuron and neuromuscular junction (NMJ) degeneration and motor units (MUs) loss contribute to muscle wasting and weakness in old age. However, these aspects are still poorly investigated in humans. This study aimed at comparing the neuromuscular system integrity and function across different stages of sarcopenia, with particular focus on NMJ and MU potential (MUP) characteristics.

METHODS: We recruited 42 healthy young individuals (YI) (aged 25.8±4.6 yr; 57% females) and 88 older individuals (aged 75.9±4.7 yr; 55% females). The older group underwent a sarcopenia screening according to the revised guidelines of the European Working Group on Sarcopenia in Older People (EWGSOP2), including the handgrip test, the Short Physical Performance Battery (SPPB) and a whole-body dual-energy X-ray absorptiometry (DEXA) scan. In all groups, knee extensors muscle force was evaluated by isometric dynamometry, muscle contractile properties by femoral nerve stimulation, morphology by ultrasound and MUP properties by intramuscular electromyography (iEMG). Motor unit number estimate (iMUNE) was also obtained.

RESULTS: From these evaluations, 39 older individuals were classified as non-sarcopenic, 31 as pre-sarcopenic and 18 as sarcopenic (SAR). Progressive reductions in whole quadriceps cross-sectional area ($p<0.001$) and appendicular lean mass ($p<0.001$) were observed across the different stages of sarcopenia. The three groups of older adults showed alterations in muscle architecture when compared to YI, evident as smaller vastus lateralis pennation angle ($p<0.001$) and increased ultrasound sarcopenia index ($p<0.001$). As expected, knee extensors force ($p<0.001$), handgrip force ($p<0.001$), chair-to-stand power ($p<0.001$) and SPPB score ($p=0.01$) were also progressively impaired. Muscle twitch peak tension was significantly reduced ($p<0.001$) in the older populations, as well as an increased half relaxation time (+19%, $p=0.049$) in SAR vs YI. Investigating potential neuromuscular mechanisms underpinning these alterations in muscle function and physical performance, we observed decreased NMJ transmission in older groups compared to YI, as suggested by elevated near fibre segment jitter ($p<0.001$). Interestingly, iEMG analysis revealed also reduced MU firing rates in SAR vs YI (-15%, $p=0.009$). The iMUNE was significantly lower ($p<0.001$) in the older groups, highlighting an age-related MUs loss.

CONCLUSION: We posit that impaired NMJ transmission and MUs loss likely contribute to the marked loss of muscle function in old age and that these alterations precede sarcopenia. The reduced MU firing rates in sarcopenic individuals may represent an adjustment to match the change in muscle mechanical properties (i.e. increased relaxation time), causing a left shift of the force-frequency curve, partly mitigating the force loss.

FUNDING: The present work was funded by the PRIN project 'NeuAge' (2017CBF8NJ_001).

ON THE MODULATION OF HOFFMANN'S REFLEX FROM SEATED TO UPRIGHT STANDING ACROSS LIFESPAN

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INTRODUCTION: Upright standing involves specific neural modulation, which may be manifested by a decrease in the amplitude of the Hoffmann's reflex (H reflex) in the soleus muscle during upright compared with seated position (1,2). A greater decrease in H-reflex amplitude in upright standing was observed in old compared with young people, suggesting an age-related reorganization of postural control with a decrease reliance on proprioceptive inputs in favor of visual inputs and greater leg muscle coactivation (3). However, other factors could contribute to such a modulation as maximal plantar flexion strength and physical activity level. The aim of this work was therefore to investigate the posture-related modulation of H reflex across lifespan by a multiple regression analysis including physiological and behavioral factors.

METHODS: Fifty-one participants aged from 21-86 yrs stood upright with eyes open (EO) and closed (EC) on a force platform to measure the path length of the center of pressure (CoP). The soleus H-reflex was recorded in seated (H-seat) and upright (H-stand) posture. The contribution of visual inputs in postural control was assessed by the ratio EC/EO. Local vibration (Vib, 60 Hz) was also applied on the Achilles tendons with eyes closed to assess the contribution of proprioceptive inputs in postural control through the ratio Vib/EC. Multiple regression analysis was conducted with EC/EO ratio, Vib/EC ratio, EO, age, maximal plantar flexion force, ankle plantar flexors/dorsiflexors electromyographic ratio and the level of physical activity as independent variables, and H-stand/H-seat ratio as the dependent variable.

RESULTS: The fitted regression model was: H-stand/H-seat = 0.1+(-.143* Vib/EC) + (.712* EC/EO) +(.001*EO). The overall regression was statistically significant [$R2 = 0.37$, $F(3, 42) = 9.7$, $p<0.001$]. It was found that EC/EO ratio ($\beta = 0.49$, $p<0.001$) and EO ($\beta = 0.39$, $p = 0.007$) significantly predicted H-stand/H-seat ratio, while Vib/EC did not ($\beta = -0.28$, $p = 0.06$).

CONCLUSION: The results suggest that H-stand/H-seat modulation could reflect the central processing of the proprioceptive signal during upright standing by a lower ratio associated with greater processing of proprioceptive signal. Importantly, the data highlight that age may not be the primary driver of H-stand/H-seat modulation.

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RETICULOSPINAL TRACT FUNCTION IN TRAINED AND UNTRAINED INDIVIDUALS; A CROSS-SECTIONAL ANALYSIS

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INTRODUCTION: Non-human primate research has highlighted the reticulospinal tract (RST) as a likely site of adaptation following resistance training (Glover & Baker, 2020), however, such observations have yet to be demonstrated in humans.

METHODS: This study examined differences in human RST function between untrained and resistance trained individuals.

Methods. Fourteen resistance trained (age: 26 ± 5 years, training age: 5 ± 3 years) and eleven untrained (age: 27 ± 5 years) males and females were recruited. RST function was indirectly inferred from responses to cervico-medullary stimulations (CMEPp) and transcranial magnetic stimulations (MEPp), paired with a conditioning startling auditory stimulation of ≥ 110 dB, either 80 ms (CMEPp) or 50 ms (MEPp) apart (Furubayashi et al., 2000). The conditioned responses were expressed as a percentage of the unconditioned response. Following a maximal voluntary contraction (MVC) of their biceps (trained vs untrained: 304 ± 40 N vs, 254 ± 56 N; p = 0.016) and triceps (251 ± 37 N vs. 209 ± 40 N; p = 0.012) muscles, evoked responses were recorded at 20% of MVC with surface electromyography. The StartReact protocol, which assesses reaction times in response to visual (VRT), auditory (ART), and startling auditory stimuli (SRT), was employed for both muscle groups (Baker & Perez, 2017). RST gain, an index of RST function, was quantified as the difference in VRT and SRT with respect to the difference in VRT and ART.

RESULTS: No differences were found in the degree of the biceps CMEPp facilitation (162 ± 27 vs. 147 ± 23 %; p = 0.317) or MEPp inhibition (77 ± 14 vs. 75 ± 17 %; p = 0.692). Similar results were also seen in the triceps for both CMEPp (249 ± 76 vs. 211 ± 24 %; p = 0.291) and TMSp (79 ± 12 vs. 82 ± 17 %; p = 0.669) responses. For StartReact, trained participants had a faster bicep reaction time during the auditory condition (128 ± 24 vs. 150 ± 21 ms; p = 0.029), but no differences were observed in the triceps (131 ± 26 vs. 149 ± 29 ms; p = 0.106). For the startle condition there was a faster reaction time in the triceps of trained participants (104 ± 20 vs. 124 ± 22 ms; p = 0.031), but not biceps (104 ± 16 vs. 117 ± 18 ms; p = 0.066). VRT, RST gain, and startle-auditory reaction time were similar between trained and untrained groups for both muscles (p range from 0.09 to 0.89).

CONCLUSION: Resistance trained individuals displayed faster reaction times to a startling auditory stimulus, but the absence of difference between the majority of the outcome measures studied suggest RST function is similar in untrained, and chronically resistance trained individuals.

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ACUTE CONTRALATERAL EFFECTS OF ECCENTRIC AND CONCENTRIC RESISTANCE EXERCISE ON THE NEUROMUSCULAR FUNCTION OF THE ELBOW FLEXORS IN HEALTHY INDIVIDUALS

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UNIVERSIDAD ANDRÉS BELLO

INTRODUCTION: Contralateral concentric and eccentric resistance training have shown differential limb-to-limb cross-transference of muscle strength and corticospinal excitability in the non-trained homologous muscle. However, the underpinning mechanisms of the transference of force-related outcomes are unclear. It is possible that acute contralateral neuromuscular responses following concentric (CONC) and eccentric (ECC) resistance exercise bout could be differently modulated at corticospinal and muscular levels. We compared the acute effects on the neuromuscular function at corticospinal and muscular levels of the non-exercised contralateral elbow flexor muscles after a CONC and ECC resistance exercise bout.

METHODS: 30 healthy young men (CONC=24.3 years; ECC=25.5 years) were randomly allocated into CONC (n=15) or ECC (n=15) groups. Both groups performed a control (CTRL) session condition one week prior to the experimental intervention to determine the reliability of measurements and to determine the changes in ECC and CONC in relationship to CTRL in all dependent variables. The resistance exercise consisted of one bout of five sets of 10 repetitions at 80% of the concentric or eccentric 1-Repetition Maximum. Biceps brachii (BB) muscle surface electromyogram (EMGRMS) was recorded during training. Maximal voluntary isometric contraction (MVIC) torque and EMGRMS of BB muscle from the non-exercised and exercised arm were assessed before and after training. Peripheral nerve stimulation (PNS) and single-pulse transcranial magnetic stimulation (TMS) mechanical (i.e., torque) and electrical responses (i.e., EMG) were measured in the non-

exercised elbow flexor muscles. All measurements were taken before and 30 min after in CTRL, and before and immediately after CONC and ECC. Furthermore, the NASA-TLX questionnaire was applied after CONC and ECC to assess the mental-physical demand of the exercise. Two-way repeated measures analysis of variance (RM-ANOVA) was used to compare groups and times.

RESULTS: The reliability for all dependent variables were good to excellent (ICC=0.75-≥0.90). All variables remained unchanged in CTRL, CONC, and ECC conditions (group x time effect; P>0.05). ECC showed a greater total training volume than CONC (20.7%, P=0.01). CONC and ECC decreased the elbow flexors MVIC torque (-21.7%, P<0.001; -34.29%, P<0.001, respectively) and BB EMGRMS (-20.1%, P<0.001; -13.8%, P<0.001, respectively) after exercise, similarly (P=0.06 and P=0.84, respectively). Both groups evoked similar (P=0.17) BB EMGRMS activity in the contralateral no-exercised arm during training and imposed similar (P=0.81) mental-physical demands after exercise. No group x time effect (P>0.05) was found between CONC and ECC for MVIC, BB EMGRMS, PNS, and TMS mechanical and electrical responses after exercise.

CONCLUSION: We suggest that acute corticospinal excitability after a single bout of unilateral resistance exercise is not related to contralateral adaptions shown following CONC and ECC training.

Oral presentations

OP-AP20 Racket Sports: Training and Testing

IMPACT OF SPRINT MECHANICAL PARAMETERS ON ELITE JUNIOR TENNIS PERFORMANCE

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RUHR UNIVERSITY BOCHUM

INTRODUCTION: Movement speed is considered essential for success in many team and racket sports. However, only split times have been used, compromising information about how two players might achieve a given split time during a linear sprint (LS). Therefore, this study aimed to correlate sprint mechanical parameters (SMP) of a 20m LS test obtained with a motorized resistance device (MRD) to the current gender-specific tennis ranking position in tennis (RP).

METHODS: 107 male and 86 female elite junior tennis players nationally ranked in the German Tennis Federation between 10 and 18 years participated in the study. The players original rankings on the overall list were revised so that the top-ranked player was placed first and the lowest-ranked player last. According to their age at peak height velocity (PHV), players were divided into pre-PHV, circa-PHV, and post-PHV groups. Players performed two maximal 20m sprints on an indoor tennis hard court. SMP, like maximal theoretical force (F0; N/kg), and maximal theoretical velocity (v0; m/s), maximal power (Pmax; W/kg), were derived from instantaneous time-velocity data measured with 333Hz. SMP of the LS were partially correlated with the current RP in the overall national ranking by controlling for biological maturation.

RESULTS: Low to moderate correlations (rs=-0.1 – -0.3) were found between SMP and the RP in all male and female age groups. However, separated by gender, low significant correlations between SMP and RP were found in females (rsv0 = -0.33; rsPmax = -0.31; rsRFmax = -0.22), whereas none were found in males. All linear SMP improved over maturation for both genders. After the PHV, F0 values improve to a lesser amount compared to v0. Regarding sprinting performance, Pmax showed the highest correlation of all SMP to 20m split time in both males (r=-0.77) and females (r=-0.86). Additionally, the correlations of F0 are the strongest for short distances, while correlation values for v0 increase for longer sprint distances.

CONCLUSION: Sprint mechanical parameters have overall a low to moderate relevance for tennis performance which can be explained by the dimensions and high demands of technical and tactical skills. The importance of LS seems to be more pronounced in girls compared to males, most likely due to different playing styles. The relevance of physical attributes might hence be elevated in female junior tennis. Male and female players develop a more velocity-oriented F-v-Profile over maturation, which is mainly responsible for the increase in Pmax. Since improvements of F0 are diminished compared to v0, especially after PHV, training should be tailored to the development of force production at low velocities. It is reasonable to assume that such training emphasis could further increase performance given the usually short distances during match play.

DEVELOPMENT OF UPPER AND LOWER EXTREMITY FUNCTIONAL ASYMMETRIES IN MALE AND FEMALE ELITE YOUTH TENNIS PLAYERS: A LONGITUDINAL STUDY

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INTRODUCTION: Functional asymmetries are defined as side-to-side differences in physical performance (e.g., regarding strength, power and agility) between both upper or lower extremities. Although every individual naturally develops a certain magnitude of functional asymmetry, systematically performing a predominantly unilateral sport (i.e., such as tennis) may increase the already present inter-limb differences. Previous research has shown that functional asymmetries have been reported to increase injury risk whilst decreasing sports performance. Nevertheless, longitudinal studies examining how the magnitude of functional asymmetry and its consistency in directionality develops according to chronological

age are currently lacking. Therefore, this three-year longitudinal study aimed to examine the development of upper and lower extremity functional performance values, together with asymmetry magnitudes and directionality.

METHODS: Dominant (i.e., the best overall result of a performance test independent of extremity) and non-dominant physical performance values (i.e., the best result of the same performance test of the same extremity on the other body side) were determined yearly (i.e., and up to 3 years) using unilateral strength, power, speed and agility tests in 53 male and 37 female elite youth tennis players aged 8 - 17 years. For each test occasion, functional asymmetry magnitude percentages were calculated using the percentage difference method. Using R version 4.2.2, linear mixed effect models examined the development of performance values according to chronological age, performance dominance and sex. Similarly, the development of functional asymmetry magnitudes was examined according to players' chronological age and sex. Kappa coefficients (k) examined the consistency in directionality (i.e., which extremity performed dominantly across test occasions).

RESULTS: Regardless of sex, the dominant and non-dominant performance values of every test significantly ($p < 0.05$) improved according to chronological age. No sex differences were apparent except for strength and power related tests, with male players performing significantly better compared to female players. Functional asymmetry magnitudes ranged from 2.5 % to 14.6 % and did not significantly change with increasing chronological age (i.e., range = -0.3 % to 0.2 % per year). The dominant upper extremity (i.e., which holds the racket) consistently displayed the dominant performance value (i.e., k-value = 1.00) across test occasions, which was not the case for the lower extremity (i.e., k-value range = -0.28 to 0.31).

CONCLUSION: The functional asymmetry magnitudes, showing a high amount of direction-specificity and variation in individual developmental patterns, did not change significantly according to chronological age over a 3-year period. It is, therefore, uncertain whether aiming for a reduction in asymmetry magnitude is favourable.

APPLICATION OF VIDEO ANALYSIS TO THE MEASUREMENT OF REACTION TIME IN HIGH-LEVEL TENNIS COMPETITION

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INTRODUCTION: 2D Video analysis is often used in tennis to analyze the technique of players movements or issues related to game tactics. In modern tennis, many physical and mental abilities are involved in the performance of high-level athletes, who are called upon to solve complex motor problems in a short time through sprints and explosive actions often performed in precarious balance[1]. Indeed, by the tennis players performance model, it appears as various coordinative and perceptive kinetic abilities, such as reaction, anticipation, and transformation, play a fundamental role[2][3]. In this paper is applied video analysis to measure and evaluate the reaction time (RT) in tennis matches. The data shows the RT analysis of some professional players made during the ATP Challenger "Castel del Monte" tournament in November 2022.

METHODS: The analysis was carried out using the software BIOMOVIE ERGO on video 240 Hz, filmed by a WOLFGANG Action Camera placed behind the center court. For the measurement of RT, the time between the impact of the opposing player and the first movement of the examined player was measured (the first movement coincides with the rotation of the shoulder line in the direction of movement or of the foot descending from the split-step or with a countermovement of the contralateral leg). Sixteen subjects were examined (25.88 ± 4.77 years old, weight 79.13 ± 5.67 kg, height 184.40 ± 5.30 cm, BMI 23.26 ± 1.19) all with an ATP ranking between the #130 position and the #1066 position updated on the day of the sampling.

RESULTS: The average reaction time was 0.249 ± 0.07 s, with a correlation to the level of play as tennis players with an ATP ranking between #130 and #400 had a mean RT of 0.246 ± 0.07 s, and subjects with a ranking between #400 and #1066 a mean RT of 0.251 ± 0.07 s. The longest reaction times were recorded on the first shot after the serve on average 0.282 ± 0.05 s, while the shortest in defensive situations when the opponent was attacking or playing a volley and the player examined anticipated the movement by starting the run even before the opponents shot sometimes. The average RT recorded in this case is 0.083 ± 0.18 s. In the service response phase, on the other hand, it approaches the general average value with 0.245 ± 0.03 s.

CONCLUSION: The RT of high-level tennis players are very short, sometimes less than 120 ms, especially in defensive actions when the player often starts before the opponents attacking stroke. This prompts us to consider the importance of kinetic perceptual skills such as reaction speed and anticipation in tennis training.

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COMPARISON OF ANTHROPOMETRIC, PHYSICAL PERFORMANCE AND MOTOR ABILITY AMONG SELECTED AND NON-SELECTED JUNIOR BADMINTON PLAYER IN MALAYSIA.

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UNVERSITI PUTRA MALAYSIA

INTRODUCTION: The purpose of this study is to determine the level of anthropometric, physical performance and motor ability among Malaysian junior badminton players. This study is a cross sectional study aiming at benchmarking the 30 best adolescent players in Malaysia.

METHODS: A sample of 135 Male players and 103 Female players between the age of 12 years to 14 years were measured with two anthropometric tests i.e., standing height and body weight. While the physical performance and motor ability tests consist of 18 tests (sit & reach, handgrip, shoulder rotation, sit up, knee push up, standing broad jump, counter movement jump, shuttle run, 30m sprint, beep test, jumping sideway, moving sideways, walking backward, eye hand coordination, shuttlecock throw and plate tapping). Data were analysed using descriptive analysis and Independent T-Test to define the differences between selected and non-selected players.

RESULTS: The findings of the study showed that there were significant differences in every age group and gender. Male players aged 12 years old showed significant differences in standing broad jump (p=0.01,t=-2.69), beep test (p=0.04,t=-2.06) and moving sideways (p=0.01,t=-3.02) between the selected and non-selected players, while only standing height show significant differences for 13 years old male players (p=0.03,t=2.13). There were significant differences among the 14 years old male players for sit up (p=0.01,t=-3.69), counter movement jump (p=0.02,t=0.21) and plate tapping (p=0.02,t=-2.56). Meanwhile, among the female players, the 12 years old show significant differences between the selected and non-selected in sit & reach (p=0.03,t=-2.16), shuttle run (p=0.01,t=4.24), standing broad jump (p=0.01,t=-4.27), moving sideways (p=0.01,t=-2.53), plate tapping (p=0.05,t=-2.03) and standing height (p=0.03,t=-2.16). As for the Female players aged 13 years old, significant differences were shown in shuttle run (p=0.01,t=2.75), sit up (p=0.01,t=-3.64) and standing height (p=0.04,t=-2.18). The female player age 14 years old showed significant differences in sit up (0.01,t=-4.91), eye hand coordination (p=0.04,t=-2.19), shuttle throw (p=0.01,t=3.07) and plate tapping (p=0.01,t=-4.27) between the selected and non-selected players.

CONCLUSION: This study attempted to explore the importance of anthropometric, physical performance and motor ability in the selection process for the Malaysian elite sport school. The results displayed the different profiles of young elite badminton players between age group and between gender regarding their performances.

Oral presentations

IS-EX01 ACSM-ECSS exchange: Contemporary Approaches to Sport Injury Rehabilitation – "Imparting Creativity and Ingenuity to Push Against the Accepted Norms"

INJURY PREVENTION DOES NOT WORK

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Although evidence suggests that sport and recreational physical activity has significant health benefits, associated injuries have substantial adverse short- and long-term side effects. With the current focus on increasing physical activity and sports, injuries will become an increasingly important contributor to ever-rising societal health care costs. Action, as such, is needed. The scientific literature contains a wealth of evidence on efficacious interventions to reduce the number and the direct and indirect burden of injuries. Evidence has been gathered for various injuries, employing different preventive measures, and across multiple sports. One would expect a reduction in the number of injuries based on this work. The opposite is true, however. An increase in the annual number of injuries is still seen over the last ten or so years. While this increase is in line with an increase in the number of active sports participants, the actual injury incidence rate - as a measure of injury risk - has also increased. The above highlights that we know less than we actually may believe. In this lecture I will explore the available preventive evidence and focus on the reach and breadth of what we actually know. I will link this to contemporary issues in sports injury prevention, and highlight potential future directions towards making significant impact by preventive injury in sports.

DE-ICED: WEANING SPORTS HEALTH CARE PROFESSIONALS OFF THEIR DEPENDENCY ON REST-ICE-COMPRESSION 2023 AND BEYOND!

KAMINSKI, T.

UNIVERSITY OF DELAWARE

The use of ICE has been a cornerstone in the treatment of athletic injuries for decades. Unfortunately, there is a lack of persuasive evidence to support its use. As we embark on a new decade and the practice of athletic training & sports health care continues to evolve, more and more clinicians (especially those in the younger generation) are beginning to question this long-standing treatment. In light of this, athletic trainers and other sports health care professionals need to gain a better understanding of the physiological effects of cryotherapy, especially in the acute setting, as well as establish

a better understanding for the importance of assisting the lymphatic system by enhancing the inflammatory response to injury. While some may consider such a topic counterintuitive to well-established clinical practice, the importance of beginning such dialogue and allowing for useful and productive dialogue is critical in moving the art and science of athletic training forward into the future.

Oral presentations

OP-BM06 Balance and posture

SPORT DEPENDENT EFFECTS ON THE MULTISENSORY BALANCE INTEGRATION DURING UPRIGHT POSTURE: A COMPARISON BETWEEN PROFESSIONAL HORSEBACK RIDERS, JUDOKAS AND NON-ATHLETES.

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UNIVERSITÉ PARIS SACLAY

INTRODUCTION: It is well-known that postural stability is improved with intensive sport practice (1). The contribution of sensory inputs to balance control also changes, with athletes relying less on vision and more on somesthetic inputs than non-athletes (NA) (2). It is however noteworthy that, in the literature, balance performance and sensory processing are investigated in athletes practising a sport in the standing posture (e.g. judo, soccer etc.). The present study hypothesised that high-level (HL) athletes practicing a sport in the sitting posture (horseback riding) develop specific balance and sensory adaptations.

METHODS: Thirty-four HL judokas (JU), 27 HL horseback riders (HR) and 21 NA participated in the experiment. They stood upright on a stabilometric platform (static condition) or on a seesaw device with a mediolateral (ML) or anteroposterior (AP) instability (dynamic conditions). These stability conditions were carried out with eyes opened (EO) or closed (EC). Experimental variables included linear (mean center-of-pressure (CP) velocity (VCP), standard deviation of CP shift along ML (SDX) and AP (SDY) direction) and non-linear parameters (SampEnX and SampEnY, corresponding to ML and AP sample entropy, respectively; these variables reflect the attentional cost of balance, (3)).

RESULTS: VCP was significantly lower in both HL groups than in NA under all stability conditions ($p<0.05$), while SDY was lower in HR than in JU under static and AP dynamic condition ($p<0.01$). In EO, VCP was lower in HR than in both JU and NA under dynamic conditions ($p<0.001$). In EC, VCP was lower in JU than in HR and NA under dynamic conditions ($p<0.05$). Finally, SampEnX was higher in HR than in JU under static condition ($p<0.05$), while SampEnY was higher in HR than in JU under both static and ML dynamic condition ($p<0.01$).

CONCLUSION: As expected, JU and HR had a better stability than NA under all stability conditions. More originally, results showed that HR relied more on vision to control balance. In addition, entropy variables revealed that JU devoted more attention to control balance than HR. These results suggest that the sensory contribution and attentional cost of balance is sport-dependent, and may depend on the posture adopted by athletes during their practice. These results open up new knowledge on the specificity of balance control in sports and may be useful to select relevant stabilometric variables for the follow-up of HL athletes.

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ASSESSMENT OF VISUAL SENSORY REWEIGHTING IN STANDING BALANCE USING VIRTUAL REALITY

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INTRODUCTION: Sensory contributions to the control of human balance is of particular interest in sport-, clinical- and basic-science. Often, proxy measures, such as visual field dependence using the rod-and-frame test, or spontaneous sway measures in different stance conditions are used. None of these measures, however, represent a valid measure of sensory contributions in standing balance. For example, a sense of instability when closing the eyes can lead to co-contraction, which can reduce spontaneous sway amplitudes. At the same time, vestibular and proprioceptive contributions increase when closing the eyes, which changes overall sensory noise properties. These and more factors affect spontaneous sway. Therefore, it is not possible to make inferences on these different factors from spontaneous sway measures alone.

Reliable assessments of sensory contributions can be achieved by inducing controlled perturbations on one system, e.g. by moving the visual scene. As the scene is used as a sensory reference, its movement evokes sway. The sway amplitude depends on the stimulus amplitude and on the extent the visual system contributes to balance. Taking into account the feedback nature of the balance control mechanism, as well as basic assumptions on neural properties and biomechanics, the contribution of the visual system in a given situation can be validly assessed.

The methods are well described in the literature. However, the implementation is difficult due to the required equipment (motorized visual scene with high precision) and the required numerical methods.

METHODS: In this study, we tested, whether sway responses to moving scene perturbations realized using a virtual reality (VR) head-mounted display (HMD) are comparable to responses using a motorized real-world scene. Furthermore, we tested the feasibility of standardized implementations of a parameter estimation routine and the reliability of the obtained measures.

Body sway of fourteen subjects wearing a VR-HMD and VR motion trackers was measured, while moving a virtual screen which covered the subjects' field of view. The setup mimicked a published real-world experiment conducted by Peterka (2002), using 10x60.5-s long screen movement sequences.

RESULTS: We statistically compared our virtual to the published real-world results using statistical non-parametric mapping and found no significant differences. Test-retest reliability of single subject parameters was poor when using only 5 cycles of a 20-s pseudo-random sequence, but became excellent, when estimating parameters from 10-15 cycles (Intraclass correlations 0.7-0.9).

CONCLUSION: In conclusion, we showed that the visual contribution to standing balance can be reliably assessed using a VR-HMD. As VR systems have become widely available, future work will provide software solutions implementing experiments and analysis techniques for such advanced balance assessment techniques.

INTERACTION OF MOTOR AND COGNITIVE FUNCTIONS RELEVANT TO DUAL TASK COSTS ARE RELATED WITH AUTOMATICITY OF POSTURAL CONTROL

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INTRODUCTION: It is well known that motor and cognitive functions decline with age (1). Dual tasking can affect performance on one or both performance domains, but the opposite is also observed (2). For example, there are cases where the performance on a dual task balance test is unaffected but even improved (3) which may be explained by higher automaticity of balance control. Therefore this study aimed to investigate automaticity of balance control relations to dual-task costs of postural control.

METHODS: Sixty-seven males and females aged 60-80 years old participated in the study. To assess balance performance a posturography method with a single piezoelectric force plate was used to measure postural sway activity. Participants were tested barefoot in two stance conditions: double-stance with eyes open (STEO) and Tandem Romberg stance with eyes open (REO).

To estimate the dynamical characteristics of the posturogram, Center of pressure (CoP) velocity vector (Vcop) and wavelet entropy (WEcop) were calculated in both the anteroposterior (AP) and mediolateral (ML) directions. Dual task cost (DTC) was expressed as percentage of the differences in the two measures relative to their baseline single task measure. The test of repeated measures of the General Linear Model (GLM) was used to assess the condition effect (dual-task and baseline-task) on the balance performance. The correlations between DTC and both baseline entropy and baseline Vcop were calculated.

RESULTS: We found that higher values of baseline entropy (i.e., better equilibrium ratio) resulted in lower values of DTC in both stance conditions, expressed by positive significant correlations between DTC and baseline entropy in all sway directions: STEOML ($p<0.001$; PES=0.212; OP=0.980); STEOAP ($p<0.001$; PES=0.338; OP=1.000); REOML ($p<0.001$; PES=0.240; OP=0.988); REOAP ($p=0.002$; PES=0.152; OP=0.886). In contrast to entropy, baseline levels of Vcop had no significant effect on DTC (all $p > 0.05$).

CONCLUSION: Since the regularity of balance behavior is associated with the systems automatic control, it can be argued that better automatic control of balance results in less dual-task loss of postural control.

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IMPROVED POSTURAL CONTROL IN THE ELDERLY AFTER BALANCE TRAINING IS RELATED TO A REDUCTION IN PREFRONTAL HEMODYNAMIC ACTIVITY

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INTRODUCTION: Aging-related deterioration of postural control is widely regarded as an important phenomenon influencing quality of life and longevity. It is thought that as we age more cortical involvement is required to cope with given task demands [1]. For example, it has been shown that the hemodynamic response of the prefrontal cortex (PFC) during balancing is higher in older compared to younger individuals. Furthermore, the fact that greater reliance on the PFC is related to poorer balance performance suggests that it is a dysfunctional phenomenon [2]. Therefore we hypothesize that

in older people, balance training (BT) may cause a shift in cortical hemodynamics towards a youth-like pattern, which in turn could be a mechanism underlying improved postural control.

METHODS: To test this hypothesis, we conducted a longitudinal, controlled trial with healthy older participants (age range 66-81y) to compare the effects of a 6–month BT intervention (n = 18; 1h of BT twice weekly) against a non-BT group (n = 15) on balance performance. Cortical hemodynamics during balancing on a wobble board was assessed using functional near-infrared spectroscopy (fNIRS) at four time points during the study: at baseline, after 2 (post1), 6 (post2) and 12 months (follow-up). fNIRS data were acquired using a stationary continuous-wave imaging system (NIRx Medical Technologies) and subsequently preprocessed with Homer [3].

RESULTS: Reproducibility of balancing-induced hemodynamic responses across three PFC subregions was sufficient (ICC's ≥ .50, p's ≤ .04). In terms of behavior, the BT group reduced the sway on the unstable device (center of pressure path) significantly more than controls (group*time interaction $p < .05$). Nonparametric combination analysis [4] revealed that at post2, the BT group showed a consistent reduction in cortical activity in three subregions of the PFC compared to the control group ($p < .05$). Furthermore, in two PFC subregions (middle and superior frontal gyri), training-related changes in balance performance at post1 and post2 were correlated with concurrent changes in cortical activity while balancing (repeated measures correlation [5]: r's ≥ .30, p's ≤ .01).

CONCLUSION: The present study suggests that the aging-related neural inefficiency of the PFC and associated declines in balance performance can be ameliorated by targeted balance training. Our results substantiate balance training as a behavioral countermeasure to aging-related decline in postural control [6] and demonstrate that fNIRS is sensitive to capture longitudinal changes in the cortical control of balance [7].

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MOTOR CORTICAL CONTROL DURING DUAL-TASK PERFORMANCE

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INTRODUCTION: Body instability increases when individuals dual-task (i.e., maintain balance while simultaneously performing a secondary task), with larger effects occurring during more challenging dual-task conditions. Although previous studies have examined the cortical mechanisms involved in balance control, these studies have largely been conducted with the individual performing only a balance task. Therefore, this study examined how the motor cortex is involved during dual-tasking and whether this control is dependent on the dual-task type (cognitive or motor secondary task) and the difficulty of the primary (balance) task.

METHODS: Thirty adults maintained their balance on a platform that rotated around the pitch axis with or without a concurrent secondary task. The balance task was performed at two resistance levels (easy and hard difficulty). The secondary task consisted of either a cognitive (2-back number recall) or a motor (balancing a ball on a hand-held tray) task. For each trial, participants received a series of single- (120% of active motor threshold; aMT) and paired-pulse (stimulus at 80% aMT followed by another at 120% aMT) transcranial magnetic stimuli over the motor cortical area representing the tibialis anterior.

RESULTS: Regardless of balance difficulty, dual-tasking with the motor task resulted in a 34±5% greater sway velocity than when balancing on its own ($p<0.001$). In contrast, dual-tasking with the cognitive task had the opposite effect. Compared to the balance-only condition, addition of the cognitive task improved balance performance by 11±5% when the balance task was easy ($p=0.014$), but elicited no change in performance when the balance task was hard. These dual-task effects were accompanied by neurophysiological changes. Corticospinal excitability (CSE), as measured by the single-pulse motor-evoked potentials (MEPs), was influenced by main effects of balance difficulty ($p<0.001$) and task ($p<0.001$). Not only were MEPs 34±8% larger when the balance task was made harder, MEPs were also larger when dual-tasking with the motor task (0.8±0.1 mV) compared to dual-tasking with the cognitive task (0.6±0.1 mV) and single-tasking with balance only (0.7±0.1 mV). Lastly, short interval intracortical inhibition (SICI), as measured by the paired-pulse MEPs, was influenced by main effects of balance difficulty ($p<0.001$) and task ($p=0.009$). SICI was smaller when the balance task was hard (28±3% inhibition) compared to easy (40±3%). Less SICI was also observed when the secondary task comprised of the motor (31±3% inhibition) compared to the cognitive task (38±3%).

CONCLUSION: The results of this study demonstrate that motor cortical control is affected by dual-tasking but that this effect depends on the type of the secondary task. Perhaps due to its higher dual-task cost, dual-tasking with a motor task resulted in an increase in CSE and decrease in SICI. Future work will examine whether dual-task training can further enhance this modulation.

Oral presentations

OP-MH02 Health and Fitness: Ageing

LONGITUDINAL CHANGES IN LIFE-SPACE MOBILITY AND AUTONOMY IN PARTICIPATION OUTDOORS AMONG FINNISH COMMUNITY-DWELLING OLDER ADULTS FROM PRE-COVID-19 TO THROUGH THE PANDEMIC

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INTRODUCTION: We investigated changes in older adults' life-space mobility (LS) i.e. range and frequency of moving in a given period, and autonomy in participation outdoors (IPA) i.e. possibilities to go where one wants to from before the COVID-19 pandemic to through the pandemic. We studied whether pre-pandemic physical performance and driving status is associated with the prevalence and incidence of restricted LS (≤ 52.3 points), a threshold predicting an increased risk of activities of daily living (ADL) disability.

METHODS: Participants were community-dwelling people aged 75, 80, or 85 years at baseline in 2017-2018, of whom 657 took part in the survey during the COVID-19 Emergency Powers Act in 2020 and the second follow-up in 2021-2022. LS (range 0-120, higher score indicates higher mobility) and IPA (range 0-20, higher score indicates lower autonomy) were assessed by same validated questionnaires at each time point (1,2). Physical performance was assessed at baseline with the Short Physical Performance Battery (SPPB; impaired 0-9 p. vs. intact 10-12 p.) (3). Driving status (drivers vs. non-drivers) was self-reported. Changes in LS and IPA according to SPPB and driving status and their combinations were analyzed with generalized estimating equations (GEE). The prevalence and incidence of restricted LS were examined with GEE and binary logistic regression, respectively.

RESULTS: In 2020, LS and autonomy decreased (LS; M 74.2 SD 17.9 vs. M 63.5 SD 23.9, IPA; 4.9, 3.7 vs. 11.6, 5.1, p<.001). At baseline, driving and intact SPPB were associated with higher LS and better autonomy (p<.001). The decrease in LS was less steep among drivers with intact SPPB compared to three other groups (group*time interaction; p<.05 for all). From 2020 to 2021-2022, LS was restored to 66.6 (20.3) points, with a similar rate in four groups. Autonomy was restored to 6.7 (4.3) points, being more complete among drivers with intact SPPB than for drivers and non-drivers with impaired SPPB (group*time interaction; p<.05 for both). In 2021-2022, LS and autonomy were still lower than at baseline (p<.001 for all combinations). Compared to the baseline, the proportion of restricted LS increased to 36.8 % in 2020 and remained higher through the pandemic. Compared to the drivers with intact SPPB, all other groups had 3 to 4.5 times the odds of becoming restricted in LS during 2021-2022 (p<.05).

CONCLUSION: Among Finnish older adults, the COVID-19 pandemic accelerated the decline in LS and weakened IPA in 2020, and the losses were not fully reverted in 2021-2022. The decline of LS to below the threshold for increased ADL disability risk was observed to increase, which may translate to a higher proportion of ADL disability in the future. Drivers with intact physical performance were at lower risk for restricted LS than non-drivers or those with impaired physical performance.

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LOW RELATIVE SIT-TO-STAND POWER IS ASSOCIATED WITH THE DEVELOPMENT OF FRAILTY, DISABILITY, AND COGNITIVE IMPAIRMENT IN OLDER PEOPLE: A 6-YEAR LONGITUDINAL STUDY

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INTRODUCTION: Relative sit-to-stand power (i.e., normalized to body mass) has been demonstrated to be an important predictor of frailty, limitations in activities of the daily living (ADL) and cognitive impairment in older adults (1-2). However, these associations have only been tested in cross-sectional studies, so no cause-effect relationship has been established yet. Thus, the aim of this study was to evaluate the relationship of low relative power with the development of frailty, disability in ADL, depression and cognitive impairment in older adults.

METHODS: A total of 895 older adults (Age range = 65 - 103 years; 46 % men) from the Toledo Study for Healthy Aging were included. Relative power was assessed through the 30-s sit-to-stand test and the Alcazars equation (1). Participants

were classified as having low relative power according to previously published cut-off points (<2.5 W·kg-1 in men and <1.9 W·kg-1 in women) (2), and moderate and high relative power based on the median value. Frailty was assessed according to the Fried's frailty phenotype (FP) (≥3) and frailty trait scale (FTS) (≥50), disability in basic ADL (Katz index <6), depression (geriatric depression scale (GDS) >4) and cognitive impairment (Mini-mental state examination (MMSE) <23), before and after 6 years of follow-up. Independent Student's t-test and logistic regression analyses adjusted for age, sex, education and comorbidities were used to analyze the data.

RESULTS: Relative power declined significantly in both men and women (-0.09 vs -0.07 W·kg-1 per year; −2.95 vs. −2.84% per year; respectively; p<0.05). In addition, low relative power at baseline in was significantly associated to the development of frailty FTS (OR [95%CI] = 2.69 [1.60 - 4.55]), frailty FP (OR [95%CI] = 2.81 [1.160 - 6.797]), cognitive impairment (OR 2.215 [95%CI] =2.215 [1.190 - 4.124]), and disability in basic ADL (OR 95%CI] = 1.850 [1.163 – 2.946]), but not depression (OR [95%CI] = 1.355 [0.848 – 2.165]), after the 6-year follow-up compared to the high relative power group, independently of sex, age, education and comorbidity.

CONCLUSION: Lower-limb muscle power declined at a rate of ~3% per year in both men and women. Importantly, low relative power at baseline was independently associated with the onset of frailty, cognitive impairment, and disability after 6 years of follow-up. Therefore, assessing relative power using the 30-s sit-to-stand muscle power test may help health professionals to prevent the development of future negative conditions at an early stage and improve the patient's prognosis.

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A SINGLE BOUT OF BLOOD FLOW RESTRICTION TRAINING AND ACCENTUATED ECCENTRIC-ONLY TRAINING AFFECT DIFFERENT COGNITIVE FUNCTION SUBDOMAINS IN OLDER ADULTS: PRELIMINARY RESULTS FROM THE BRAIN-M TRIAL

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INTRODUCTION: A single bout of exercise can transiently enhance cognitive performance in older adults. Exercise-induced increases in lactate (La) levels are suggested to play a role in the mechanism of this effect. Therefore, it has been proposed that high-intensity exercise may be the most optimal exercise protocol to enhance cognitive performance in older adults, yet mostly studied in aerobic exercise. We hypothesize that in resistance exercise not the relative intensity (i.e. % one-repetition maximum, %1RM), but rather the elevation of La would be associated with larger cognitive changes. Therefore, we aimed to compare the effects on cognitive function in older adults between two different resistance exercise interventions, with either a high metabolic (high La, low %1RM) or a high mechanic (low La, high %1RM) training stimulus.

METHODS: In this randomized controlled trial, 22 older adults (60-74y old) were allocated to a single bout of blood flow restriction training (BFRT, n = 10), accentuated eccentric-only resistance training (ECC, n = 6) or 45min seated rest (n = 6). Both exercise groups performed three lower body exercises at an equal relative volume % of 57.6% (number of exercises x sets x repetitions x %1RM). BFRT consisted of 4x12 repetitions at 40% 1RM and 50% lower limb occlusion pressure. ECC consisted of 4x4 repetitions at 120% 1RM. Two-way repeated measures ANOVA was used to assess pre-to-post 1min changes in La and pre-to-post 5min changes in cognitive function between the three groups. Cognitive tests included a 2-Choice Reaction Time test, Go/No-Go test, Memory Search test and Switching task. The main outcome measures were response time (RT, in ms) of the correct responses, and changes in performance index (PI; 100×[accuracy/response time of all responses]).

RESULTS: A significant interaction was found for La level changes ($p = 0.026$, partial $\eta^2 = 0.350$). BFRT (+3.55 ±2.67 mmol/L) significantly elevated La levels compared to the control group (+0.44 ±0.77 mmol/L), while La changes after ECC (+1.18 ±1.23 mmol/L) did not significantly differ from the other groups. A significant interaction was found for PI change on the Go/No-Go test ($p = 0.041$, partial $\eta^2 = 0.286$). Especially the BFRT group (+2.58 ±1.40), but also the ECC group (+1.90 ±2.41) improved their PI on the Go/No-Go test from pre to post compared to the control group (-0.20 ±2.30). ECC participants tended to improve more on the 2-Choice Reaction Time and Memory Search test, while BFRT participants tended to improve more on the Go/No-Go and Switching task (partial $\eta^2 > 0.06$, $p > 0.05$). After BFRT, higher La changes tended to correlate with Go/No-Go test PI and Switching task RT and PI changes ($R > 0.300$, $p > 0.05$).

CONCLUSION: A single bout of BFRT tended to improve performance on executive function tasks more than ECC, and this effect may be related to the larger increase in La induced by BFRT. Our results suggest that the role of La in enhancing cognitive performance may be specific to executive functions.

EFFECTS OF ONCE- VERSUS TWICE-WEEKLY MULTI-JOINT ECCENTRIC EXERCISE ON LOWER-LIMB MUSCLE FUNCTION AND STRUCTURE IN OLDER ADULTS

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INTRODUCTION: Resistance training combats sarcopenia in older adults by improving both muscular size and strength, although poor adherence rates to the twice-weekly guidelines can limit its effectiveness [1]. However, the high-force low-metabolic cost nature of eccentric resistance training has demonstrated greater adherence and functional adaptations

compared with traditional strength training, even by individuals with pre-existing health conditions [2]. Therefore, the present study examined the dose-response and temporal characteristics of eccentric resistance training by comparing the effects of once- and twice-weekly 12-week training on lower-limb muscle function and structure of older adults.

METHODS: Participants were randomly assigned to control (CON [n = 14]), once-weekly (G1X [n = 14]), or twice-weekly (G2X [n = 14]) experimental groups. Eccentric and isometric strength, rate of torque development (RTD), sit-to-stand (STS), vastus lateralis thickness, fascicle length and angle, and quadriceps femoris volume were measured at baseline (week 0), mid-training (week 7), and post-training (week 13). Training was performed unilaterally on an isokinetic stepper ergometer at 50% of maximal eccentric strength at 18 step/min for 7 and 9 min in weeks 1 and 2, respectively, then for 12 min at 24 step/min in weeks 3-12. Two-way mixed model ANOVAs were conducted to identify significant (P <0.05) differences with effect sizes (ES) calculated to determine the magnitude of change.

RESULTS: Within G1X, one participant withdrew, whereas in G2X, two participants withdrew and one was not included in analyses due to low adherence (<80%). Compared to baseline, after six weeks of training significant increases in eccentric strength (294-338 N [ES = 1.01-1.76]) and muscle thickness (1.1-1.8 mm [0.78-1.35]) were detected in both training groups. Compared to baseline, after 12 weeks of training significant increases were observed in eccentric strength (415-498 N [1.38-1.88]), isometric strength (22-35 N·m [1.29-1.30]), RTD (69-95 N·m/s, [0.82-1.03]), STS performance (2.92-2.94 s [0.65-0.85]), muscle thickness (1.7-2.9 mm [1.05-1.56]), fascicle angle (1.5-2.0° [0.92-1.04]), and muscle volume (92-99 cm^3 [1.06-1.52]) in both groups. No significant change in fascicle length occurred in any group. No differences were revealed between G1X and G2X in any measure at any timepoint.

CONCLUSION: Once-weekly eccentric resistance training elicited similar improvements in neuromuscular function and structure compared to twice-weekly training in older adults. Given the difficulty older adults (and other exercise intolerant populations) have adhering to twice-weekly strength training programmes, these findings have important implications for clinical exercise prescription where substantial improvements in lower-limb muscle function and structure can be attained following once-weekly eccentric training.

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A WEIGHT-BEARING STAIR-CLIMBING EXERCISE PROGRAM IS NOT INFERIOR TO MACHINE-BASED RESISTANCE TRAINING FOR IMPROVEMENTS IN MUSCLE POWER AND FUNCTIONAL CAPACITY AMONG OLDER ADULTS

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INTRODUCTION: Improvement in maximal lower-limb muscle power (Pmax) is a crucial target for resistance training (RT) in older adults. Machine-based RT can induce large gains in Pmax. However, many older adults are reluctant to initiate a training program in a traditional fitness center, stressing the importance of weight-bearing alternatives. Therefore, this study compared the effects of a machine-based RT and a stair-climbing exercise program (STAIR) on Pmax, force-velocity (F-V) profile and functional capacity in older adults.

METHODS: Older adults (♂30 ♀16; 70.9 ± 4.3 years) were randomly assigned to RT (n=23) and STAIR (n=23). RT used a leg press (Leg Press CC, HUR, Kokkola, Finland) and STAIR a step with adjustable height and a flight of stairs (2 x 6 steps) as training tool. Training sessions were performed in the lab, twice weekly for 12 weeks, and supervised by experts. In the first 4 weeks, exercises were performed at controlled speed (hypertrophy-oriented; 4 x 12-15 repetitions; 60% of one-repetition maximum (1-RM) in RT; step-up exercise with height of 30-40 cm in STAIR), in the following 8 weeks as fast as possible (power-oriented, 4 x 12 repetitions; 40% of 1-RM for RT and 4 x 2 flights of 6 steps for STAIR). Pre and post intervention, the following outcomes were measured: leg-extensor F-V profile (Pmax, maximal force (F0), maximal velocity (V0), the slope divided by F0 (SFV/F0)) and functional capacity.

RESULTS: Two participants dropped out in RT, none in STAIR. The results revealed an increase over time for Pmax, F0, V0 and SFV/F0 (all $P < 0.01$), but no interaction effects (all $P > 0.10$, $\eta 2$ 0.02-0.05). A greater increase in 6-step stair ascent power was found in STAIR (+13.3 ± 13.5%) compared to RT (+4.9 ± 13.9%, Ptime = 0.002, Pint = 0.04, $\eta 2 = 0.10$). Similar improvements were found in STAIR and RT on 5-repetition sit-to-stand power (Ptime = 0.002, Pint = 0.17, $\eta 2 = 0.05$) and 10m fast walk (Ptime < 0.001, Pint = 0.29, $\eta 2 = 0.03$). No time ($P = 0.44$) nor interaction effect ($P = 0.15$, $\eta 2 = 0.05$) was found for countermovement jump height.

CONCLUSION: It appears that a weight-bearing stair-climbing exercise program is not inferior to machine-based RT for improvements in Pmax and its F-V components. Both programs resulted in an improved force production, in particular at high velocities (as evidenced by a significant change in the slope of the F-V relationship), and simultaneous improvements were found on functional capacity tests. The stair-climbing exercise program was beneficial over machine-based RT for gains in stair-climbing performance, which is in line with the principle of training specificity. Future research should investigate whether similar effects are found when the stair-climbing exercise program is implemented in a home-based setting with limited expert oversight.

Oral presentations

OP-MH07 Cardiovascular disease/Stroke (incl. ESSA-ECSS Exchange)

ESSA-ECSS EXCHANGE: FEASIBILITY AND SAFETY OF EARLY-INITIATED CARDIAC REHABILITATION IN STROKE SURVIVORS TO IMPROVE SURVIVORSHIP (CRISSIS)

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INTRODUCTION: Multiple National Clinical Guidelines for Stroke Management recommend the early commencement of cardiorespiratory fitness (CRF) training after stroke. But it is unclear if it is safe and feasible to do so. The aim of this study is to investigate the safety and feasibility of early-initiated CRF testing and training within a program of stroke-adapted cardiac rehabilitation.

METHODS: People with ischaemic stroke admitted to Epworth Rehabilitation were screened for eligibility and invited to participate in a stroke-adapted cardiac rehabilitation program, consisting of CRF training 3-days per week during inpatient rehabilitation, and 2-days per week CRF training + health education for 6-weeks during outpatient rehabilitation. A submaximal CRF test, measures of physiological function, fatigue, mood, and quality of life were taken pre- and post-intervention, and at 3-month follow-up.

RESULTS: Between April 2018 and December 2019, 164 people with stroke were screened, 117 (71.3%) were eligible, with 62 (53%) consenting to participate. 10 participants ceased the study due to: lack of time (n=1), transferred to acute hospitals (n=3) or declined further participation (n=6). Five unrelated adverse events were reported. Following consent, 41 (66%) participants were able to complete the fitness test early post stroke and 49 (79%) completed CRF training during inpatient rehabilitation. Participants attended 94% of scheduled sessions. The minimum recommended CRF training intensity (40% heart rate reserve) and duration (20 minutes), as per the exercise guidelines for people with stroke, was achieved by 57% and 55% of participants, respectively during inpatient rehabilitation.

CONCLUSION: Preliminary data suggests early initiated stroke-adapted cardiac rehabilitation is: 1) safe, and 2) feasible for some people with stroke. High attendance and retention rates were observed, but not all people with stroke could achieve the recommended minimum intensity and duration of CRF training early post stroke.

STROKE-HEART SYNDROME: SEX-SPECIFIC INCIDENCE AND RISK FACTORS FOR MAJOR ADVERSE CARDIOVASCULAR EVENTS IN 682,203 PATIENTS WITH ISCHAEMIC STROKE

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INTRODUCTION: Newly diagnosed cardiovascular complications post-stroke, termed stroke-heart syndrome, are common and associate with worsened prognosis. We therefore investigated the sex-specific incidence and 5-year major adverse cardiovascular events following stroke-heart syndrome, by pre-existing risk factors (age, obesity, hypertension, type 2 diabetes mellitus (T2DM), and high LDL cholesterol).

METHODS: A multi-centre cohort study was conducted using anonymised electronic medical records from 56 participating healthcare organizations. Patients with incident ischaemic stroke aged ≥18 years with 5-years of follow-up were included. Patients diagnosed with new-onset cardiovascular complications (heart failure, severe ventricular arrhythmia, atrial fibrillation (AF), ischaemic heart disease, Takotsubo syndrome) within 4-weeks of incident ischaemic stroke (exposure) were 1:1 propensity score-matched (age, sex, ethnicity, comorbidities, cardiovascular care) with ischaemic stroke patients without newly diagnosed cardiovascular complications (control).

Cox proportional hazards regression models reported hazard ratios (HR) with 95% confidence intervals (CIs) and Kaplan-Meier curves for 5-year risk of all-cause mortality, recurrent stroke, and acute myocardial infarction (AMI).

RESULTS: Of 682,203 patients with ischaemic stroke, 20% (n=135,834) presented with stroke-heart syndrome (49% (n=67,008) female and 50% (n=67,683) male). Following propensity score matching, composite stroke-heart syndrome associated with significantly higher risk of 5-year mortality (HR 1.47 (95%CI 1.44, 1.49) P<0.01), recurrent stroke (1.12 (1.11, 1.13) P<0.01), and AMI (2.50 (2.43, 2.58), P<0.01). These outcomes were similar for males and females and all investigated risk factors associated with worsened prognosis compared to matched controls. Of the modifiable risk factors, T2DM associated with the highest risk of mortality and AMI. Hypertension, T2DM, and high LDL associated with the highest risks of recurrent stroke.

CONCLUSION: Incidence and 5-year major adverse cardiovascular events following stroke-heart syndrome were similar for females and males. All investigated risk factors associated with worsened prognosis. Type 2 diabetes mellitus seemed particularly important for mortality and AMI, and hypertension, type 2 diabetes mellitus and high LDL cholesterol seemed particularly important for recurrent stroke.

INVESTIGATING THE DOSE RESPONSE RELATIONSHIP BETWEEN PHYSICAL ACTIVITY AND STROKE BETWEEN NORM- AND HYPERTENSIVE (MEDICATED AND NON-MEDICATED) SUBJECTS: A COHORT STUDY AMONG 140,000 ADULTS.

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INTRODUCTION: Regular physical activity (PA) demonstrates a strong dose-dependent relationship with the risk of stroke. Interestingly, recent studies suggest that the dose-dependent protection of regular PA is attenuated in the presence of cardiovascular risk and/or disease. Hypertension is the most important risk factor for stroke. However, no previous study explored whether hypertension (and associated medication) interacts with the benefits of regular PA. Therefore, the aim of this study was to compare the dose-response relationship between PA and stroke between normo- and hypertensive subjects.

METHODS: A cohort study was performed in the Netherlands (data from 2006-2018, median follow up of 6.75 years. A total of 140,000 participants (44±13 years, 41% male) were stratified at baseline as hypertensive (i.e. systolic >130 and/or diastolic >80 mmHg, or self-reported physician diagnosed hypertension with the use of blood pressure lowering medication: 61,638) or normotensive (n= 78,311). Individuals were categorised into quartiles of lowest (Q1) to highest (Q4) PA based on self-reported moderate to vigorous PA (MVPA) volumes. Primary outcome was stroke. Cox regression was used to estimate hazard ratios (HRs), 95% confidence intervals (Cis) and P values. The main analyses were stratified on baseline blood pressure (hypertension versus normotension) and adjusted for age, sex, income, education level, alcohol consumption, kidney function, BMI, glucose, SBP, DBP, low density lipoprotein, use of acetylsalicylic acid, anti-platelets and antihypertensive medication.

RESULTS: Compared to the lowest PA quartile (Q1), adjusted HRs for individuals with normotension were 0.79 (95% CI 0.50 to 1.25, P=0.32), 0.75 (95% CI 0.48 to 1.18, P=0.22), 0.97 (95% CI 0.62 to 1.51, P=0.90) for PA Q2 to Q4, respectively. In hypertensive subjects, HRs for the risk of stroke in Q2 to Q4 compared to physically inactive individuals (I.e., Q1) were 0.89 (95% CI 0.68 to 1.17, P=0.41), 0.74 (95% CI 0.56 to 0.98, P=0.03), 0.92 (95% CI 0.69 to 1.23, P=0.56). There was no significant difference in risk reduction between normo- and hypertensive subjects for Q2, Q3 and Q4 (P=0.63, 0.93,0.71 respectively). Comparing medicated (n=13,178) versus non-medicated hypertensive individuals (n=48,460), a trend was observed for a smaller benefit of PA in medicated hypertensives for all MVPA volumes. Adjusted HRs for Q2 were 0.85 (95% CI 0.61-1.18, P=0.32) and 0.96 (95% CI 0.61-1.52, P= 0.89), for Q3 were 0.67 (95% CI 0.47-0.94, P=0.02) and 0.88 (95% CI 0.56-1.39, P=0.58) and for Q4 were 0.81 (95% CI 0.57-1.16, P=0.26), 1.15 (95% CI 0.70-1.89, P=0.59) for medicated and non-medicated hypertensives, respectively.

CONCLUSION: Our analysis reinforces the benefits and dose-dependent protective effect of PA on the reduction in stroke risk, which is not affected by the presence of hypertension. Use of anti-hypertensive medication, however, may interfere with the protective impact of PA on stroke risk.

CARDIOPROTECTIVE EFFECT OF INTRADIALYTIC EXERCISE ON LEFT ATRIAL MECHANICS.

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INTRODUCTION: The left atrial (LA) function plays an important role in cardiac performance by modulating left ventricular (LV) function. Alterations in LV function are commonly reported during hemodialysis, but available data describing changes in LA function are limited. There is growing evidence of the cardioprotective effect of intradialytic exercise (IDE) on the LV function but studies analyzing its effect on LA myocardial function are scarce.

METHODS: This prospective, open-label, two-center randomized crossover trial aimed to evaluate the effect of IDE on LA strains using speckle-tracking echocardiography. Fifty-six stable individuals receiving hemodialysis for more than 3 months participated in a random order in 2 hemodialysis sessions: standard hemodialysis (HD) and a session incorporating 30 min of aerobic exercise (HDEX). LA and LV global longitudinal (GLS) strains were obtained at before (T0) and at peak stress (i.e. 30 min before hemodialysis-ending).

RESULTS: IDE totally abolished the decline in LA reservoir strain observed during HD (HD: -4.7±7.5% vs HDEX: -1.6±6.9%; 3.1%, 95%CI: 0.3/5.9, p=0.03) whereas it did not affect the other components of LA mechanics. A similar result favoring IDE intervention was also demonstrated on GLS changes from T0 to Tpeak (p<0.001). Between-session differences of changes in GLS and LA reservoir strain were correlated (r=-0.32, p=0.03). The cardioprotective effect of IDE disappeared in patients with LA enlargement (i.e.>34 mL/m²).

CONCLUSION: A single bout of 30 minutes of intradialytic cycling was sufficient to limit the hemodialysis-related reduction in LA reservoir function. Loading conditions and ultrafiltration volumes were similar between HD and HDEX, suggesting that the benefits of IDE on LA reservoir function were not related to hemodynamic factors. Furthermore, between-session differences of changes in GLS and LA reservoir strain were correlated, indicating that the relative preservation of LV systolic function by IDE partially explains that of LA reservoir function. Other mechanisms must be advanced. The cardioprotection conferred by IDE on LV systolic function has already been explained via a reduction of hemodialysis-induced perfusion abnormalities. Since ischemia also impairs LA relaxation and compliance, we can reasonably speculate that IDE might have also preserved LA myocardial perfusion (and thus its relaxation properties and compliance), thereby limiting the impairment in LA reservoir function.

Interestingly, the cardioprotective effect of IDE was however lost in patients with pathological LA remodeling. The higher degree of interstitial fibrosis associated with LA enlargement may have weakened the cardioprotective effects of exercise preconditioning.

Conclusion. IDE represents an interesting non-pharmaceutical therapeutic strategy to attenuate acute hemodialysis-related cardiac complications. Further studies are needed to evaluate the clinical impact of the repetitive cardioprotective effects of IDE on LA function

THE ASSOCIATIONS BETWEEN THE UNHEALTHY BODY WEIGHT AND PHYSICAL FITNESS OF THE ELDERLY IN CHINA: A CROSS-SECTIONAL STUDY

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INTRODUCTION: Too high and too low body weight are unhealthy manifestations, prone to a variety of diseases, affecting the quality of life of the elderly. The paper aimed to to analyze the proportion of unhealthy body weight of the elderly in China through national data and investigate the association between different levels of health-related physical fitness measurements and BMI status in Chinese elderly through national data.

METHODS: A cross-sectional study was conducted in 39973 elderly people (49.5% males) aged 60-79 years in 31 provinces of Chinese Mainland. And the data is from the 5th National Physical Fitness Surveillance data in China, and the collection period is from August to November 2020. The demographic information of the subjects was obtained through the questionnaire, including age, gender, the home, education level, pre-retirement occupation, marriage, exercise, sleep, smoking and physical self-evaluation. Body weight status was divided into four groups by BMI: low body weight, normal body weight, overweight and obesity. Physical fitness indicators including height, weight, Waist and hip circumference, body fat percentage, 2 minutes step test, sit and reach test, 30 seconds sit-up test, standing with eyes closed and one foot, reaction time was measured. The quartiles of each physical fitness measurement were used for unconditional logistic regression analyses.

RESULTS: (1) The total rates of low body weight, overweight and obesity among the elderly in China were 2.4%, 41.7% and 16.7% respectively（$P<0.001$）, and the detection rate of low body weight increased with the increase of age（$P<0.001$）. (2) In general, the physical performance of elderly men and women in the normal weight group were better than those in the overweight, obese and lean groups respectively; (3) There is a clear negative correlation between cardiopulmonary endurance and unhealthy body weight. Low level of cardiopulmonary endurance can increase the risk of low body weight by 51% - 68% and 31% - 40% respectively for elderly men and women, and increase the risk of overweight and obesity by 4% - 57% for elderly men and 5% - 66% for elderly women. Poor limb muscle strength performance will increase the risk of overweight and obesity by 10% to 61% in older women, respectively, but there is no clear relationship in older men. At the same time, the relationship between low-level flexibility, balance and reaction ability and overweight and obesity is not clearly reflected.

CONCLUSION: According to the results, two physical fitness measurements clearly

predicted the risk of overweightness and obesity. Specifically, maintaining good cardiopulmonary endurance and muscle strength level may effectively promote the improvement of the poor weight status of the elderly, so as to obtain more health benefits. However, further research on the association between flexibility and obesity status is still needed.

Oral presentations

OP-AP11 Statistics: Challenges and Applications

ATTITUDES TOWARDS AND PERCEPTION OF REPRODUCIBILITY AND REPLICABILITY IN SPORTS AND EXERCISE SCIENCE

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INTRODUCTION: There are formal calls for increased reproducibility and replicability in sports and exercise science, yet, there is minimal information on the overall knowledge of these concepts at a field-wide level. A survey was conducted to explore the attitudes and perceptions of active researchers towards reproducibility and replicability in sports and exercise science.

METHODS: Sports and exercise science researchers was recruited via the Web of Science mailing list of published authors to complete the survey, which was adapted from a Nature survey (Baker & Penny, 2016, Nature, 533 (7604), 452–454). Responses were analysed using descriptive statistics (for multiple choice responses) in R statistical software and thematic analysis (for open text box responses).

RESULTS: Of the 511 respondents, 42% (n = 217) believe there is a significant crisis of reproducibility or replicability in the field of sports and exercise science while 36% (n = 182) believe there is a slight crisis. 3% (n = 15) of respondents believe there is no crisis while 19% (n = 95) did not know. Insufficient mentoring, low statistical power, selective reporting of results, and pressure to publish were identified as the highest contributing factors to poor reproducibility and replicability. Four

themes were generated in the thematic analysis: the research and publishing culture, educational barriers to research integrity, research responsibility to ensure reproducibility and replicability, and current practices facilitating reproducibility and replicability. Researchers believe that engaging in open science can be detrimental to career opportunities due to lack of incentives. They also feel journals are a barrier to reproducible research due to high publication charges and a focus on novel research. Journals appear to act as gatekeepers in science and have too much research responsibility. Statistical expertise was identified as a key factor for improving reproducibility and replicability in the future, particularly, a better understanding of study design and different statistical techniques.

CONCLUSION: Statistical education should be prioritised for early career researchers which could also positively affect peer review. Researchers must accept responsibility for reproducibility and replicability through thorough project design, appropriate planning of analyses and transparent reporting practices.

DE NOVO ANALYTICAL FRAMEWORK ON COMPUTATIONAL EXERCISE PHYSIOLOGY VIA DYNAMICAL MODELING AND AI ALGORITHMS

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INTRODUCTION: In the area of computational sports medicine, clinical and experimental data have been explosively increased due to the development of medical facilities. Under this circumstance, de novo techniques to analyze data emerge. Our work rigorously presents two modeling frameworks, dynamic models and artificial intelligent algorithms in the background of investigating sarcopenia mechanism and the maximal heart rate estimation, respectively.

METHODS: Here, we proposed a minimal regulatory network and developed a dynamic model to rigorously investigate the mechanism of sarcopenia. Our model was consisted of eight ordinary differential equations and incorporated linear and Hill-function terms to describe positive and negative feedbacks between protein species, respectively. All recruited subjects visited the laboratory for screening and signed an informed consent form one week prior to the beginning of the study. Alcoholic drinks were prohibited on the day of the test, and coffee and tea consumption was ceased at least 1 h before the test. All participants have provided informed consent at the time of enrollment. Additionally, an artificial neural network (ANN) was applied to accurately evaluate the maximal heart rate based on experimental data from 121 middle-aged adults at an average age of 57.2 years with an average body mass index (BMI) of 25.9, after performing on a power bike with a starting wattage of 0 W that was increased by 25 W every three min until the experiment terminated. The data were randomly divided into two subsets.

RESULTS: With the technique of dynamical modeling, A total of 720 samples with 10 scaled intensities were included in simulations, which revealed the expression level of AKT (maximum around 3.9-fold) and mTOR (maximum around 5.5-fold) at 3, 6, and 24 h at high intensity, and non-monotonic relation (ranging from 1.2-fold to 1.7-fold) between the graded intensities and skeletal muscle mass. Furthermore, continuous dynamics (within 24 h) of AKT, mTOR, and other proteins were obtained accordingly. Meanwhile, for the new technique to process data, the input variables for ANN were selected by correlation for the reduction of dimension. The accuracy of estimation by multivariate regression model and ANN were 9.74% and 9.42%, respectively, which outperformed the traditional age-based model (with an accuracy of 10.31%).

CONCLUSION: The de novo modeling framework sheds light on the interdisciplinary methodology integrating computational approaches with experimental results, which facilitates the deeper understandings of exercise training and sarcopenia. At the meantime, artificial intelligent algorithms provide comprehensive approaches to estimate the maximal heart rate using multiple indicators, revealing that ANN incorporated with age, resting heart rate, and second-order heart rate are more accurate than univariate models.

ESTIMATING THE INTENSITY WORKOUT USING AN HIDDEN MARKOV MODEL AND THE IMPACT OF MENSTRUAL CYCLES

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INTRODUCTION: The impact of womens hormonal cycles of training and performance is central to the customization of training programs. Several studies have shown potential changes in the stages of menstrual cycles in efforts. In this study, we focus on high intensity training and its links with time factor and especially menstrual cycles for cyclists.

METHODS: We used as a Hidden Markov Model trained on the heart rate and powermeter captors streaming data to identify different training regimes. The dataset is collected from 16 elite (international level) and semi-elite women cyclists, sessions without missing values from the streams are kept (N=6303 sessions) and span from June 2017 and November 2022. The time spent in each state is then aggregated and used for time-dependent analysis of the different sessions regarding the reported data of the menstrual cycle. We collected menstrual data for 14 of the athletes included in the sessions dataset over several months (median follow-up time: 178 days) overlapping the session collection time. This collection is based on declarative data from the athletes (beginning and end of menstruations). The other phases of natural cycles are inferred using the method developped in [1]. In order to assess the influence of menstrual cycles, we focus on regular cycles of nature (not using contraceptive pills) athletes (N=9 athletes). Note that we used as a stringent criterion for regular cycles: a cycle length between 22 and 35 days and a variation over the last three cycles less than 7 days.

RESULTS: We found an important connection between high intensity sessions (Kruskal Wallis test: p-value=0.009), the time spent in the high intensity state and the menstrual phase for the regular cycles of female athletes (40 selected trainings for

3 athletes resulting of a sample of 17 cycles) . The time spent in the high intensity state is also closely related to the self-assessed training intensity of the athletes (session RPE) (pearson correlation = 0.4).

CONCLUSION: As with other studies focusing on elite female athletes, the number of participants limits some of our findings regarding statistical significance. However, our results are aligned with other studies [2] and show an influence of hormone cycles on the performance of elite female athletes.In addition, the Hidden Markov Model approach can be used to give coaches insights to assess compliance with training instructions as well as fitness and fatigue in multi-day competitions.

[1] Soumpasis et al., Real-life insights on menstrual cycles and ovulation using big data, Human Reproduction Open 2020

[2] Meignie et al., The Effects of Menstrual Cycle Phase on Elite Athlete Performance: A Critical and Systematic Review, Frontiers in Physiology, 2021

DETERMINANTS OF PERFORMANCE IN ELITE FENCING: A DELPHI STUDY OF FOIL, EPEE, AND SABER INTERNATIONAL LEVEL COACHES.

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INTRODUCTION: Fencing is an open-skilled combat sport present in the Olympics since 1896. Performance in fencing has been studied mostly from a physiological and technical perspective, but it also depends on tactical, psychological, and social factors. Thus, it is challenging to objectively investigate the main determinants of fencing performance at elite level. Qualitative research involving high-level fencing coaches could help to identify the key factors to perform at elite level. The aim of this study was to (1) understand the determinants of performance in fencing across the different weapons (foil, épée and saber) and (2) rank the extracted determinants from the most important to the less important.

METHODS: Thirty-one experts who coached foil (n = 8), epee (n = 8), or saber (n= 16) at international level participated in a three-round online Delphi survey. Round 1 asked coaches to identify the determinants of performance in their respective weapon. Common or similar determinants were combined. Round 2 asked coaches to rate the importance of each determinant using a Likert scale (range: 0 = not important to 9= extremely important). Determinants reached a consensus if the score had an interquartile range ≤1. Round 3 was similar to Round 2, but presented solely the determinants that did not reach an agreement, plus an anchor for each determinant, that consisted of the mean value obtained in Round 2.

RESULTS: A total of 25 determinants of fencing performance for the foil, 24 for the epee, and 42 for the saber were reported in Round 1, of which 17, 11 and 39 reached consensus after Round 3 for the foil, epee and saber, respectively. Common determinants across the three disciplines were information scanning and processing, coordination capacity, the ability to repeat efforts at high intensity, good tactic and technique, the ability to surpass yourself, determination, motivation, the attraction for challenges, prophylaxis, injury prevention, and the quality of the entourage (e.g. family, friends). Specific to the disciplines, most of the coaches for the epee agreed mostly on physiological, technical and strategical qualities being determinants for performing well at elite level, while in foil and saber emotion regulation was also considered important.

CONCLUSION: These findings, despite being based on the coaches opinion, offer a base for future studies planning interventions to improve performance in fencing. Some applications can be talent identification and optimization of training practices. Moreover, these results might be useful the development of discipline-specific tests to monitor training in fencers.

ADVANCED MODELING IN SPORTS SCIENCES: THE STUDY CASE OF EXERCISE-INDUCED HYPOXEMIA

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INTRODUCTION: Exercise-Induced Hypoxaemia (EIH) phenomenon is present in some endurance-trained athletes. Its consequences on adaptations to exercise during acute and chronic exposure to altitude have been recently published [1], suggesting that responses to altitude training could be linked to it. Determined at sea level, considering the drop of oxygen saturation during a maximal exercise ([2 - 4]), EIH is not always detected in athletes before altitude training. Thus, the aim of this study is to determine EIH without a direct indicator of the phenomenon. As Artificial Intelligence (AI) and computational approaches are powerful and seems promising for sport sciences development [5] we used those approaches in this work.

METHODS: To investigate this phenomenon, we used 127 endurance trained athletes data measured during previous stress test including anthropological variables (age, height, weight and sex), physiological variables (heart rate, gas exchanges, start and end saturation) and training information (years of training, training volume and sport). Three data sets were created using those data: the first with raw (measured) values, the second using relatives (to the maximal measured) values and the last one using data resulting from a principal component analysis. Those data were then analyzed using a newest version of the Gradient Boosted Machine (GBM): Light Gradient Boosted Machine (LGBM), whose parameters were tuned using the optuna framework.

RESULTS: Our approach that aimed to classify EIH or non-EIH athletes had a correct prediction in about 79% of the time (35 out of 44 in the test data set, with Kappa = 0.59). Furthermore, we were able to determine the most important factors used

to discriminate EIH athletes: training years, maximal and minimal ventilation, minimal heart rate and maximal oxygen consumption .Those results show that Machine Learning (ML) method can be more powerful and allow new approaches.

CONCLUSION: Our study demonstrates that AI and especially ML could be applied to detect EIH afterwards. This possibility could be a supplemental tool for coaches and scientists and could allow to re-investigate data about altitude training in order to better understand the inter-individual responses and individualize the monitoring.

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Oral presentations

OP-SH05 Emotion

INFLUENCE OF RESPIRATORY FREQUENCY OF SLOW-PACED BREATHING ON CARDIAC VAGAL ACTIVITY IN ATHLETES

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Influence of respiratory frequency of slow-paced breathing on cardiac vagal activity in athletes

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Abstract

As shown by a recent meta-analysis (Laborde, Zammit et al., 2022), breathing techniques are used by athletes to enhance performance. Among them, slow-paced breathing (SPB), the voluntary slowing down of breathing frequency, was found to increase cardiac vagal activity (CVA; Laborde, Allen, et al., 2022), which is associated to enhanced stress management and emotion regulation. Most of the times, SPB is performed at the standard frequency of 6 cycles (inhalation/exhalation) per minute (cpm). However, whether the effects of SPB on psychophysiological outcomes change according to the respiratory frequency used is still unknown. The aim of this study was to investigate the effects of a brief SPB intervention (i.e., 5min) on CVA, as indexed non-invasively via heart rate variability (HRV) measurement. A total of 75 athletes (22 female; Mage =22.32; age range = 19-31) took part in the study. They had to come once to the lab, and performed 6 breathing conditions: at 5cpm, 5.5cpm, 6cpm, 6.5cpm, 7cpm; as well as a control condition with spontaneous breathing. HRV was measured, and CVA was indexed via the root mean square of the successive differences (RMSSD). Results showed that the control condition differed from all other SPB conditions ($F(2.404, 177.873) = 60.295$, $p < .001$, partial $\eta 2 = .45$; post-hoc tests with 5cpm (Cohen's d = 1.13), 5.5cpm (Cohen's d = 1.118), 6cpm (Cohen's d = 1.125), 6.5cpm (Cohen's d = 1.073) = 1.073, 7cpm (Cohen's d = 0.988)), however the different frequencies did not differ between themselves. To conclude, we can say that slowing breathing frequency to a range from 5cpm to 7cpm represent an effective method to increase CVA, which in turn is suggested to lead to improvements in stress management and emotion regulation. A short SPB exercise may therefore be seen as effective for athletes as a pre-performance routine, as well as during short breaks during the competition.

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NONVERBAL BEHAVIOR AND EMOTIONS IN THE CONTEXT OF SPORTS

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According to evolutionary accounts of nonverbal expressions, humans have evolved to be well-equipped for communicating important internal states like emotions or social intentions nonverbally. Somewhat surprisingly, research on body

language (nonverbal behavior) in sport is only slowly emerging, although it is considered important and has been frequently studied in other disciplines. In this presentation, I attempt to introduce a bio-cultural framework and methodological guidelines for studying nonverbal behavior and, in particular, emotion expressions in sports. I argue that the ubiquity of (intense) emotional expressions and the wide-ranging documentation and coverage of sports events provides an ideal context for studying naturally occurring emotional expressions and their influence on interpersonal outcomes. I will outline the latest empirical research from our group showing that athletes, coaches, and referees' display certain nonverbal behaviors that are correlated with various internal (e.g., emotions) or contextual (e.g., success, playing location) variables and that observers can decode these nonverbal behaviors. In addition, I will discuss recent studies that show that these (emotional) nonverbal expressions by athletes and officials have the potential to influence other people and thereby influence various relevant outcomes in sports. Recommendations for future research will be made on how researchers can exploit the fact that nonverbal behavior often informs observers about what is going on inside a person and thereby gain insights on the reciprocal relationships between contextual factors, the athlete, and performance in sports.

EFFECTS OF A PHYSICALLY CHALLENGING ADVENTURE PROGRAMME ON GENERAL SELF-EFFICACY AND RESILIENCE: RANDOMISED CONTROLLED TRIAL

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Effects of a Physically Challenging Adventure Programme on General Self-efficacy and Resilience: Randomised Controlled Trial

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Introduction

Adventure programmes involving recreational physical challenges (e.g. high ropes courses and rock climbing) are popular with employers and educators to develop valuable psychosocial skills among their staff and students. These programmes are designed to take participants outside of their everyday comfort zone through exposure to physically and psychologically challenging activities in novel environments. Growing evidence supports their value in improving an array of interpersonal and intrapersonal skills, however, the quality of evidence has been critiqued and few rigorous controlled investigations exist. The present research examined the impact of an adventure-based intervention through a randomised controlled trial.

Methods

A total of 107 adults (52% male; mean age 25 years) were randomly allocated to an intervention group, which involved a half-day high ropes challenge course, or a waitlist control group. Self-report measures of general self-efficacy, resilience, risk-taking propensity and perceived stress were administered four weeks before and four days after the intervention. Assessments of participants' affective valence and perceptions of the intervention were also taken immediately after participation. Data were analysed through multivariate analysis of variance (MANOVA).

Results

MANOVA results showed an overall medium, statistically significant (Wilks' Lambda(4, 92)=5.263, p=.001, np2=.186) time * group effect. Further examination of univariate effects for dependent variables revealed a medium (np2=.152) time * group effect for changes in self-efficacy and a small effect (np2=.040) for risk-taking propensity and no significant differences for perceived stress (np2=.001) and resilience (np2=.010). Bivariate correlation analyses indicated that baseline self-efficacy scores negatively correlated with post-intervention self-efficacy change (r=-.556, p<.000), indicating that those with initially low levels of self-efficacy showed the greatest change. Correlation analyses also revealed that participants who felt a greater sense of challenge, engagement and affective valence after participation reported larger positive changes in study outcomes.

Discussion

These findings provide support for the effectiveness of adventure programmes using recreational physical challenges for increasing general self-efficacy among adult participants. The inclusion of such interventions within workplace and educational training programmes may enhance positive psychological development. Further research should explore if changes in intrapersonal outcomes translate into desirable workplace and educational outcomes, such as employee productivity and academic performance.

SYSTEMATIC REVIEW OF CHOKING UNDER PRESSURE IN MOTOR PERFORMANCE

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Introduction: Anyone can experience choking under pressure and it is especially common in sports where performance is the focus. The present literature review focuses on "choking under pressure", which refers to a sub-optimal sporting performance that occurs under stressful conditions. This systematic review aims at examining the conditions (i.e., the moderators like as example the types of pressure) in which choking under pressure influences motor performance and the mechanisms that may explain it (i.e., mediators as for example the arousal).

Method: This systematic review was conducted following PRISMA Guidelines. We systematically searched relevant articles in PubMed, PsycINFO, PsycArticles, SPORTdiscus, Psychology and Behavioral Sciences Collection, Web of Science and Eric from inception to February 2023. We only included studies focusing on motor tasks (i.e., body movements assessed on coordination, or conditioning, or both).

Results: 642 articles were identified from the databases. Out of 368 articles (without duplicates) that were screened, 94 studies met the inclusion criteria for the first and 69 studies for the second screening review. Among the studies who examined the effect of choking under pressure on motor performance, most of them examined at least one moderators/mediators. Specifically, regarding moderators, studies mainly focused on the types of pressure (e.g., financial incentive or video recordings), on task characteristics (e.g., well-learned task or complex/simple task) and on others (e.g., emotional regulation or personality). Regarding mediators, studies mainly focused on distraction-related mechanisms (attention shifts from task-relevant to irrelevant cues), on arousal (e.g., heart rate or self-reports of arousal), on anxiety, on self-focus (e.g., self-awareness or self-consciousness).

Conclusion: Overall, our findings identified several conditions under which choking under pressure occurs, and showed that several mechanisms are involved in choking under pressure effects on motor performance.

Oral presentations

OP-AP06 Modelling Sport Specific Performance

HOW WINNING TEAMS KICK FOR SUCCESS IN RUGBY UNION: A BIG DATA APPROACH

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SWANSEA UNIVERSITY

INTRODUCTION: Studies within Rugby Union have repeatedly identified kicking as a key indicator of success (1,2), yet no further analysis has been completed to quantify why. While it has been demonstrated that out-kicking your opposition is strategically important, a greater contextual understanding is required to allow deployment of actionable interventions to promote improved outcomes. Given this, the aims of this study were i) to profile the kicks taken during a season of the United Rugby Championship and ii) to quantify whether these kicks differed between winning and losing teams.

METHODS: Coded video analysis files were downloaded from 144 matches within the 2021-22 season of the United Rugby Championship. Sequences containing kicks were isolated and the kicks in each sequence collected (n=6587). For each kick, the type was identified, and allocated to one of five zones across the field. The proportion of kick type and kicks taken in each zone was recorded across the full dataset and then divided into winning and losing team kicks, according to match outcome. The outcome of each sequence was obtained and defined a positive, negative, and neutral outcome. The proportion of positive outcomes were compared between winners and losers within each kick type and zone using Chi-Squared test of association. The rate per sequence of actions made within kicking sequences were calculated for winning and losing teams and compared using two sample Poisson test.

RESULTS: Winning teams kicked more than losing teams in all zones of the field and all kick types. However, both teams had a similar distribution across the field and by kick type, proportional to their total number of kicks. Winning teams had significantly higher percentage of positive sequences outcomes when they kicked from their opposition 10-22m (38% vs. 31%) and their own 10-22m zones (43% vs. 32%). Winners also had significantly higher positive sequences outcomes when completing bomb (51% vs. 38%), territorial (38% vs. 33%) and low kicks (42% vs. 32%). Successful teams also recorded a higher rate of attacking qualities, alongside their use of different kick types and in different zones.

CONCLUSION: Winning teams implement effective kicking strategies in both their own half and opposition half, suggesting that both attacking and defensive kicking styles are required for winning outcomes. Territorial kicks were identified as important to winning sides, alongside bomb and low kicks, suggesting that a combination of both longer, territorial kicks and shorter, contestable kicks can be utilised to promote positive outcomes. The rate at which teams perform attacking qualities, such as completing line breaks, was also important for winning, highlighting the importance of the actions of surrounding players prior, during and after the kicks to support positive sequence outcomes.

1) Bennett M et al., 2019, J Sci Med Sport.

2) Scott G et al., 2022, J Sci Med Sport.

FACTORS INFLUENCING IN-GAME PLAYER ACTIVITY IN RUGBY LEAGUE: A NEW APPROACH

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UNIVERSITY OF CAPE TOWN

INTRODUCTION: Player activity and load profiling are important in training and management decisions to optimise performance in rugby league. Player movement is a complex phenomenon, involving both spatial (place on field) and temporal (time in match) dimensions. Current approaches to activity profiling typically rely on univariate measures derived from distance-based variables collated from GPS data to classify profiles and player movement with user-defined numeric thresholds, where the metrics used are often aggregated to one observation per match.

These approaches have yielded useful insights into player activity profiles in rugby league and other sports. However, two important research areas are less amenable to analysis with this approach: (i) Investigating the influence of in-game events on player movement (e.g., do activity states change following a try?), and (ii) Combining different dimensions of player activity (e.g., speed, directionality, and acceleration) when constructing activity profiles.

The aim of this study was to introduce Hidden Markov Models (HMMs) - a flexible, data-driven, and statistically robust approach capable of modelling the complexity of player movement. We applied HMMs to both rugby league training and match GPS data to address these two research questions and thus provide valuable tactical and player management decision support.

METHODS: We fitted several HMMs to 1000 rugby league player training GPS files across five training modalities and 215 match GPS files across 35 matches of one team from the 2018 and 2019 English super league competitions. Activity states were constructed jointly from player speed, direction and PlayerLoad data. We investigated the effect of both elapsed time and score difference on the probability of being in or transitioning between different states of activity in a match context. We also compared the activity and load profiles between training modalities and between training and matches.

RESULTS: The HMMs successfully combined multiple movement variables to detect different activity states for both training and match data, and to reveal the probability of being in these states as a function of the two time-varying covariates. Players were more likely to engage in directed, high speed movement as well as very undirected, slow movement at the beginning of a match and when behind on the scoreboard. There are some key differences in activity profiles within training modalities and between training and matches, notably a high-activity training state rarely accessed by players during matches.

CONCLUSION: HMMs are capable of modelling the complexity of player movement in rugby league and can be used to investigate the influence of in-game, time-varying factors on player movement as well as several other research questions of interest. HMMs therefore offer a statistically robust method to profile player activity data that can provide decision support for optimal performance in rugby league as well as several other sports.

SCORING PERFORMANCE OF THE THREE PHASES IN TABLE TENNIS

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INTRODUCTION: Table tennis is a fast-paced sport where the serve-attack and the service-return-attack have been considered the most important and effective scoring tactics. The 'three-phase evaluation method' has been developed to analyze table tennis match performance based on three key phases: the attack after service, the service-return with attack, and the stalemate phase. The method combined with other variables such as stroke type and ball bouncing area have usually been used to analyze the techniques and tactics of the individual players. There has been evidence to support that the impact of the serve and subsequent attack on the rally outcome decreases as the number of strokes increases (1). This study aimed to use a revised three-phase evaluation method to analyze the scoring performance of elite mens singles matches in relation to the outcome of the matches.

METHODS: The notational analysis was applied to analyze seven mens singles matches from the quarter-finals to the finals in the 2022 World WTT Cup Finals Xinxiang. Every point in a game was assigned to one of three phases: scored at stroke 1 and 3 of the rally for the service phase, scored at stroke 2 and 4 of the rally or the service-return phase, and scored at stroke 5 or later for the stalemate phase. The scoring rates of each phase were calculated by dividing the total points won in that phase by the total number of services, service-returns, or 5 or longer rallies, respectively. The 3 (phase) × 2 (outcome) repeated measure ANOVA was used to analyze the scoring rates.

RESULTS: The effect of phase was significant, $F(2, 12) = 31.38$, $p < .001$; the post hoc paired comparisons showed that the stalemate phase had significantly higher scoring rate than the other 2 phases (ps< .001). In addition, the winners also had significantly higher scoring rate than the losers, $F(1, 6) = 22.03$, $p < .01$. No significant interaction effect was found.

CONCLUSION: The stalemate phase had the highest scoring rate over the three phases. This indicates that more points were determined later in the rally rather than from the service or service-return attack tactics. Service and service-return both are important techniques and tactics in table tennis, but the result of the analysis suggests that developing tactics for stalemate phase may be the key to winning the table tennis matches.

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AUTOMATIC QUANTIFICATION OF DISPLACEMENT AND RING GENERALSHIP DURING HIGH-LEVEL ELITE BOXING COMPETITIONS.

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INRIA - LJK, IRMES - INSEP - UNIVERSITÉ DE PARIS, FÉDERATION FRANCAISE DE BOXE

INTRODUCTION: Keywords : Boxing Performance, Video Analysis, Performance Analysis, Ring Generalship

Ring generalship (RG), or ring occupancy, is an essential key performance indicator in elite boxing. Understanding position and movement of an opponent leads to defining better strategies, controlling the pace of the bout and imposing advantageous fighting ranges [1]. In addition to landed strikes, effective pressure and defense, RG influences the final score. Due to the high-intensity nature of boxing, fatigue is directly related to punch effectiveness as well as stances, even if the latter

is significantly less studied in the literature. To date, little has been made available to measure and analyze the concept of RG in real-life scenarios, especially using automatic method to avoid any bias. The purpose of this study is to accurately track fighters locations inside the ring and extract relevant metrics.

METHODS: Based on a single video camera, we automatically capture 2D position of each athlete onto the ring plane during a live combat. A tracking-by-detection algorithm [2] is first trained on a short sub-sample of the fight to detect unique boxers in the scene. The resulting classification allows to build a data-set specific to the bout (context, outfits, lighting). These specific features are used to retrain a multi-person detection algorithm [3]. By combining athlete detection and 2D keypoints estimation, we map features in an image coordinate system. Athletes positions with respect to the ring plane are derived from the feet joint locations and expressed in a metric world reference system through homographic transformation.

RESULTS: 32 fights (3 rounds × 3 min) were studied with this method during a French elite national competition with the collaboration of the French Boxing Federation. During the event, 33 fighters (18 women, 15 men) competed, they traveled an average of 155 m ± 28 per round. The average distance maintained between boxers was 1.23 m ± 0.16. Our study addresses performance indicators such the distance covered by each athlete, heatmaps of the boxing activity, combat profiles (clinch phases, distances ...) and orientation of the fight in relation to the judges.

CONCLUSION: In order to quantify RG during elite boxing combats, we proposed a suitable approach that required simple equipment for use in the wild. With only 96 rounds processed, more fights need to be collected to address the correlations between the metrics investigated in this study. During this event, all landed punches (15464 hits) were annotated by experts and will allow a more in-depth analysis in combination with our tracking data.

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QUANTIFYING AND CHARACTERIZING PUNCHES IN ELITE BOXING MATCHES DURING AN OFFICIAL COMPETITION

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1.IRMES - INSEP - UNIVERSITÉ DE PARIS, 2.INRIA - LJK - LOKI - ZENITH, 3.FÉDERATION FRANCAISE DE BOXE

INTRODUCTION: Quantifying and characterizing punches in boxing fights enables profiling athletes and study winning strategies [1]. Producing this data requires analyzing videos to detect punches and further characterize them. Automatically detecting punches from videos remains challenging, leaving this task to a tedious manual annotation. In collaboration with the French Federation for Boxing (FFB) in the context of an official competition, accelerometers from Inertial Measurement Units (IMU) strapped in the gloves have been tested to efficiently detect punches.

METHODS: FFB officers equipped every athlete with wireless IMU (Xsens Awinda, 120 Hz) before every fights. IMU were strapped on the distal part of the forearms at each hand, and protected under gloves. Punches were automatically identified as peaks detected in the acceleration. IMU were synchronized with high-resolution videos (Qualisys Miqus Video, HD 60 fps) to produce short sequences of animated images representing each punch. A manual annotation tool of these sequences was provided to video analysts of the FFB for the characterization of punches. Punches trajectories were labelled as miss", hit or blocked. Logistic regression analysis is used for establishing the potential associations between the fight result and the number of blocked, missed and hit punches.

RESULTS: A total of 21.474 punches over 94 × 3 minutes rounds (31 matches of 3 rounds, one match lasted 1 round only) has been detected. Analysts excluded 25.09% of false positives. We present results with respect to two different aspect: the efficiency of the annotation task and the athlete productions. Characterizing a punch required in average 7.16s [7.09, 7.23] (95% confidence intervals) for 11 annotators. We observed in average 144 [134, 154] punches towards the head and 22 [20, 24] towards the torso per round, with an average of respectively 56 [51, 62] and 13 [12, 15] successful hits, which agrees with results from the literature [2]. In the logistic regression, fight result is found to be significantly associated with both number of missed ({p}value < 0.001 , OR = 0.97 (0.94, 0.98)) and hit (pvalue = 0.002, OR = 1.03 (1.01, 1.05)) punches but not with blocked punches (pvalue = 0.913, OR = 1.00 (0.98, 1.09)).

CONCLUSION: Instrumenting boxers with IMU enables automatically identifying punches, saving precious manual annotation time that analysts can leverage to solely characterize hits. Better punch identification algorithms should likely reduce false-positives and save even more time. All characterization were performed over an accumulated time of 37.05 hours.

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Oral presentations

OP-PN24 Nutrition I

PERCEPTIONS AND PRACTICES REGARDING DIETARY SUPPLEMENTS OF NUTRITIONISTS WORKING WITH ELITE SOCCER CLUBS

OLIVEIRA, C.B.1,2, ABREU, R.2, BRITO, J.2, TEIXEIRA, V.H.3,4,5

1. NMS|FCM-UNL; 2. PORTUGUESE FOOTBALL FEDERATION; 3. FCNAUP; 4. CIAFEL-FADEUP; 5. ITR, PORTO

INTRODUCTION: Dietary supplement use is widespread among soccer players. Nutritionists working with soccer clubs play a crucial role in the decision to supplement, and on the types of dietary supplements to recommend and in which situations. However, there is no evidence of their perceptions and practices regarding dietary supplements and the scientific evidence surrounding them. Therefore, this study aimed to assess this issue among nutritionists working with elite soccer clubs.

METHODS: Nutritionists (N=134) working with elite soccer teams from six leagues in Europe (England, France, Germany, Italy, Portugal, and Spain) and Brazil were invited to participate. After ethical approval, practitioners were contacted via e-mail, and professional or personal networks. Data collection ran from 8 November 2022 to 8 February 2023, and used an anonymous online questionnaire with 19 questions, adapted from another used for a similar purpose (1). Overall, 62 nutritionists had responded (46.3% response rate); two refused to participate, and one was excluded due to incorrect fulfilment. Therefore, 59 nutritionists [34.6 (5.6) years] were included in the descriptive statistics analysis presented. Except for age (n=57), data are available for all and expressed in mean (SD) and percentages (%).

RESULTS: Nearly all participants considered themselves knowledgeable and interested in dietary supplements (94.9% responded agree or strongly agree) and reported being often asked about these products (93.2%). Most nutritionists stated consider dietary supplements more effective for enhancing sports' physical and physiological performance (93.2%), fatigue recovery (81.4%), and enhancing sports' cognitive and mental performance (76.3%). The barrier to recommending dietary supplements mentioned by most nutritionists concerned about regulation (50.9%), whereas the enabler was having sufficient training in the area (76.3%) and autonomy to recommend supplements (59.3%). Also, most nutritionists reported wishing to learn more about dietary supplement use for sports performance (66.1%).

Regarding practices, most participants reported being dietary supplement users (57.6%) and recommending supplements regularly (69.5%). Obtaining information from evidence databases and academic journals (93.2%) and conferences (59.3%) were the sources stated by most nutritionists. Finally, some nutritionists reported selling dietary supplements (15.3%).

CONCLUSION: Participants considered themselves knowledgeable and showed a great interest in learning about dietary supplements while also revealing caution about recommending supplement use. Nutritionists reported seeing these products as most effective for enhancing sports' physical and physiological performance, and having sufficient training was the main enabler for recommending supplement use. These findings provide novelty data and open new perspectives for research into supplement use in soccer.

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REVIEW OF FOOD PROVISION FOR ATHLETES COMPETING AT THE TOKYO 2020 OLYMPIC AND PARALYMPIC GAMES

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1. UNIVERSITY OF THE SUNSHINE COAST 2. CANADIAN OLYMPIC COMMITTEE

INTRODUCTION: Teams that are competing at the Olympic and Paralympic Games (OPG) rely on food provided onsite at athletes' villages and at competition venues. Evidence has demonstrated that despite advance planning, food provided at these events does not adequately meet the needs of all athletes (1). Furthermore, restrictions have been placed on large scale catering with the advent of COVID-19 (2). The aim of this study was to review the proposed food provision for the Tokyo 2020 OPG in 2019 before COVID-19 and compare to the onsite delivery in 2021 during COVID-19.

METHODS: A previously developed survey (1) was distributed to nine sport nutrition experts on two occasions during 2019 to review the on-paper menu for the Tokyo 2020 OPG. This was followed by an onsite review of food provision by 18 sports nutrition practitioners appointed to national teams during the delayed Tokyo OPG in 2021.

RESULTS: Results demonstrated a significantly higher mean rating (1 = not suitable to 10 = very suitable) for the suitability of the main village menu on site (8.0) in comparison to the initial paper review (7.0; p=0.037). There was a negative correlation between sports nutrition practitioner experience (r = -0.479; P=0.009) and menu rating. Areas that were rated significantly better in terms of availability and acceptability on site than the 2019 paper review included pizza, fruit, yoghurt and food appropriate to make weight. Provision of breakfast cereal and muesli, vegetarian/vegan and snack/ sports foods were rated the worse by experts in 2021, with a rating of 'poor' for the ability to request specific items on the menu. No significant differences were evident between the main village food and satellite villages and venues from the onsite 2021 review, however specific areas such as meeting food allergies, cultural diversity and vegetarian/ vegan items were rated as 'poor' in locations outside the village.

CONCLUSION: This is the first time that the food provision on site has been rated higher by experts than the proposed menu in advance of the event. Changes in food delivery due to COVID-19, including restricted numbers through the dining hall and fast turnover time of food, as well as a longer lead in time may have resulted in improved catering processes. Unlike in previous events (3), budgetary constraints, planning and procurement issues did not appear to be a limitation to appropriate food provision.

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THE COMPLIANCE TO COVID-19 FOOD SERVICE SAFETY GUIDELINES BY CATERERS AT THE TOKYO 2020 SUMMER AND BEIJING 2022 WINTER OLYMPIC AND PARALYMPIC GAMES

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UNIVERSITY OF THE SUNSHINE COAST

INTRODUCTION: Catering for athletes competing at international sporting events such as Olympic and Paralympic Games (OPG) is challenging. This has been heightened during COVID-19 due to the need for caterers to adapt to new food service guidelines (1), such as those suggested by the International Olympic Committee (2). The purpose of this research was to compare the compliance of caterers to various COVID-19 counter measures (CCM) placed on food provision at the Tokyo 2020 and Beijing 2022 OPG. These included provisions around personal hygiene, sanitization, and physical distancing with the aim of reducing athletes' risk of infection.

METHODS: An online survey was distributed to expert dietitians attending July 2021 Tokyo (n=20) and February 2022 Beijing OPG (n=7). Eleven different CCM were included in the survey for the main dining halls (MDH) in the athlete villages, satellite villages, and venues at both events. The CCM were observed by experts and rated as compliant (100%), partially compliant (50%) or non-compliant (0%) over the course of the event.

RESULTS: Overall, the MDH at both Tokyo and Beijing had higher compliance on CCM than other dining sites. In Tokyo, most CCM were rated as partially or fully compliant, with the exception of reduced seating time with 40% (6/15) experts rating this as non-compliant. Greater than 80% of experts (12 /15) rated full compliance for hand sanitizer, gloves, masks, and plexiglass dividers. Similarly in Beijing's 3 villages, greater than 80% of experts rated full compliance for hand sanitizer, gloves, masks, plexi-glass dividers on seating and regular wiping of seats. In Tokyo satellite villages, experts reported only partial compliance (4/5; 80%) for sanitization of condiments and no or partial compliance (4/5; 80%) for self-service. At venues, 90% (10/11) experts reported full or partial compliance to reduced seating and mask wearing (9/9; 100%) but observed non-compliance to social distancing and eating outdoors. Comments from experts suggested that CCM compliance was reasonable at both events. In Tokyo, however, the MDH was overcrowded at peak times, while in Beijing other aspects of food safety were considered as less rigorous, with two comments about gastrointestinal distress from potential cross contamination in some athletes.

CONCLUSION: Findings suggest that the greater the number of diners relative to the size and flow of the dining area, the more challenging it is for caterers to adhere to CCM. Caterers also must consider all factors affecting food safety in terms of decreasing risk of illness in the dining environment of the Olympic and Paralympic Games.

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EFFECT OF SUPERVISED NUTRITION EDUCATION PROGRAMME ON ELITE ATHLETES DURING PREPARATION OF MAJOR GAMES

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1, NATIONAL INSTITUTE OF SPORTS MEDICINE, 2 WINTER SPORTS MANAGEMENT CENTER OF THE GENERAL ADMINISTRATION OF SPORT OF CHINA

INTRODUCTION: Nutritional strategy and characteristics are largely varied between different sports and even between teammates in accordance to their individualized nutritional goals and competition plan. Furthermore, for those return-to-play athletes who need dietary aims to meet their specific needs, sports nutritionist and dietitian can play a vital role for athletes' professional career and for their exercise performance. As early as 2003, IOC issued its global consensus on sports nutrition 2003: new guidelines for nutrition for athlete, which primarily demonstrated that the amount, composition, and timing of food. And in this programme, we majorly adopted the education slides and lectures based on the well recognized IOC consensus.

METHODS: In this prospective nutrition study, sports nutrition education were conducted with 20 professional elite athletes at the baseline. Nutrition surveys were provided for four months throughout the study. Energy expenditure were estimated

using a strong evidence proved HRV exercise training load monitoring system (Switzerland) and PAL reporting method. DEXA was used for monitoring body composition. Blood biochemistry profile was measured along with the education programme including CK, BUN, Testosterone, and Cortisol for exercise fatigue. Training load was calculated according to routine training including warm-up, strength conditioning, active stretching, and sport-discipline specific training.

RESULTS: The largest need of nutrition is to achieve their ideally optimal body composition and to achieve quick recovery from intense exercise training. After education on foods choices, nutrition survey indicates athletes prefer to choose low fat foods than before supervision. Their bodyweight became lower by the end of major Game season. And the average weight loss was 1.49 kg for ladies and 1.68 kg for men throughout entire season (both P-values$<$0.05). We also found that Fat% and BMI of female athletes were significantly decreased after four months of the intervene, meanwhile, their muscle mass and lean mass increased significantly (both P-values$<$0.05). While, in male participants, we only found significantly increased muscle mass (P-value$<$0.05), though the improvement of Fat% and BMI were observed from the baseline, the change was not significant (both P-values$>$0.05).

CONCLUSION: With nutrition education and supervision, elite athletes prefer to choose healthy foods for achieving optimal body composition and quick recovery purposes. Nutrition supervision under professional dietitian is of great value for optimal exercise performance especially during the preparation for major sport games.

WADA MONITORING PROGRAM SUBSTANCES-CONTAINING DIETARY SUPPLEMENTS MIGHT CAUSE UNINTENTIONAL DOPING OR HEALTH RISK

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INTRODUCTION: The World Anti-Doping Agency (WADA) issues the monitoring program annually. The substances in monitoring program are not prohibited, but they are monitored by WADA in order to detect potential patterns of misuse in sport. Many top athletes try to find "legal" performance enhancer products, especially containing these not prohibited substances (PSs), but instead of being safer, their use can provide high risk to a positive doping test. On the one hand, these ingredients can be expensive, thus to reduce the production costs in many cases they are omitted or substituted with other compounds. On the other hand, in several cases these DS are produced in illegal pharmaceutical industries without any quality control, thus contamination of DS with PS might occur. The detection of PSs by the WADA in DSs used by athletes is a crucial preventive step to avoid unintentional doping. Measurement of active compounds can help also in the evaluation of the cost/benefit of the usage of DSs.

METHODS: The analyses of DS containing active compounds present on the WADA monitoring list were carried out by means of suitable chromatographic techniques (liquid or gas) coupled to tandem mass spectrometry (LC- or GC-MS/MS). Our scopes were to quantify the legal active substances (ecdysterone (ECD), caffeine (CAF), synephrine (SYN), bemethyl (BEM)) and to detect eventual PSs (115 mostly occurring anabolic androgen steroids (AASs), stimulants, narcotics, diuretics, hormones and metabolic modulators). Our analytical methods were optimized to obtain the lowest possible limit of detection (0.6-500 ng/g or mL) of PSs.

RESULTS: Among the different analysed samples (14 ECD-containing DS; 30 CAF- and/or SYN-containing DS, 1 BEM-containing DS) more than 30% of them contained almost one PS, mainly AASs and stimulants, in the concentration range from ng/g to µg/g. At the same time in many cases the measured content of the active substances was not in accordance with that on the label. In the case of CAF-containing products 20% were contaminated with PSs, while only in half of them was the CAF content in the range of ±10% respect to the labelled values. In one pre-workout product the measured caffeine content was double as labelled, resulting in 597 mg/dose quantity, which can cause serious health issues for non-habitual CAF consumers. Totally, 14 different ECD-containing DSs from 9 brands were analysed. In all cases the measured ECD content was much lower that on the label. In addition, 25% of the samples contained PS. Concentration of the active compound and contaminations varied from batch to batch randomly. BEM-containing DS contained 3 different selective androgen receptor modulators and 1 stimulant in the concentration of µg/g.

CONCLUSION: Serious discrepancies were explored on the labelling of program substances-containing supplements, including lack of active compounds and presence of PS. The developed methods provide outstanding support for athletes regarding DS safety.

Oral presentations

OP-SH23 Sociology (mixed)

PHYSICAL EXERCISES OF CHINESE OLDER ADULTS AND SOCIAL PARTICIPATION: HEALTH PROMOTION AND NETWORK EXPANSION

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Introduction

There is a logical relationship among physical exercise, health level and social participation of the elderly, but the research on the influence of physical exercise on social participation of the elderly in China is relatively lacking. Physical exercise will improve peoples health and expand the social network of the elderly. The changes of these factors may promote the elderly to actively participate in society from different aspects such as ability, willingness and ways. In order to effectively promote the social participation of the elderly through physical exercise, it is necessary to investigate the intermediary role of subjective and objective health of the elderly.

Methods

Using data from China Longitudinal Aging Social Survey conducted in 2016, we perform binary logistic regression model to analyze the relationship between physical exercises and social participation of Chinese older adults. The structural equation modeling is used to estimate the mediating effects of subjective and objective health. The mediating effect of subjective and objective health was examined by Sobel test, and the moderating effect of urban-rural heterogeneity and age marriage was also analyzed.

Results

This paper studies the mechanism of physical exercise (integrating the information of participation, frequency and the intensity of each exercise) on the social participation of the elderly, and tests the intermediary role of health factors in the relationship between them.

Discussion

Results suggest that regular physical exercise will significantly enhance the increase the probability of older adults' social participation.; physical exercises affect social participation in both direct and indirect ways through health. The direct effect is embodied in that physical exercise expands the social network of the elderly and enhances the degree of socialization, thus improving the enthusiasm of the elderly for social participation; the indirect effect is realized by improving the health level of the elderly, and subjective and objective health plays an intermediary role. Participating in exercise can not only improve the objective health status, but also have the ability and conditions to participate in economic, political and voluntary activities. It can also improve the subjective health status of the elderly and make them more willing to participate in various forms of society. There are internal differences in the promotion of physical exercise to the social participation of the elderly. For the rural elderly, the very old and the elderly without spouses, improving the participation of physical exercise will bring more obvious spillover social effects and significantly improve their social participation level. This paper further confirms the positive social effects of physical exercise on the elderly, and provides a theoretical basis and a case study of China for promoting the integrated development of physical education and old-age care.

THE INFLUENCE OF SPORT CLIMBING JOINING THE OLYMPIC GAMES ON THE FINANCIAL SITUATION OF THE INTERNATIONAL FEDERATION OF SPORT CLIMBING AND ITS IMPLICATIONS

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CHINA UNIVERSITY OF GEOSCIENCES, WUHAN

Introduction

Organizational change is an important factor affecting its development. The International Federation of Sport Climbing (IFSC) contributes to the sustainable and healthy development of sport climbing and further expands the influence of sport climbing in the Olympic Games. For such a non-profit organization, good financial management is an important material basis for its long-term healthy development. Therefore, it is necessary to systematically study the economic situation of the IFSC after the entry of sport climbing into the Olympic Games, which is not only of great guiding value to the guarantee of healthy growth of the IFSC, but also of positive reference value to other international sports associations, especially for those which are looking for the entry into the Olympic Games.

Methods

This study uses a variety of non-profit sports organization financial status analysis methods such as literature research, comparison analysis, trend analysis and gray relational analysis to comprehensively and systematically investigate the financial situations based on the published financial statements on the official website of the IFSC from 2015 to 2019. This study mainly focuses on the variation trend of its financial situation before and after the sport climbing joining the Olympic Games and makes a comparative analysis.

Conclusions

(1)The total assets of the IFSC significantly increase after the successful entry of sport climbing into the Olympic Games. The entry of sport climbing into the Olympic Games has played a positive role in promoting the funds of the IFSC.

(2)The successful entry of sport climbing into the Olympic Games has stimulated the vitality of the liquidity of the IFSC, enhanced the asset elasticity, improved the speed of fund turnover, avoided the insufficient fund in the operation process, which are conducive to the long-term and healthy development of the IFSC.

(3)The successful entry of sport climbing into the Olympic Games has increased the liabilities of the IFSC, which may reduce the financial elasticity and make the cash flow insufficient to support the normal operation of the organization. However, based on the results of gray relation analysis, the subsequent impact of solvency on the finance of the IFSC tends to be stable.

(4)The financial revenue and expenditure of the IFSC is balanced, which demonstrates the organization is in good condition. However, the gray relation analysis results show that the balance relationship between revenue and expenditure has

a high impact on the financial status of the IFSC, and the organization should pay attention to maintaining a good balance relationship between revenue and expenditure to stabilize the overall financial status.

TRANSFORMING EQUESTRIAN SPORTS TO A MORE ENVIRONMENTALLY JUST ACTIVITY

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THE SWEDISH NATIONAL EQUESTRIAN CENTRE AT STRÖMSHOLM AND KARLSTAD UNIVERSITY

Introduction

While the equine sector in Sweden and Norway provide leisure activities, entertainment and employment for many people of all ages, these come with associated negative effects. The equine sector is cast as a 'climate villain' that emits more carbon dioxide than domestic aviation. It is concluded that while research is scarce, feed and transport are serious threats to the environment. Similar conclusions are found in other studies on the environmental impact caused by the equine sector, which show how nutrient leakage from manure piles, paddocks and pastures is a major problem, alongside the aforementioned issues of feed and transport. This study aims to understand the decision-making processes and actions taken by actors in equestrian sports to transform the sport into a more environmentally just activity. The project is informed by two framing theoretical perspectives: institutional economic theory and directional transformation (North, 1990; Scoones et al 2015).

Methods

Data consists of 30 semistructured interviews. These have been analyzed using thematic content analysis.

Results

Results point to the following challenges in transforming equestrian sports into a more environmentally just activity: providing sporting activities with animals, organizational frameworks, economy, transport, location, knowledge, horse welfare, time and consumption. Suggested solutions are connected to behavior change.

Discussion

Institutional theory sheds light on how change is hindered by institutions and norms. Equestrian sports face challenges in relation to transforming to more sustainable sports. Some of these challenges are shared with other sports (such as people's logic for participating in sports, cf., Larneby et al 2022), while others are connected to a specific 'stable culture' (cf., Thorell et al 2015) in which equestrian sports is seen as dependent on, for example, carbon dioxide emissions and consumption patterns. In the project's next phase, workshops will be conducted to find solutions together with collaborative partners in the sport.

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11:30 - 12:45

Invited symposia

IS-AP02 Supporting female athletes through pregnancy and postpartum

INITIATING THE MOTHER-ATHLETE ROLE: DILEMMAS AND OPPORTUNITIES

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Womens participation in competitive sport has increased markedly over the last century. At the first Winter Olympics in Chamonix in 1924 only 4% of the competitors were women. 98 years later, at the 2022 Beijing Winter Olympics, female participation had reached 45%. This significant rise in representation has been accompanied by a development in the professionalisation of womens sport. Nevertheless, sporting opportunities and incentives remain unequal between the sexes, with social, cultural and economic factors continuing to hinder women to a greater extent than their male counterparts. As such, continued efforts are needed to provide female athletes with the tools they need to develop and succeed in sport.

Motherhood is distinct from fatherhood in that women undergo pregnancy, childbirth and postpartum recovery. While women and men may have an equal desire and commitment to start a family, the immediate consequences have a far greater impact on women. The effects of motherhood are exacerbated in elite sporting contexts, due to the physicality of

athletic endeavours and the inability of women to compete during certain time periods. Despite these distinct challenges, relatively little is known and communicated about how to facilitate female athletes through pregnancy and postpartum.

Several studies across different sports and a range of countries have identified recurring dilemmas facing sportswomen as they initiate, maintain and/or discontinue the mother-athlete role. In a recent study conducted with elite Scandinavian endurance athletes, we identified four such themes: Biological clock versus peak performance; Maintaining fitness versus training safely; Receiving support versus facing deselection; Balancing competing mother-athlete demands. Many of the participating athletes felt pressured into prioritising either athletic excellence or motherhood, particularly in their early to mid-thirties. Further, maintaining fitness and training safely during pregnancy was perceived as a challenge, as was balancing the mother-athlete role after childbirth. In many cases athletes felt uncertain about the support they may or may not receive from their team or federation and there were perceptions of incompatibility surrounding the mother-athlete role.

With a growing number of studies uncovering similar issues, it is clear that greater efforts are needed to promote mother-athlete-specific knowledge and provide policies to support female athletes. These are vital future steps towards greater equality, the prolongation of athletic careers and enhanced wellbeing for elite female athletes. In this lecture, Dr. Kerry McGawley will delve into the existing research that has investigated the challenges and dilemmas experienced by mother-athletes and will further highlight opportunities for future development in research and practice.

RAISING THE BAR: EXERCISE RECOMMENDATIONS FOR PREGNANT ATHLETES

DAVENPORT, M.

UNIVERSITY OF ALBERTA

Over the last decade, elite athletes have begun to challenge stereotypes regarding participation in performance sport during pregnancy. From marathon runner Paula Radcliffe to tennis star Serena Williams, and most recently sprinter Allyson Felix, female athletes are pushing back against the societal narrative that they should "take it easy" during pregnancy. Although extensive literature supports the safety and benefits of prenatal exercise, these data are primarily limited to the general obstetric population. Current exercise guidelines outline 150 minutes of moderate-intensity physical activity each week. However, these conservative recommendations do not serve elite athletes who substantially exceed this advice during training. Several studies demonstrate that sport and exercise participation declines in pregnant athletes due, at least in part, to a lack of research and policy in this area.

Pregnancy is a period of profound physiological and psychological adaptation to support the growing foetus. Although early recommendations cautioned against exercise during pregnancy, over the last decade we have had a transformational shift in our view of physical activity and exercise away from an activity that is "nice to do" to a prescription for enhanced health for both mother and baby. Yet, prenatal exercise is fraught with numerous myths and misconceptions, especially for recreational and elite athletes. In this lecture, Dr. Davenport will provide an overview of current global guidelines for prenatal exercise (including recommendations, screening tools and contraindications to exercise), and describe how physiological adaptations to pregnancy impact exercise prescription. She will also present novel data and considerations specific to the pregnant athlete, including heavy weightlifting, HIIT, Valsalva and supine exercise. This lecture will be designed to be relevant to the practitioner and researcher, as well as coaches and athletes.

MAKING IT WORK: A CASE STUDY OF AN ELITE ATHLETE NAVIGATING HER WAY THROUGH PREGNANCY AND RETURN TO SPORT POSTPARTUM

HAYMAN, M.

CENTRAL QUEENSLAND UNIVERSITY

Historically, motherhood signalled the end of an elite athlete's career. However, we are now witnessing a shift away from motherhood and being an athlete as two mutually exclusive periods in time, to an increasing number of elite female athletes wanting motherhood to be a part of their athletic journey. Although the exact numbers of elite female athletes who become pregnant and return to sport postpartum is not known, research suggests pregnancy and childbirth within high-performance sport is an increasing phenomenon with more athletes choosing to continue their training during pregnancy and return to sport and competition postpartum.

Despite this phenomenon, there remains a paucity of literature examining the exercise behaviours of elite athletes during pregnancy, and the maternal and foetal outcomes of athletes who exceed exercise during pregnancy recommendations. Of the literature that does exist, much of the data has been subjectively collected via qualitative approaches. Only two studies to date provide quantitative insight into the training and exercise characteristics of elite athletes during pregnancy, one that involved a sherpa and the other a cross-country skier, both of which adopted a longitudinal observational methodological approach.

Longitudinal observational case studies represent a practical and ethically defensible manner to examine the exercise behaviours among elite athletes during pregnancy, particularly in women who are already active and intend to remain highly active during pregnancy. As such, Associate Professor Melanie Hayman will present novel data from an ongoing case study of a sprint kayaker navigating her way through pregnancy and return to sport postpartum as an elite athlete.

Invited symposia

IS-BM03 Muscle shape change and 3-D fascicle behaviour in skeletal muscles: An emerging picture of dynamic muscle contraction

DETERMINANTS AND MECHANICAL CONSEQUENCES OF SKELETAL MUSCLE SHAPE CHANGE

ROSS, S.
SIMON FRASER UNIVERSITY

Skeletal muscles are the motors that drive movement of the body, from endurance tasks such as long-distance running to explosive activities such as jumping. Most of what we know about whole muscle performance comes from studies on sarcomeres, single fibres, or bundles of fibres. As a result, the complex 3D dimensional deformations of whole muscles are often ignored not only in our understanding of whole muscle performance, but also in how we represent muscles in musculoskeletal models such as OpenSim. When muscles contract and shorten in the longitudinal direction, they must bulge to maintain a nearly constant volume. In pennate muscle, this transverse expansion is accommodated by the fibres rotating to greater angles, which alters a muscle's mechanical output. In this talk, I will discuss the fundamental determinants of skeletal muscle shape change and how they impact output force and mechanical work using simulation results from a 3D continuum model of muscle.

Firstly, I will discuss how and why pennate muscles change shape when they contract and what behavioural consequences this may have for muscle performance. During contraction, energy from ATP hydrolysis is redistributed in muscle tissues as they deform. How the energy and deformations are distributed depends in part on the architecture and geometry of the muscle, which subsequently dictates the energy that is used to move an external load. We simulated isometric contractions of blocks of muscle with different fibre pennation angles and found that the energy stored in the tissue surrounding fibres (primarily extracellular collagen matrix) during contraction was higher in more pennate muscles, which was associated with lower muscle force output despite higher physiological cross-sectional area (PCSA). This suggests that greater pennation angle may have less functional significance for increasing muscle force through increasing PCSA, as is commonly assumed.

Secondly, I will discuss the impact of muscle tissue mass and inertia on muscle performance during cyclic contractions like those seen in leg muscles during walking and running. Muscles are commonly assumed to behave as massless structures in which the tissue mass and internal accelerations are not considered. We simulated cyclic contractions of whole muscle the size of a human medial gastrocnemius and found that accounting for the effects of tissue mass resulted in substantially lower work output. We also found that increasing pennation in mathematical muscle models resulted in smaller reductions in work when accounting for mass. Thus, pennation may be important for reducing the energetic penalty of greater mass in larger muscles such as those in humans.

Finally, I will consider the implications of this greater fundamental understanding of muscle shape change during contraction for sports performance and rehabilitation.

THE EFFECT OF FATIGUE ON SKELETAL MUSCLE GEARING DURING CONCENTRIC AND ECCENTRIC CONTRACTIONS

BLAZEVICH, A.
EDITH COWAN UNIVERSITY

During dynamic muscle contractions, whole-muscle length change results from both fibre length change and rotation. Therefore, muscles can work in a gear >1.0, where muscle length change exceeds fibre length change. The reduced need for fibre length change should profoundly affect fibre, and thus whole muscle, function in accordance with the muscle's force-velocity, force-length, and history dependent properties. In eccentric contractions in particular, the reduced fibre strain for a given muscle length change is speculated to reduce fibre injury risk as well as influence chronic adaptations to repeated exposures (e.g. hypertrophy). Nonetheless, studies of muscle gearing in vivo in humans are still relatively scarce, and little information exists in relation to gearing during eccentric contractions in particular. In one experiment, vastus intermedius fascicle length changes (measured using ultrasonography) were greater during singular (non-consecutive) eccentric than concentric knee extensions, although length changes in vastus lateralis were similar between contraction modes. Such fascicle behaviours may partly explain the greater muscle damage observed in vastus lateralis after bouts of eccentric contractions. However, it is unclear whether such behaviours are observed in other muscles or when consecutive concentric-eccentric contractions are performed. The first aim of this presentation is to present new data from experiments in which we have studied both biceps femoris (long head) and gastrocnemius medialis during dynamic contractions. Data show that fascicle behaviours, and thus gearing, during concentric and eccentric phases were similar under the study conditions, so eccentric contractions appeared to be 'mirror images' of the concentric contractions. Nonetheless, data from research currently underway in which gearing is studied under conditions of different muscle forces and contraction speeds will be presented.

INFLUENCE OF MUSCLE SHAPE CHANGES ON THE METABOLIC AND MECHANICAL DEMANDS OF HUMAN MOVEMENTS

MONTE, A.

UNIVERSITY OF VERONA

Skeletal muscle contraction triggers dynamic changes in muscle shape, with pennate muscles bulging in thickness, width, or both. The direction of shape change mediates the muscles mechanical output (e.g., work and force production). For example, unidirectional transversal (external) muscle loading induced by a plunger influences muscle shape and reduces muscle force, suggesting that compression garments typically used in sports activities as well as pressures exerted by neighbouring muscles may negatively affect muscle force capacity and, thus, muscle performance. Therefore, the first aim of this presentation is to introduce the current state-of-the-art as well as new data describing how factors that reduce the muscles capability to change shape affect muscle contraction and fascicle dynamics. In this regard, using a combination of ultrasound, EMG and dynamometric measurements, we observed that changes in muscle fascicle behaviour imposed by a transversal load could negatively affect muscle force and work production during both maximum and explosive contractions. This impairment in contractile capacity could be partially attributable to an internal deformation imposed by the load, which affects fascicle dynamics during contraction.

Along this line of reasoning, the metabolic demand of contraction should increase for a given mechanical requirement when the muscle is not free to change shape. Consequently, physiological (e.g., ageing), pathological (e.g., dystrophy) and external (e.g., wearing compressive garments) factors that can affect the muscle shape change capacity could affect the metabolic cost of muscle contraction Therefore, the second aim of this presentation is to present new data where the effects of muscle shape change on the metabolic demands of human movements have been evaluated. In particular, I will report data from experiments in which plantar flexor muscle shape changes were manipulated during sub-maximal fixed-end as well as dynamic concentric contractions. For a given muscle force, we observed that external load application reduced the muscles radial expansion and hence reduced fascicle rotation (i.e., changes in pennation angle). Consequently, changes in fascicle length increased as a function of the applied load alongside an increase in muscle EMG activity and the mechanical work produced. These increases, which were needed to sustain the same level of force, increased the metabolic cost of muscle contraction. The results suggest that factors that limit muscle shape changes can affect not only the mechanical but also the metabolic demands of muscle contraction.

In the final part of this talk, I will discuss the implications of these results in daily and sports-related activities.

Oral presentations

OP-AP07 Modelling Endurance Performance

OPTIMAL MODELING AND ANALYSIS OF PACE STRATEGY FOR WOMENS 20KM RACE WALKERS

QIAO, H., YAN, C., TINGGANG, Y.

CHINA INSTITUTE OF SPORT SCIENCE

INTRODUCTION: The results of competitive sports are the comprehensive performance of athletes technical and tactical level, physical fitness and psychology. Race walking can be interpreted as a continuous single-person sport, and the choice of the optimal rest period in the process of continuous exercise will affect the fatigue degree and fatigue relief of athletes and the speed distribution of athletes during the race walking.As a long-distance periodic endurance event, how to effectively control the athletes efforts and reasonably allocate their time to make the race walking performance reach the best under the limit of physical skills is an urgent scientific problem, which can also be equated with the problem of minimizing the time required for athletes to seek to cover a fixed distance in time trial.

METHODS: Based on the fatigue negative utility characteristics of athletes effort distribution, an optimization model of speed distribution strategy during race walking is constructed.The model parameters are fitted by using the collected data of international womens 20km race walking events, and the most effective time effort distribution mode and optimal pace strategy of athletes are verified.

RESULTS: Based on the fatigue negative utility characteristics of athletes effort distribution, the optimization model of speed distribution strategy during race walking is established and solved by establishing the problems of minimizing time, maximizing athletes "output" and minimizing sports cost under the constraints of athletes effort and physical fitness level. On this basis, the model is fitted with the competition data of the worlds outstanding female race walkers, and the "high-low-high" pace strategy is obtained. According to the characteristics of long distance, competition rules and technical requirements, this study establishes three models of the transformation relationship between speed and effort rate.

CONCLUSION: By solving the model, it can be known that the longer the total score time, the shorter the time required for full sprint, because the poor total score does not need to maintain a long full sprint state; At the same time, it is found that for long-distance competitions, athletes should not stay too long in the fatigue growth stage, but should save their physical strength to complete the long-distance race. It is suggested to strengthen the targeted training of pace strategy in the sprint stage of preparing for large-scale events, and pay attention to the choice of coping strategy and pace strategy for the large fluctuation of precipitation probability.

PREDICTING HEART RATE AT LACTATE THRESHOLDS USING MACHINE LEARNING

OUTWIN, J.R.1, CHANG, J.1, DAVIS, F.1, MELVIN, A.C.1, STUMP, O.1, REED, S.1, DEJONG LEMPKE, A.F.1, KOZLOFF, K.M.1,2, LEPLEY, A.S.1

UNIVERSITY OF MICHIGAN

INTRODUCTION: Wearable technology gives users a myriad of training information. Predicted maximum heart rate (HR) is often used to delineate "training zones," but prescribing exercise intensity in this way elicits heterogeneous stimuli [1]. Lactate thresholds have been proposed as a more informative means of prescription [2], but current methods require specialized equipment and training. Utilizing demographic information and HR metrics in machine-learning (ML) models could allow for a more individualized approach to predict HR at these submaximal anchor points.

METHODS: 218 runners of varying experience levels volunteered as part of a larger study, with 188 included in this analysis. A 12-lead ECG collected HR during a graded treadmill exercise test to maximal effort with blood lactate recorded at the end of each 3 min stage. First and second lactate thresholds (LT1, LT2) were identified at 0.5 and 1.5 mmol above baseline. A 30 s average centered around the time point corresponding to each threshold was recorded as threshold HR, and maximum heart rate during the test was recorded as HRmax. HR/workload slope (HRWS) was recorded as the slope of the best-fit line for the HR vs speed plot. A random subset of 125 participants was used to train various linear and ML regression models using gender, age, BMI, HR max, and HRWS. The remaining 63 participants were used to test for model accuracy. Models were compared against current HR guidelines for the lower bound of vigorous and near-maximal exercise intensity domains from the American College of Sports Medicine (ACSM), roughly corresponding to LT1 and LT2.

RESULTS: ACSM guidelines were the least correlated in the training subset (adj. $R2=0.21, 0.25$; $p<0.01$) and least predictive in the test subset with mean absolute error (MAE) of 13.8 bpm at LT1 and 15.4 at LT2. Linear regression showed significant, moderate correlations for both LT1 and LT2 in the training subset (adj. $R2=0.53, 0.50$; $p<0.01$) as well as reduced prediction MAE at 10.1 and 7.9 bpm. ML models demonstrated lesser fit to the training data with similar predictive accuracy to linear modeling, also outperforming ACSM guidelines (Multi-Layer Perceptron: $R2=0.46, 0.36$, MAE=10.3, 7.6 bpm; Support Vector: $R2=0.39, 0.36$, MAE=10.1, 7.6 bpm).

CONCLUSION: Regression modeling with demographics and HR metrics demonstrated improved accuracy over current ACSM guidelines in predicting HR at lactate thresholds in a population of runners. This technique could allow for a novel means of providing athletes with easily accessible, individualized, and accurate exercise intensity information through wearable technology. While ML appears capable of identifying useful trends in the data, future research is needed to refine its prediction capabilities.

REFERENCES

1. Iannetta et al. (2020), 2. Jamnick et al. (2020)

TOWARD AN INDIVIDUALIZED APPROACH TO COMPARE 1D TIME SERIES

RAO, G.1, AYAD, E.1, JANIN-POTIRON, P.1, DELATTRE, N.2, GUÉGUEN, N.2, PATAKY, T.3

1AIX MARSEILLE UNIV, CNRS, ISM, MARSEILLE, FRANCE; 2MOVEMENT SCIENCES DEPARTMENT, DECATHLON SPORTSLAB RESEARCH AND DEVELOPMENT, VILLENEUVE D'ASCQ, FRANCE; 3DEPARTMENT OF HUMAN HEALTH SCIENCES, KYOTO U

INTRODUCTION: Group-based analysis have long been known to provide valuable information regarding the general behavior of a population but lack the ability to provide reliable and specific conclusions for each individual of the considered population. Several single subject analysis methods have been proposed to better consider the individual level and provide the most appropriate intervention to everyone [1-2]. These existing methods are restricted to 0-dimensional variables, while recently, one-dimensional time series analyses have been proposed at the group-level and proven a very powerful way to assess the influence of various factors (expertise, equipment, pathology…) on behavior [3]. A major limitation of a single-subject experimental procedure is randomization weakness due to a limited number of condition order permutations. The aim of this study was to propose a new statistical procedure, based on the SPM1d framework, to provide 1d single-subject statistical comparisons while taking into account the limitations of randomization.

METHODS: Ten participants ran on a treadmill at a controlled speed for 5 minutes while wearing 4 different pairs of shoes in a randomized order. 3D lower limb joint kinematics were obtained from motion capture data acquired at 300Hz. 150 consecutive cycles were then selected, and kinematics data time-normalized to 101 points for each cycle. From the time stamps of the different experimental conditions and of each cycle, a time-based linear detrending was included in a general linear model based on the spm1d framework. The results from ANOVA procedure testing for the influence of the shoes factor on the joint kinematics with and without the detrending process were compared.

RESULTS: The results of the ANOVA comparisons revealed the individual nature of the adaptations to the experimental conditions. Indeed, some participants exhibited similar ANOVA results with or without the detrending while others revealed dramatically different outputs. For the participants revealing a strong influence of the detrending, the conclusions would have been different (and sometimes opposite) if no detrending was taken into account. This point suggests that detrending should be an important consideration for single-subject analyses.

CONCLUSION: The proposed procedure is a first step in attempting to allow for the statistical comparison of 1d continua in a single-subject experimental design. This new procedure encompasses both a suggestion for a single-subject experi-

mental design and an updated version of the spm1d framework better suited for such sport science oriented experimental designs.

1. Harry et al. (2020) 2. Krasny-Pacini et al. (2018) 3. Pataky (2012)

PHYSICAL FITNESS COMPARISON ANALYSIS IN ADOLESCENT ATHLETES USING MACHINE LEARNING : TRACK AND FIELD, FOOTBALL AND SWIMMING

LEE, Y.1, CHANG, J.1, LEE, D.2, LEE, H.1

1. DANKOOK UNIVERSITY, 2. CHUNGNAM NATIONAL UNIVERSITY

INTRODUCTION: Physical fitness (PF) is an important factor in determining the physical condition of an athlete and their athletic performance. The main PF factors such as body composition, strength, flexibility, endurance, and agility can contribute to the differences between various sports . The previous approaches to analyzing PF in athletes have mainly focused on using statistical and machine learning algorithms to predict the injury or performance. However, by focusing on the application of machine learning to PF analysis, it is possible to identify the relative importance of different aspects of PF for different types of athletes and sports.

METHODS: The subjects of this study were 1,267 male adolescent athletes (track & field: 402, football: 537, swimming: 105), and the data of physical fitness measured from September 2018 to October 2019 at the Korea Sports Science Center was used. In total, 15 elements of physical fitness (body fat, body weight, BMI, grip strength (L, R, avg), back muscle strength, push-up, sit-up, standing long jump, sargent jump, side-step, backward flexion, sit & reach, eye-hand coordination) were recorded. Different machine learning algorithms (linear regression, support vector machine, random forest, XGBoost) were evaluated by accuracy, area under the curve, and f1-score, and calculated main PF factors from the SHAP value.

RESULTS: As a result, XGBoost showed the highest performance. Based on XGBoost, accuracy, area under the curve, and F1-score were 0.87 0.84, 0.86 in track & field and football, 0.92, 0.86, 0.87 in track & field and swimming, and 0.91, 0.92, 0.86 in football and swimming, respectively. Furthermore, SHAP value showed that standing long jump in track & field and football, sit & reach in track & field and swimming, and sit-up in football and swimming were the main PF factors.

CONCLUSION: The proposed method will be able to identify the PF characteristics of general adolescent who start exercising and recommend suitable sports type, and it will be possible to develop and present training methods that consider PF factor customized for the sports type in adolescent elite athletes.

FOUR-YEAR LONGITUDINAL ASSESSMENT OF MODIFIABLE AND NON-MODIFIABLE RISK FACTORS FOR BONE STRESS INJURIES IN INTERCOLLEGIATE DISTANCE RUNNERS

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UNIVERSITY OF MICHIGAN

INTRODUCTION: Bone stress injuries (BSI: stress fracture/reaction) are the clinical endpoint of mechanical and metabolic events that are prevalent in sports emphasizing leanness, endurance, and skeletal loading. Despite identifying contributions of individual BSI risk factors, translating data into predictive and actionable models of BSI prevention remains elusive. The Female Athlete Triad Risk Assessment Tool [1] was adapted to prospectively identify female [2] and male [3] athletes at high risk for BSI, but doesn't account for modifiable factors such as sleep, which has been associated with BSI in military personnel [4]. The purpose of this study was to evaluate BSI risk in distance runners using the modified Triad assessment tool and to compare risks to those derived from sleep surveys as an independent predictor of BSI.

METHODS: Male and female distance runners from an NCAA D1 Cross Country program were recruited over four years. Prospective BSI risk scores were evaluated using a modification of the Female Athlete Triad Risk Tool [2,3] using preseason surveys and DEXA-derived bone mineral density (BMD) of the hip and spine. Individual scores on a 0-2 pt scale were summed as follows: Prior BSI (none:0 pt; 1 low risk site:1 pt; >1 high risk site or >2 low risk site:2pt); dietary restriction (none:0pt; some/past DE history:1pt; current DE:2pt); body mass index (BMI>18.5: 0pt; BMI 17.5-18.5: 1pt; BMI<17.5: 2pt); and low BMD Z-score (>-1: 0pt; -1 to -2: 1 pt; <-2: 2 pt). Female surveys included age at menarche (<15 yrs: 0pt; 15-16: 1pt; >16: 2pt) and cycles over past year (>9 menses: 0pt; 6 to 9:1 pt; <6: 2pt). Sleep hygiene was assessed by validated sleep instrument [5] pre- and mid-season. Annual BSI incidence was monitored. Surveys were updated annually and subjects were treated independently for each year of enrollment. Relative risk (RR) scores for BSI for any year was compared to BSI incidence for subjects scoring 0-1pts on the modified Triad tool and to subjects registering a change of -1 to +1 points on sleep hygiene.

RESULTS: 41 men and 49 women enrolled with participation ranging between 1-4 yrs. A total of 38 (women) and 14 (men) BSI were observed. Of 194 athlete-seasons of data, 160 included complete assessments. Women scoring 6-7 out of 12 maximal points on the modified Triad tool increased RR of BSI 2.7 fold (95% CI 1.2-5.9, p=0.016). Men scoring 4-5 (out of 8) increased BSI RR 8.2 fold (95% CI 1.4=48, p=0.012). Within-season worsening of sleep hygiene by 4-5 points (17 max) independently increased BSI RR 3.4 fold (95% CI 1.9-6.0, p<0.0001) in women, but not men.

CONCLUSION: Predictive tools that incorporate sleep as a modifiable behavior may be combined with other personalized metrics to help identify athletes at greatest risk for BSI.

Refs: 1.De Souza Br J Sports Med 2014; 2.Tenforde Am J Sports Med 2017; 3.Kraus Br J Sports Med 2019; 4.Firestone Med Sci Sports Exer 2008; 5.Bender Sports Med Open 2018

Oral presentations

OP-AP33 Long Distance Running

THE TRAINING INTENSITY DISTRIBUTION OF 119,747 MARATHON RUNNERS.

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INTRODUCTION: There is an ongoing debate about the effectiveness of the various training intensity distribution (TID) approaches on endurance performance (1,2). This is, in part, due to the relatively small sample used in studies reporting TID, primarily elite and well-trained athletes, and the lack of consensus surrounding how different training zones are established. Here, we investigated TID strategies prior to a marathon in a large sample of recreational runners, using three training intensity zones demarcated by physiological thresholds.

METHODS: A dataset of 119,747 unique runners who completed 152,160 marathons between 2014 and 2017 was analysed. The dataset contained running activities recorded onto a running platform (Strava®) in the 14 weeks prior to a marathon, excluding the taper phase (herein defined as 3 weeks prior to the marathon). A 3-zone (Z1 to Z3) training model was created for each runner. First, Z3 was defined as intensities above critical speed (CS), which was calculated from the best performance recorded in discrete segments, as described elsewhere (3). Then, Z1 and Z2 were determined as intensities below the lactate threshold (LT), and intensities above the LT but below CS, respectively. The LT was estimated to be 85% of CS, following a meta-analysis of 22 studies reporting both LT and CS. TID was characterised as polarised when time spent in Z1>Z2 and Z3>Z2; pyramidal TID as Z1>Z2 and Z2>Z3; threshold TID as Z2>Z1 and Z2>Z3; and high-intensity interval (HIT) TID as Z3>Z1 and Z3>Z2. Runners were grouped for TID analysis based on their marathon finishing time, in 30-min intervals.

RESULTS: The pyramidal TID was the most common approach for all subgroups. In the fastest runners (marathon time 120-150 min), 82.4% of runners adopted this approach, higher than polarised (8.1%), threshold (5.8%), and HIT (1.8%). Runners in this group completed 66% of their training in Z1, 22% in Z2, and 12% in Z3. As marathon performance decreased, the pyramidal TID remained the most popular approach, but runners adopted more varied TID strategies. A pyramidal TID was adopted by 36.9% of runners with finishing times of 240-270 min, followed by threshold (33.8%), HIT (18.3%), and polarised (11.0%). These runners performed 40% of their training in Z1, 34% in Z2, and 26% in Z3.

CONCLUSION: A pyramidal TID, whereby runners spend most time in Z1 (below the LT) and progressively less time in Z2 (between LT and CS) and Z3 (above CS), was the most common TID approach. This finding was consistent irrespective of marathon performance, but the percentage of runners following a pyramidal TID approach was highest in the fastest runners, and decreased in popularity as marathon performance decreases.

1. Burnley et al. (2022). Med Sci Sports Exerc, 54(6):1032-1034

2. Foster et al. (2022). Med Sci Sports Exerc, 54(6):1028-1031

3. Smyth & Muniz-Pumares (2020). Med Sci Sports Exerc, 52(12):2637-2645

TRAINING FOR OLYMPIC GOLD IN ENDURANCE SPORTS: VIEWS FROM SUCCESSFUL COACHES

SANDBAKK, Ø., BUCHER SANDBAKK, S., TØNNESSEN, E., LOSNEGARD, T., SEILER, S., HAUGEN, T.
NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

INTRODUCTION: Performance development in endurance sports is determined by a multifaceted interaction of manifold variables, such as training volume, frequency, and intensity distribution. While training practices among world-leading athletes in long-distance running, road cycling and cross-country skiing are extensively explored, best practice training information is limited for many other endurance disciplines such as swimming, biathlon, speed skating, rowing and triathlon. In addition, comparisons of training variables across studies and sports are challenging due to lack of a common methodological framework (e.g., intensity zones) and terminology.

Norway has been one of the world-leading sport nations in the last 2-3 decades, with the majority of Olympic and World Championships medals won in endurance sports. One of the advantages of the Norwegian system is that all endurance sports use the same framework for defining training content, allowing valid comparisons across athletes and sports. Acknowledging that the very best coaches are often ahead of sport science in employing the fundamental features of training, the aim of this study was to explore successful Norwegian endurance coaches' views on training practices required for winning international medals in endurance sports.

METHODS: Twelve male Norwegian coaches with a track record of coaching endurance world-class athletes (total of >320 Olympic, World and European Championship medals; mainly Norwegian athletes) in cross-country skiing, biathlon, speed skating, rowing, road cycling, swimming, long-distance running and triathlon participated. Initially, we performed training diary analyses of their best-performing athletes followed by interviews with each of the coaches about their views on training practices required to win future international medals in their sports.

RESULTS: Our preliminary analyses shows that all coaches employ a high-volume approach, ranging from 600 annual training hours in running up to 1400 hours in triathlon. In all cases, around 90% the training time is aerobic endurance, in which 80-90% of this contains low-intensity endurance training interspersed by 2-3 days (i.e. 2-5 key sessions) weekly at

higher intensities. All coaches utilize a tradidional periodization model where key sessions becomes gradually more competition-specific towards the competition period. The sport-specific differences in training content are mainly caused by variations in mechanical and muscular loading. Detailed training data in terms of volume, intensity distributions and use of exercise modes periodized throughout the year will be presented and discussed during the presentation.

CONCLUSION: This study illustrates how successful endurance coaches describe "state-of-the-art" endurance training, including quantitative and qualitative insights in common features and sport-specific variations in best practice training organization and characteristics in endurance sports.

SYSTEMATIC REVIEW OF 92 MARATHON TRAINING PLANS

APPELHANS, D., KNOPP, M., SCHÖNFELDER, M., WACKERHAGE, H.

TECHNICAL UNIVERSITY OF MUNICH

INTRODUCTION: A typical training plan is a mix of many interventions, such as runs of different lengths and intensities. It is virtually impossible to measure the effectiveness of such a complex, months-long intervention in high quality intervention trials such as a randomised control trial [1]. To start addressing this evidence problem, Haugen et al. have summarised training plans of elite athletes that have achieved world-class performance despite or because of the training plan [2]. They termed this approach results-based practice. The aim of this study was to use a novel systematic review strategy to quantitatively analyse subjective sub-elite marathon training plans in order to determine a typical marathon training recommendation and report recommended training strategies.

METHODS: We obtained training plans from non-scientific sources using the search term "marathon training". We found 92 training plans and transcribed them into a uniform format with the goal to split each session into a kilometre distance in each of the five intensity zones [3]. To do this, two researchers independently agreed upon the classification for each session. Subsequently, each training plan was grouped based on the total mileage in the peak week, defined as highest volume week, into low (< 65 km/week), middle (65-90 km/week), and high (> 90 km/week) training volume.

RESULTS: Low mileage training plans had an average weekly volume of 43.5 ± 15.5 km that was split into 9.9 ± 3.6% in zone 1, 68.6 ± 5.7% in zone 2, 16.5 ± 5.9% in zone 3, 2.8 ± 1.0% in zone 4, and 2.2 ± 0.5% in zone 5. Low mileage training plans recommend the shortest weekly long runs of 20.5 ± 8.3 km ($p < .001$). Next, the middle mileage training plans recommended an average weekly volume of 58.1 ± 19.4 km with 15.4 ± 1.8% in zone 1, 61.3 ± 4.5% in zone 2, 17.6 ± 5.1% in zone 3, 2.3 ± 0.6% in zone 4, and 3.3 ± 0.5% in zone 5, and recommended an average weekly long run session of 23.0 ± 8.3 km. Lastly, high mileage training plans recommended an average weekly volume of 104.9 ± 39.2 km that was split into 15.0 ± 4.5% in zone 1, 68.1 ± 4.8% in zone 2, 8.7 ± 3.7% in zone 3, 5.2 ± 2.9% in zone 4, and 3.0 ± 1.2% in zone 5, and had the longest weekly long runs of 26.9 ± 7.9 km ($p < .001$). Especially, the high mileage training plans recommended a polarized training intensity distribution with around 85% in zone 1+2 and 8% in zone 4+5.

CONCLUSION: There is a lack of experimental high-quality evidence for the effectiveness of complex training plans over several months. By performing a systematic, quantitative analysis of 92 marathon training plans, we determined typical recommendations for varying performances. Whilst this approach has obvious limitations such as no measurement of the resulting marathon performance, it is arguably a useful strategy to address the evidence problem in training practice.

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THE RELATIONSHIP BETWEEN THE MODERATE-HEAVY BOUNDARY AND CRITICAL SPEED IN RUNNING

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INTRODUCTION: Training characteristics including duration, frequency, and intensity can be manipulated to maximise endurance performance (1). There is a growing interest in the role of training intensity distribution (TID) to augment training adaptations (2). Typically, TID is determined from the percentage of time spent exercising in the moderate (below gas exchange (GET) or lactate threshold (LT)), heavy (above GET/LT but below critical speed (CS)), and severe (above CS) intensity domains. Estimates of the heavy-severe intensity boundary can be determined from habitual training (3). However, the determination of GET or LT (T1) necessitates testing which can be costly and time-consuming. Thus, determination of the percentage at which T1 occurs relative to CS may permit easier prescription or remote monitoring of TID. A further aim was to examine whether this differs between fitness levels.

METHODS: A literature search was conducted on two databases (PubMed and Scopus). After analysing 1,198 resultant articles, studies were included if they met the following inclusion criteria: 1) CS was reported, 2) either GET or LT was reported, and 3) participants were 18+. Twenty-two studies were included in the final analysis with 458 participants. Studies were grouped into three groups based on the mean CS: low, medium, and high. A sample size-weighted mean and SD, and confidence intervals were calculated for the percentage of CS at which T1 occurred in each group. Hedge's g was used to calculate effect sizes between the three groups of mean CS.

RESULTS: The CS across the included studies was 13.56±2.55 km·h−1 (95% CI [13.33,13.79]). The CS of the low, medium, and high CS subgroups was 11.09±1.85 km·h−1 (95% CI [10.78,11.40]), 13.40±1.45 km·h−1 (95% CI [13.18,13.61]), and 15.93 km·h−1 (95% CI [15.65,16.21]), respectively. Across all studies, T1 occurred at 82.6±14.0% CS (95% CI [81.4,83.9]). In the low,

medium, and high CS groups, T1 occurred at 80.1±18.2% CS (95% CI [77.9,84.0]), 83.2 ± 11.9% CS (95% [81.4,85.0]), and 83.5±11.4% CS (95% CI [81.7,85.3]), respectively. Hedge's g revealed a tendency for the percentage of T1 to be greater in the medium (g=.205); and high (g=.229) CS group compared to the low CS group. A trivial effect size was noted between the medium and high groups (g=.025).

CONCLUSION: It was demonstrated that T1 occurs at approximately 83% of CS. However, this may differ due to different fitness levels. The 95% CI in each tertile demonstrates uncertainty in where T1 occurs relative to CS. This may be due to inconsistent approaches used to determine T1 and CS. Still, the findings provide a basis on which remote analysis and prescription of TID can be performed. Further work could explore the potential to model the relationship between T1 and CS based on fitness levels, sex, and anthropometry.

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VALIDATION OF END OF SESSION DISTANCE LIMIT BALANCE FOR DIFFERENTIATING EXHAUSTIVE AND NON-EXHAUSTIVE INTERMITTENT TRAINING SESSIONS IN RUNNERS

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INTRODUCTION: The accurate modelling of intermittent running sessions by the Distance limit (D') balance would aid in the prescription of such sessions, and enhanced understanding of their demands. During cycling, Work limit (W') balance can be quantified using the model described by Skiba et al. [1] which allows W' depletion to be tracked while work rate is above critical power (CP), and determines exponential recovery of W' while work rate is below CP. While the Skiba model can validly quantify W' balance in recreational athletes during cycling [1], the model has not been validated in intermittent running sessions, which is this project's aim.

METHODS: The study is a retrospective analysis of a typical period of racing and training completed between December 2021 and March 2022 by national level endurance runners (n=6). Critical speed (m/s) and D' (m) were calculated from the linear relationship between distance (Y axis) and time (X axis) over 1500, 3000 and 5000m race distances. Intermittent training sessions (n=30) were classified as exhaustive (n=15) vs non-exhaustive (n=15) by the athletes' coach. Timestamped GPS data (i.e. speed) from the training files were exported from TrainingPeaks to CSV files. Within session D' balance was calculated at each timepoint using the D' depletion and recovery models proposed by Skiba et al. [1], allowing an end of session D' balance to be found. End of session D' balance for exhaustive vs non-exhaustive intermittent sessions was compared using independent samples t-test.

RESULTS: There was a large difference (effect size±95% CI=1.20±0.72; p=0.003) between end of session D' balance in exhaustive (mean±95% CI=173±19m; 63±6%) vs non-exhaustive (212±14m; 74±6%) sessions, indicating that end of session D' balance calculated using the Skiba model did differentiate between exhaustive vs non-exhaustive intermittent sessions. However, the 95% CI of end of session D' balance in exhaustive intermittent sessions did not include "0", indicating that end of session D' balance calculated using the Skiba model did not accurately quantify these sessions as exhaustive.

CONCLUSION: Since the D'/W' depletion model is accepted [2], the inaccurate quantification of end of session D' balance during exhaustive intermittent running sessions may be related to the exponential recovery of D' that is reliant on an accurately quantified recovery time constant. In cycling, this recovery time constant is scaled in relation to the absolute watts below CP that the individual is cycling at during recovery, and validated in recreational athletes [1]. Since one watt in cycling is not equal to one m/s in running, and the runners in the current study were highly trained [3], the Skiba recovery model may not be valid for accurate calculation of end of session D' balance during the intermittent running sessions performed by athletes in the present study.

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Oral presentations

OP-PN03 Physiology and Ageing

A POTENTIAL MECHANISM FOR THE PROTECTIVE EFFECTS OF EXERCISE ON NEUROMUSCULAR FUNCTION WITH AGEING

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INTRODUCTION: The number of limb motoneurons declines with age (1), leading to an irreversible loss of muscle fibres and ultimately a loss of muscle function. Exercise has neuroprotective effects that facilitate reinnervation of denervated

muscle fibres (2) and potentially also limit motoneuron decay. While there is limited understanding of what drives these neuroprotective effects, muscle-derived factors are likely contenders. The aim of this study was to investigate the neuroprotective properties of muscle cells derived from lifelong exercisers, compared with inactive counterparts.

METHODS: Primary muscle stem cells (MuSC) and fibroblasts (FB) were isolated from biopsy tissue collected from the vastus lateralis muscle of 7 elderly lifelong exercising males (LLEX, age: mean 72 ± SD 3 y, BMI: 25±3 kg/m^2), 6 elderly sedentary males (SED, age: 73±4 y, BMI: 27±3 kg/m^2) and 8 young sedentary males (Young, age: 25±5 y, BMI: 25±3 kg/m^2) (3). Isokinetic concentric leg extensions were performed to assess maximal voluntary contraction (MVC) and muscle performance index during repeated contractions (MPI, % of MVC). Motoneurons from rat embryos were cultured with MuSCs or FBs from each of the 3 groups for 24 hours. Motoneuron survival and neurite growth were analysed by immunofluorescence and RT-qPCR. In vivo data were compared by t-test, and cell culture data by 2-way ANOVA (group x cell).

RESULTS: Compared to SED, LLEX had 15% higher MPI ($p<0.05$) but similar MVC ($p<0.132$), while Young, compared to old groups combined, had 34% higher MVC ($p<0.01$) but similar MPI ($p=0.43$). Motoneurons incubated with muscle cells from LLEX, compared to SED, were characterised by a 63% higher survival ($p<0.001$), and a 55% higher number of neurites per area ($p<0.05$). There were no differences between young and old in vitro. mRNA levels of three "neurite growth" genes revealed cell type specific responses, with two out of three favouring FBs (Fth1, Ppp1r1a) over MuSCs (Rack1).

CONCLUSION: Exercise confers protective effects on neuromuscular health, but how these effects are mediated is largely unresolved. Our data provide a potential explanation, clearly showing that, when compared to inactive older individuals, muscle cells from lifelong exercisers exert a strong stimulatory effect on motoneurons, both in terms of survival and growth. Preservation of motoneurons through exercise could protect against the loss of muscle fibres and associated decline in physical function in old age. In relation to exercise recommendations therefore, it is possible that, while it is never too late to take up regular physical activity, optimal preservation of muscle function can only be achieved by maintaining a physically activity lifestyle throughout life.

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LOWER LIMB HYPERTHERMIA SIMILARLY AUGMENTS FUNCTIONAL HYPERAEMIA DURING KNEE-EXTENSOR EXERCISE IN TRAINED ELDERLY AND YOUNG HUMANS

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INTRODUCTION: Exercise and heat therapies are commonly recommended to improve vascular function and health in young and elderly people (1, 2). Ageing is associated with reduced limb tissue and systemic perfusion during passive and exertional whole-body hyperthermia (3) and large-muscle groups exercise (4); however, evidence in isolated limb hyperthermia, small-muscle group exercise and its combination is conflicting (5). Here, we tested the hypothesis that the combination of single-leg hyperthermia and knee-extensor exercise would have an additive effect on limb haemodynamics, albeit lower in the elderly group.

METHODS: Nine trained, healthy elderly (69±5 years) and ten young (26±7 years) adults underwent 90 min of single-leg heating followed by 10 min of low-intensity single-leg knee-extensor exercise at 6 W and 12 W work rate (5 min each), with both the heated and control legs. Temperature and tissue oxygenation profiles, and leg haemodynamics at the femoral and popliteal arteries were measured.

RESULTS: In both groups, passive leg heating increased whole-leg skin temperature, blood flow and tissue oxygenation by 9.3±1.6 ºC, 0.7±0.2 L/min (>3-fold), and 18±6 % units ($p<0.0001$), respectively. Larger increases in leg blood flow were seen in the heated leg in comparison to the control leg during exercise (3.1±0.6 vs 2.3±0.4 L/min, $p<0.0001$) as leg blood flow was tightly coupled to leg temperature ($R2=0.77$, $k=0.27$ [0.05, 0.70]). Shear rate increased 3-fold during leg heating, 8-fold during control exercise, and 10-fold during heated exercise ($p<0.0001$). There were no differences in limb haemodynamics between cohorts, other than the elderly group exhibiting a 16±6 % larger arterial diameter, a 51±6 % lower blood velocity, and a 73±7 % lower shear rate following heating ($p<0.0001$).

CONCLUSION: Local hyperthermia increased leg blood flow over 3-fold and had an additive effect during knee-extensor exercise with no differences in leg perfusion between the healthy, exercise-trained elderly and the young groups. Hence, against our hypothesis, age per se does not compromise local hyperthermia-induced or small-muscle group functional hyperaemia despite evident aged-related structural and functional differences in the leg conduit arteries. The novel finding that leg hyperthermia induced a 2–3-fold higher shear rate—an important stimulus for vascular adaptation (2)—during rest and exercise may have important implications for elderly, sedentary populations who are not able to participate in sustained exercise. The combination of lower limb heating with low-intensity exercise may be a suitable intervention to enhance the stimulus for vascular adaptation without inducing systemic thermal discomfort and physiological strain.

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ENDURANCE TRAINING COUNTERACTS AGE-RELATED FUNCTIONAL AND STRUCTURAL ALTERATIONS OF NEUROMUSCULAR JUNCTION IN MICE

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INTRODUCTION: The deterioration of neuromuscular junction (NMJ) is considered one of the factors of muscle weakness in old age. The structural alteration of NMJ can not only impair the signal transmission from motor neurons to muscle fibers, but also lead to the alterations in muscle fiber type through repeated cycles of denervation and reinnervation. Several studies have found that endurance training influences the structure of NMJ in aged mice (1), but its effects on the functions of NMJ remain unclear. The purpose of this study was to clarify the effect of endurance training on the function and structure of NMJ in aged mice.

METHODS: Young (3 months old) and aged (22 months old) male C57BL/6J mice were divided into three groups: Y (young, n = 10), AC (aged control, n = 8) and AT (aged trained, n = 8). AT was subjected to low intensity treadmill running (5–15 m/min, 15–60 min) five times a week for eight weeks, while Y and AC remained untreated. After the intervention period, we examined voluntary grip strength, neuromuscular transmission index (the ratio of evoked plantar flexion torques between supramaximal nerve and muscle stimulations), muscle fiber composition and the structure of NMJ (axon width, nerve terminal area, acetylcholine receptors area, pre- to post-synaptic overlap) in the plantaris and soleus muscles. A one-way ANOVA followed by Tukey's post hoc test and a two-way ANOVA followed by Holm-Bonferroni post hoc test were performed to detect differences. The difference was considered statistically significant at $p < 0.05$.

RESULTS: AC had a significantly lower grip strength than Y and AT. The wet weight of the plantaris and the soleus muscles was significantly smaller in AC than in Y, but was similar between AC and AT. The neuromuscular transmission index of AC was significantly lower than that of Y and AT. The size of the nerve terminal area and the synaptic overlap in the plantaris and fast-twitch fibers in the soleus were significantly lower in AC than in Y. The overlap was significantly correlated to the transmission index. AC showed a significantly higher proportion of type I fibers and a significantly lower proportion of type IIb/IIx fibers in the soleus than Y. The proportions of the denervated NMJ in the plantaris and the soleus were significantly higher in AC than in Y and AT. In AC, the proportion of the denervated NMJ in the soleus was significantly higher in fast-twitch fibers than in slow-twitch fibers.

CONCLUSION: These results suggest that the age-related decline in the pre- to post-synaptic overlap of NMJ is associated with the impairment of neuromuscular transmission. The age-related denervation is pronounced in fast-twitch fibers, resulting in the reduced proportion of fast-twitch fibers. Endurance training can counteract these alterations, thus contributing to the maintenance of voluntary muscle strength.

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AGE-DEPENDENT CEREBRAL BLOOD FLOW RESPONSES TO ACUTE CONCURRENT PHYSICAL AND COGNITIVE ACTIVITY

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INTRODUCTION: Concurrent physical and cognitive training may be a viable intervention to support cognitive function throughout the lifecycle, by combining the benefits of each into an efficient protocol. Transient increases in cerebral blood velocity have been proposed as a potential mechanism responsible for the observed cognitive benefit. However, little is known about the acute cerebral haemodynamic response to concurrent training, and how this may be influenced by age. This study compared the cerebral blood velocity response to physical only and concurrent training and assessed the potential age-related differences in this response.

METHODS: Fourteen younger (25±2 years, 7 female) and fourteen older (64±3 years, 8 female) adults completed two exercise protocols in a randomised order. Participants cycled for 30-minutes at 60% of their maximal aerobic power output, with the addition of an incongruent Stroop Task (Exercise-Stroop) and without (Exercise-Only). Transcranial doppler ultrasound was used to simultaneously record cerebral blood velocity within the right middle (MCA) and left anterior (ACA) cerebral arteries, with average values recorded at 7-minute intervals during each protocol. A general linear mixed model was used to determine the effects of time, condition (Exercise-Stroop vs. Exercise-Only), and age (younger vs. older adults) on the recorded velocities within each vessel.

RESULTS: No three-way interaction effects (time*condition*age) were observed for the MCA ($p=0.95$) or ACA ($p=0.76$), and no significant two-way interactions with condition were identified for either vessel. A time*age interaction was noted for both MCA (b= 5.4 to 7.5 cm/s, $p<0.05$) and ACA (b= 4.9 to 7.9 cm/s, $p<0.05$) velocities, with the older group steadily declining towards baseline values across the duration of each protocol.

CONCLUSION: Regardless of age, concurrent engagement in physical and cognitive activity did not modify cerebral blood velocities beyond those observed during exercise. However, the capacity to sustain the elevations in velocity appears to be influenced by age, potentially the result of age-related changes in cerebrovascular function. Future research should

assess the influence of these age-related cerebrovascular changes, and the effect that different cognitive tasks may have on the observed cerebral haemodynamic response to concurrent training.

Oral presentations

OP-AP02 Training and Testing: Team sports

SUBMAXIMAL FITNESS TEST IN TEAM SPORTS: A SYSTEMATIC REVIEW AND META-ANALYSIS OF EXERCISE HEART RATE MEASUREMENT PROPERTIES

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INTRODUCTION: Submaximal Fitness Tests (SMFT) are a pragmatic approach for evaluating athlete's physiological state, due to their time-efficient nature, low physiological burden and relative ease of administration in team-sports settings. Whilst a variety of outcome measures can be collected during SMFT, exercise heart rate (HRex) is the most popular. Understanding the measurement properties of HRex can support the interpretation of data and assist in decision-making regarding athlete's current physiological state and training effects. The aims of our systematic review and meta-analysis were to: 1) establish meta-analytic estimates of SMFT HRex reliability and convergent validity; and 2) examine the moderating influence of athlete and protocol characteristics on the magnitude of these measurement properties.

METHODS: We conducted a systematic literature search with MEDLINE, Scopus and Web of Science databases for studies published up until January 2022 since records began. Studies were considered for inclusion when included team-sports athletes and the reliability and/or convergent validity of SMFT HRex was investigated. Reliability statistics included the group mean difference (MD), typical error of measurement (TE) and intraclass correlation coefficient (ICC) derived from test-retest(s) designs. Pearson's correlation coefficient (r) describing the relationship between SMFT HRex and a criterion measure of endurance performance was used as the statistic for convergent validity. Mixed-effects, multilevel hierarchical models, combined with robust variance estimate tests were performed to obtain pooled measurement property estimates, effect heterogeneity, and meta- regression of modifying effects.

RESULTS: The electronic search yielded 21 reliability (29 samples) and 20 convergent validity (29 samples) studies that met the inclusion criteria. Reliability meta-analysis indicated good absolute (MD = 0.5 [95% CI: 0.1 to 0.9] and TE = 1.6 [1.4 to 1.9] % points), and high relative (ICC = 0.88 [0.84 to 0.91]) reliability. Convergent validity meta-analysis indicated an inverse, large relationship (r = –0.58 [–0.62 to –0.54]) between SMFT HRex and endurance tests performance. Meta-regression analyses suggested no meaningful influence of SMFT protocol or athlete characteristics on reliability or convergent validity estimates.

CONCLUSION: Submaximal Fitness Test HRex is a reliable and valid proxy indicator of endurance performance in team-sport athletes. Athlete and SMFT protocol characteristics do not appear to have a meaningful effect on these measurement properties. Practitioners may implement SMFT HRex for monitoring athlete's physiological state by using our applied implications to guide the interpretation of data in practice. Future research should examine the utility of SMFT HRex to track within-athlete changes in aerobic capacity, as well as any further possible effects of SMFT protocols design elements or HRex analytical methods on measurement properties.

MAXIMIZING PHYSICAL PERFORMANCE IN FEMALE HANDBALL PLAYERS DURING THE COMPETITIVE SEASON: THE IMPACT OF HIGH-LOAD STRENGTH TRAINING VERSUS POWER-PLYOMETRIC TRAINING

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INTRODUCTION: Handball players practice various types of resistance training to enhance physical performance. Whether it is beneficial to prioritize high-load or high-velocity resistance training for preserving strength and power capacities throughout the in-season period remains to be determined. As such, the aim of this study was to compare the effects of in-season power and plyometric training versus high-load strength training on body composition and strength- and power performance.

METHODS: Thirty-one female handball players from two senior sub-elite teams were randomized into high-load strength training (high-load; n=16, 20±3yrs, 170±6cm, 70±14kg) or power and plyometric training (power-plyo; n=15, 20±3yrs, 170±6cm, 66±7kg). Biweekly training sessions were conducted for 12 weeks and supervised once a week. The high-load group performed 2-6 sets per muscle group at 80-85% 1RM, while power-plyo completed 75-90 bodyweight jumps in addition to 2-4 sets of 3-6 power exercises at ≤50% 1RM. Before and after the training period, 1RM in squat and bench press, theoretical maximal force (Fmax) and -power (Pmax) from pneumatic leg press, and bench press power by a linear encoder were assessed. Countermovement jump (CMJ) height was measured on a force plate, and vertical reach with single-leg jump-and-reach. Sprint (10-, 20-, and 30m) and change of direction (CoD) times (4x180° turns) were measured with timing gates, and body composition was assessed using Dual-X-Ray-Absorptiometry. All data were analyzed with t-tests and are reported as mean change with 95% confidence intervals or standard deviations.

RESULTS: Training attendance was 90±8% in the high-load group and 90±9% in the power-plyo group. Further, 1RM increased more in high-load compared to power-plyo, squat by 8.6% (1.4, 15.7, p=0.02) and bench press by 6.6% (0.7, 12.6, p=0.03). No between-group differences were observed in other parameters (p=0.17-0.95). Compared to baseline, both groups improved (all p<0.05); Fmax (high-load: 8.5±9.8%, power-plyo: 4.9±8.2%), Pmax (high-load: 10.5±7.6%, power-plyo: 8.5±7.3%), bench press power (high-load: 8.1±9.8%, power-plyo: 5.5±10.2 (tendency p=0.06), CMJ (high-load: 6.6±6.9%, power-plyo: 7.2±5.4%) and jump-and-reach (high-load: 5.6±8.0%, power-plyo: 6.1±9.5%). Sprint was unchanged, but high-load improved CoD (2.0±2.5% vs. 1.0±2.6%). No changes were observed in body mass or fat mass, but both groups increased fat-free mass (FFM, high-load: 2.0±2.0%, power-plyo: 1.7±2.3%) and legs FFM (high-load: 2.5±2.9%, power-plyo: 2.9±2.3%).

CONCLUSION: Our findings suggest that if maximal strength is prioritized, handball players should choose high-loads over power-plyo training during the in-season; otherwise, they may use either approach to maintain or increase FFM, power, jump, and sprint performance. However, more research is needed to elucidate specific neuromuscular adaptations of high-loads versus high-velocity training to better understand and prescribe in-season training programs for handball players.

AN EVALUATION OF THE FACTORS PREDICTING TOTAL ATHLETIC ABILITY VIA ENERGETIC MODELLING OF A SINGLE-VISIT, OVERGROUND ASSESSMENT OF THE SPEED- AND POWER-DURATION RELATIONSHIP IN TEAM SPORTS PLAYERS

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INTRODUCTION: The 3-minute all-out test (3MT) provides a single-visit, field-based method to characterise parameters of the overground speed-duration relationship. Data from this test can be used to determine whole-body power output using a novel energetics modelling approach. When all speed and mechanical outputs captured during the single-visit assessment of the overground speed- and power-duration relationship are considered, it is possible that they could explain variance in athletes' overall physical ability. This could help to determine team sport athletes' total score of athleticism (TSA), which relies on a battery of separate physical performance tests. This can be logistically impractical and poorly adopted by coaches. However, it is unclear whether data extracted from the 3MT can explain variance in TSA and which variables have the greatest relative contributions. This study aimed to evaluate the variance explained in a composite battery of physical performance tests to overground running mechanical parameters derived from a 3MT.

METHODS: Following ethical approval, 94 competitive team sport players consented to take part in three separate testing visits. Across days, this included assessment of: countermovement jumping (CMJ) on a force plate; 0-to-30-m overground sprinting, measured using electronic timing gates and a Yo-Yo intermittent recovery level 1 (Yo-Yo IR1) test. The TSA was calculated using a summated z-score from: jump height, CMJ peak power, Yo-Yo IR1 score, 10-m and 30-m speed. Additionally, an overground 3MT was conducted using a 10-Hz global positioning system (GPS), from which critical speed and Distance-prime (D') were determined. Energetic modelling was used to determine over-ground mechanical work, from which critical power (CP) and Work-prime (W') were calculated. Partial least squares regression (PLSR) was used to explain variance in the TSA using 8 variables derived from the 3MT. The number of components explaining the greatest variance (R2) in TSA were selected in the final model. The contribution of each variable to the overall model was calculated via the jack-knife function.

RESULTS: The final model comprised one component, which explained 47.2% of the variance in TSA. The strongest variables contributing to the overall model were: CP (beta=4.22, P<0.001) W' (beta=4.49, P<0.001), maximal mechanical power (beta=5.06, P< 0.001), total mechanical work per metre-squared of body surface area (beta=6.14, P <0.001), maximal force production (beta=3.23, P=0.002) and peak speed (beta=4.75, P<0.001). Critical speed (beta=2.02, P=0.01) and D' (beta=1.81, P=0.04) were the weakest contributors.

CONCLUSION: Mechanical parameters derived from the 3MT provided the strongest contributions in the model, which overall explained 47.2% of variance in TSA. These preliminary data demonstrate the potential utility of overground power-duration parameters for athlete profiling but question its capacity, in its current form, to capture all aspects of athletic ability.

THE RELATIONSHIP BETWEEN SPECIFIC GAME-BASED AND GENERAL PERFORMANCE IN YOUNG ADULT ELITE MALE TEAM HANDBALL PLAYERS

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INTRODUCTION: In young adult elite team handball players, physical performance is an essential factor for becoming a top-elite player and should be measured adequately. However, in elite team handball academies, general, unspecific tests are often used to determine this physical performance. It is unknown if these unspecific physical performance tests have an influence on the specific team handball performance, although this knowledge is essential for the selection process during adolescence or for young adults before transitioning to professional elite team handball. Additionally, reducing the overall testing time and the test equipment is also important for an economical testing. Consequently, the aim of the study was (1) to analyze the relationship between specific game-based and general physical performance in young elite male team handball players, and (2) to reduce the number of tests for a more practical implementation of physical performance diagnostics in team handball.

METHODS: Twenty young adult elite male team handball field players (18.6 ± 2.1 years) performed the team handball game-based performance test (GBPT) and general tests including a 20 m sprinting test, a repeated sprint ability test (RSA), a modified T-test, countermovement (CMJ), squat (SJ) and drop jump test (DJ), a standing long jump test, a single-leg lateral three jumps test, a standing throw test, and the determination of the one repetition maximum (1RM) in the bench press, bench pull, front squat, and deadlift. The relationship between general physical performance tests (the GBPT) and anthropometric variables (body height and weight) was determined by calculating Pearson Product-Moment correlation coefficients. Additionally, a principal component factor analysis was conducted to determine a few components that define multiple variables.

RESULTS: Significant correlations (> 0.60 or < -0.60) were mostly found between different sprinting and jumping tests (20 m sprinting test, RSA, modified T-test, defense time in the GBPT, CMJ, SJ and DJ test, standing long jump test, and the single-leg lateral three jumps test) as well as between different strength tests (1RM in the bench press, bench pull, front squat, and deadlift) and body weight. The principal component factor analysis revealed four components (power and speed, strength, jump shot performance, and endurance) including 21 variables of high loads (> 0.60 or < -0.60).

CONCLUSION: To reduce the number of tests and optimize the testing process in elite team handball, we suggest five physical performance tests (20 m sprinting test, GBPT, CMJ test, 1RM in the bench press and front squat) that enable testing several times in one season. However, due to the high financial costs of the GBPT (for equipment and manpower), we would suggest a different testing procedure in youth and non-elite team handball, including six physical performance tests (20 m sprinting test, T-test, CMJ test, 1RM bench press and front squat, as well as the YoYo intermittent recovery test).

CONSTRUCT VALIDITY OF A NEW DECREASING RECOVERY INTERMITTENT RUNNING TEST IN SOCCER

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INTRODUCTION: In recent years a new protocol of an intermittent running test with decreasing recovery called MAP (MAnari Protocol from the surname of his inventor) has been used to assess professional soccer players. However its validity is yet to be established. The main aim of the study was to explore MAP construct validity by examining the correlation between the peak of oxygen consumption (VO2peak) and other variables measured by MAP and various parameters of match physical performance. A secondary aim was to validate the Mognoni Test (MT) (1).

METHODS: Ten Serie A players were tested with MAP and MT. The selected parameters of match physical performance (raw and normalized by min played) were: metabolic power, very high power, high power distance, high and very high speed running distance, maximum acceleration and maximum deceleration distance, total distance (2). After warm-up, players performed to volitional exhaustion sets of 3 to 7 50m intermittent runs at 18 km/h with recovery between each run decreasing after each set (from 17s in the first set to 2s in the final set). VO2peak, ventilatory parameters like the respiratory compensation point (RCP), lactate, and MAP distances were recorded. 48 hours later players were also tested with MT to estimate the speed at the onset of blood lactate accumulation (OBLA). Parameters of match physical performance were obtained from the average of two video-tracked matches played for at least 45 min within 2 weeks from the date of the MAP and MT.

RESULTS: VO2peak was positively correlated with power variables, high speed distances, distance maximum accelerations and decelerations per min, total distance per min during the match. MAP distance was positively correlated with power variables (metabolic power, high distance power) and match-related distance variables (total distance, total distance per min). Lactate at the end of MAP was positively correlated only with average metabolic power per min. The difference between the MAP distance and distance at RCP, was positively correlated with power variables (metabolic power, very high distance power) high speed distance, distance maximum acceleration and decelerations per min, total distance per min and maximum speed. Speed at OBLA estimated with the MT was negatively correlated with distance run at very high speed and with distance run at very high power, and their respective values per min.

CONCLUSION: This study provides empirical support to the construct validity of both the MAP and the MT as indicators of between-subject differences in match physical performance in professional soccer players. With the exception of distance at OBLA, all MAP variables correlate significantly with various parameters of match physical performance. MAP variables requiring the use of a portable metabolimeter do not show superior construct validity compared to MAP distance.

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Oral presentations

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SHORT-TERM LOW ENERGY AVAILABILITY DOWN-REGULATES CIRCULATING TRIIODOTHYRONINE AND BONE FORMATION MARKERS IN MALES, WHILST SKELETAL MUSCLE PROTEIN SYNTHESIS IS PRESERVED.

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INTRODUCTION: Low energy availability (LEA) is thought to downregulate the hypothalamic-pituitary-axes and impair bone health and physical capacity in exercising individuals. However, the effect of LEA on skeletal muscle is unclear. This study aimed to assess the effect of five days of LEA on endocrine, metabolic, physiological, and skeletal muscle phenotype responses in males.

METHODS: In a quasi-experimental design, 10 healthy males (25 ± 5 yrs, body mass: 78.8 ± 8.2 kg, VO2peak: 52 ± 8 ml/kg/min) completed three consecutive 5-day periods of 1) free-living, 2) energy balance (EB: energy availability (EA) = 45 kcal/kg Fat Free Mass [FFM]/day), and 3) LEA (EA = 10 kcal/kg FFM/day). EB and LEA diets provided 60% carbohydrate, 20% fat, 20% protein, and participants performed standardised cycling exercise to expend 15 kcal/kg FFM on days 1, 3 and 5 of EB and LEA. Skeletal muscle phenotype shift was determined via proteomics. To determine dynamic proteomic profiling, participants consumed D2O daily and muscle biopsies were collected from the vastus lateralis at the start and end of each period. Body composition and resting metabolic rate (RMR) were also collected at these timepoints. Fasting venous blood was collected throughout and assessed for plasma total triiodothyronine (T3) and markers of bone resorption (ß-CTX) and formation (P1NP). Data were explored via one-way ANOVA and linear mixed models.

RESULTS: Body mass, FFM, and fat mass were stable during EB but reduced by 2.9 ± 0.7 kg ($P < 0.001$), 2.1 ± 0.7 kg ($P < 0.001$), and 0.8 ± 0.6 kg ($P = 0.003$), respectively after LEA. RMR was unchanged following LEA ($P = 0.151$). Compared to baseline concentrations (131 ± 22 ng/dL), T3 was reduced following LEA (108 ± 23 ng/dL; $P = 0.009$). Plasma ß-CTX was higher after four days of LEA (0.90 ± 0.23 µg/L) compared to four days of EB (0.80 ± 0.29 µg/L; $P = 0.020$), whilst P1NP concentrations reduced from 79.3 ± 22.7 µg/L to 67.3 ± 17.8 µg/L ($P < 0.001$) after LEA. Proteomic analysis determined the abundance of 1550 proteins and turnover of 565 proteins. Between EB and LEA, there were no differences in global fractional synthetic rates of the myofibrillar, soluble, and mitochondrial protein fractions. After LEA, the abundance of 131 proteins and turnover of 20 proteins were significantly different ($P < 0.05$) compared to EB. KEGG pathway analysis revealed alterations in protein abundance associated with metabolic pathways, including mitochondrial function, fatty acid, and branched-chain amino acid metabolism.

CONCLUSION: In conclusion, five days of LEA reduced markers typically associated with LEA, including plasma T3 and P1NP concentrations in males. Global protein synthetic rates for myofibrillar, soluble and mitochondrial fractions were preserved following LEA and skeletal muscle phenotype shifted towards fatty-acid metabolism. These data suggest that despite down-regulated endocrine responses to LEA, skeletal muscle protein turnover is preserved with concomitant alterations in skeletal muscle phenotype.

INGESTION OF MYCOPROTEIN, PEA PROTEIN OR THEIR BLEND SUPPORT COMPARABLE POST-EXERCISE MYOFIBRILLAR PROTEIN SYNTHESIS RATES IN RESISTANCE TRAINED INDIVIDUALS.

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INTRODUCTION: Pea protein is commercially advanced, digestible and leucine rich (>5.9% total protein), making it an attractive non-animal derived protein source for supporting post-exercise myofibrillar protein synthesis (MyoPS). However, a low methionine content (<1.6% total protein – WHO criteria) has been suggested to limit its anabolic potential. Mycoprotein has a more balanced amino acid profile which, at least in part, explains its ability to robustly stimulate MyoPS rates. We hypothesised that an inferior post-exercise MyoPS response would be seen following ingestion of pea protein compared with mycoprotein, which would be (partially) rescued by blending the two sources.

METHODS: Thirty-three healthy, young (age; 21±1 y, BMI; 24±1 kg.m-2) and resistance trained volunteers participated in a randomised, double-blind parallel group trial. Participants received primed, continuous infusions of L-[ring-2H5]phenylalanine and completed a bout of whole-body resistance exercise before ingesting 25 g protein from mycoprotein (MYC; 1.7 g leucine, 0.4 g methionine, n=11), pea protein (PEA; 1.9 g leucine, 0.2 g methionine, n=11) or a blend (39% MYC, 61% PEA) of the two (BLEND; 1.7 g leucine, 0.3 g methionine, n=11). Blood and muscle (vastus lateralis) samples were taken pre-, 2 h and 4 h post- exercise/protein ingestion to assess postabsorptive and temporal postprandial postexercise myofibrillar protein fractional synthetic rates (FSRs). Two-way ANOVAs were used to detect differences in plasma amino acid kinetics (group × time) and myofibrillar FSRs (group × time), with Sidak tests applied post-hoc.

RESULTS: Protein ingestion increased plasma essential amino acid and leucine concentrations (time effect; $P<0.0001$), but more rapidly in BLEND and PEA compared with MYC (time x condition interaction; $P<0.0001$). Postprandial plasma methionine availability (4 h iAUC) was greater in MYC (576 µmol·L-1 x 240 min) compared with BLEND (-188 µmol·L-1 x 240 min) and PEA (-567 µmol·L-1 x 240 min). From similar postabsorptive values (MYC, 0.026±0.008%·h-1; PEA, 0.028±0.007%·h-1;

BLEND, 0.026±0.006%·h-1), resistance exercise and protein ingestion increased myofibrillar FSRs (time effect; P<0.0001) over a 2 h (MYC, 0.077±0.015%·h-1; PEA, 0.089±0.014%·h-1; BLEND, 0.091±0.013%·h-1) and 4 h (MYC, 0.076±0.004%·h-1; PEA, 0.087±0.01%·h-1; BLEND, 0.085±0.01%·h-1) period, with no differences between groups (all; P>0.05).

CONCLUSION: Ingestion of isonitrogenous boluses of mycoprotein, pea protein and their blend results in equivalent rates of MyoPS following whole-body resistance exercise. These data suggest that all three non-animal derived protein sources are effective in supporting post-exercise muscle reconditioning.

NUTRITIONAL AND PHYSIOLOGICAL DETERMINANTS OF PEAK FAT OXIDATION IN MODERATELY TRAINED MEN

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INTRODUCTION: Peak fat oxidation (PFO) is strongly linked to metabolism-regulating proteins (1,2),but the extent to which these can be altered using a short-term dietary intervention remains unexamined. Furthermore, the impact of endogenous and exogenous store alteration on PFO has not been fully elucidated. Assessment of muscle characteristics may prove to further explain the variability in PFO largely unaccounted for (3). This study assessed the determinants of PFO using a short-term fat-rich or carbohydrate-rich diet, hypothesising that a fat-rich diet would lead to alterations in substrate availability, and thus elevations in PFO.

METHODS: Moderately trained men [n = 40, VO2peak 56.2 ± 5.1 ml/kg/min, BMI 24.1 ± 1.9 (mean ± SD)] were allocated to either a 3-day isocaloric high-fat (HIFAT: 65% fat, 20% carbohydrate and 15% protein) (n = 20) or high-carbohydrate diet (HICHO: 70% carbohydrate, 15% fat and 15% protein) (n = 20). Participants completed an incremental exercise test to determine PFO and maximal oxygen uptake. Fasting blood samples and a muscle biopsy from the vastus lateralis were collected before and after the diet intervention. Two-way RANOVA were used to assess differences between diet groups over time.

RESULTS: At baseline, simple bivariate analyses revealed VO2 peak (r2 = 0.12, p = 0.03) and FFA (r2 = 0.10 p = 0.0484) were positively associated with PFO. No significant association was found between PFO at baseline and resting muscle glycogen or IMTG. The HIFAT group displayed elevated PFO (0.59 ± 0.18 vs 0.27 ± 0.10 g/min, p = 0.02) compared to HICHO. Muscle glycogen was significantly increased following the carbohydrate-rich diet and reduced by the fat-rich diet, respectively (delta 91.09 ± 142.3 vs -81.66 ± 89.30 nmol/mg dry weight, p < 0.0001). IMTG stores remained unchanged after dietary intervention. Expression of mRNA for key regulatory proteins GLUT4, ANT1, CPT-1 and ß-HAD were not significantly altered by diet, however UCP3 mRNA expression was significantly elevated after HIFAT by 1.7 fold (p = 0.046). Plasma triglyceride and ketone levels were significantly increased following HIFAT (p < 0.05).

CONCLUSION: PFO was significantly elevated after HIFAT and reduced following HICHO. Nutritional interventions of only 3 days provide sufficient duration to elicit metabolic changes facilitating fat oxidation during exercise.

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THE EFFECT OF COMBINED JUMP TRAINING AND COLLAGEN SUPPLEMENTATION ON BONE MINERAL DENSITY IN MALE AND FEMALE ELITE CYCLISTS

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INTRODUCTION: Accumulating evidence indicates that most elite cyclists have low bone mineral density (BMD). Jumping exercise has been shown to improve BMD, although this has never been investigated in elite-level road-race cyclists. Collagen supplementation may augment the effect of jumping exercise on BMD, as collagen is a key component of bone tissue. The present study aimed to evaluate the effect of combined jump training and collagen supplementation on BMD in elite road-race cyclists.

METHODS: In this open-label, randomized controlled study with two parallel groups, 36 young male (n=8) and female (n=28) elite cyclists (21±3 y, BMI 21±1 kg/m2) were allocated to either an intervention (INT: n=18) or a no treatment control (CON: n=18) group. The 18-wk intervention period, conducted during the off-season, consisted of 5-min jumping exercise bouts performed five times per week, with each exercise bout preceded by the ingestion of 15 g hydrolyzed collagen. Body composition, trabecular bone score (TBS), and BMD of the total hip, femoral neck, lumbar spine and whole body were assessed before and after the intervention period by dual-energy x-ray absorptiometry, along with serum bone turnover markers P1NP and CTX-I. The effect of the intervention on the dependent variables was assessed by using mixed model ANOVA, with time (pre- and post-intervention) as within-subject factor and treatment (CON vs INT) as between-subject factor.

RESULTS: Compliance with the intervention was 3.5±0.9 sessions with collagen supplements per week (77% of planned sessions completed). Lean body mass increased to a similar extent (~2.6%; time-effect: P<0.001) in CON (from 46.3±7.8 to 47.5±7.5 kg) and INT (from 47.9±4.8 to 49.0±5.1 kg; time x treatment: P=0.78). In contrast, fat mass remained unchanged

in CON (11.3±2.6 to 11.3±2.8 kg), while a decrease was noted in INT (12.0±3.9 to 10.5±3.7 kg; time x treatment: P<0.01). BMD of the femoral neck decreased in CON (from 0.789±0.104 to 0.774±0.095 g/cm2), while being preserved in INT (from 0.803±0.058 to 0.809±0.066 g/cm2; time x treatment, P<0.01). No differences between treatments were observed for changes in BMD at the total hip, lumbar spine and whole body (time x treatment, P>0.05 for all). TBS increased from 1.38±0.08 to 1.40±0.09 in CON and from 1.46±0.08 to 1.47±0.08 in INT, respectively (time effect: P<0.01), with no differences between treatments (time x treatment: P=0.33). Serum P1NP concentrations decreased to a similar extent in CON (83.6±24.8 to 71.4±23.1 ng/mL) and INT (82.8±30.7 to 66.3±30.6 ng/mL; time-effect, P<0.001; time x treatment, P=0.22). Serum CTX-I concentrations did not change over time, with no differences between treatments (time-effect, P=0.08; time x treatment, P=0.58).

CONCLUSION: Frequent short bouts of jumping exercise combined with collagen supplementation beneficially affect femoral neck BMD in elite cyclists. As such, this intervention appears a promising strategy for mitigating the adverse effects of professional cycling on bone health.

PERI-EXERCISE L-CITRULLINE SUPPLEMENTATION REDUCED EXOGENOUS GLUCOSE UTILISATION, WITHOUT ALTERING ENDURANCE PERFORMANCE OR GASTROINTESTINAL DAMAGE IN MALE CYCLISTS

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INTRODUCTION: Carbohydrate intake during endurance exercise is a recognised strategy to improve performance. Pre-exercise supplementation of l-citrulline has been demonstrated to improve endurance performance, VO2 kinetics and to reduce gastrointestinal (GI) symptoms/damage [1]. Arginine co-ingestion with carbohydrate during exercise has been shown to increase exogenous carbohydrate oxidation [2], but the effect of l-citrulline (which increases circulating arginine concentrations) in this regard remains unknown. Therefore, we examined the effect of adding l-citrulline to a carbohydrate supplement during prolonged cycling on exogenous carbohydrate oxidation, performance, and GI responses.

METHODS: Eleven trained male cyclists/triathletes (26 ± 6 y; 58 ± 5 ml/kg/min; 11 ± 5 h/week training) completed VO2peak and familiarisation trials, followed by two experimental trials involving 140 min cycling at ~55% Wpeak (preload) and a ~15 min time trial (TT). The study utilised a double-blind design and participants ingested glucose (60 g/h enriched with 0.2% [U-13C]-glucose) every 20 min either with (CHO+CIT) or without (CHO) the addition of l-citrulline (6 g/h). Expired breath samples were collected every 20 min to determine exogenous oxidation and venous blood samples/GI scales were collected at 0, 60, 140 min and post-TT.

RESULTS: TT performance was not different between trials (CHO 946 ± 90 s; CHO+CIT 923 ± 70 s; P=0.279), but there was a significant negative relationship between VO2peak and performance improvement in CHO+CIT (R=0.659; P=0.027). Mean 40-140 min (CHO+CIT 0.55 ± 0.09 g; CHO 0.62 ± 0.11 g; P=0.006) and peak (CHO+CIT 0.74 ± 0.12 g; CHO 0.82 ± 0.13 g; P=0.017) exogenous carbohydrate oxidation were reduced in CHO+CIT. Heart rate (P=0.347), RPE (P=0.948), overall GI comfort (P=0.804), plasma glucose (P=0.925) and plasma insulin (P=0.429) were not different between trials. Plasma lactate was higher in CHO+CIT post-TT (CHO+CIT 9.17 ± 3.74 mmol/L; CHO 7.36 ± 4.02 mmol/L; P=0.008). Sweat rate, dehydration accrued, plasma osmolality and plasma volume change were also not different between trials (P≥0.142), and neither were CD14 or IFABP-1 (blood markers of GI permeability/damage; P≥0.239).

CONCLUSION: The addition of l-citrulline to glucose consumed during prolonged cycling did not influence TT performance, but may be ergogenic in individuals with lower VO2peak scores. Additionally, these data suggest that the ability to use glucose provided in drinks during exercise is reduced when glucose is co-ingested with l-citrulline, although the mechanisms explaining these data are not clear. Finally, l-citrulline co-ingestion did not benefit GI symptoms (although these were low in both trials) or markers of GI damage (CD14 or IFABP-1), possibly due to the protective effect of carbohydrate intake on GI damage.

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Oral presentations

OP-BM16 Neuromuscular Physiology: Central and/or spinal drive II

MOTOR UNIT MODULATION PARTLY EXPLAINS THE REPEATED BOUT PHENOMENON

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INTRODUCTION: Unaccustomed eccentric exercise (EE) causes symptoms of exercise-induced muscle damage that are accompanied by changes in contractile properties and nervous system function, which persist for several days post-exercise[1]. Following a repeated bout of EE, the damage response is attenuated, however, it is unknown whether there is an alteration in motor unit (MU) behaviour during the performance of a repeated bout, which might contribute to the re-

peated bout phenomenon[2]. Accordingly, this study aimed to examine single MU properties during an initial and repeated bout of EE.

METHODS: Twenty-eight participants performed 2 bouts of 10 × 10 maximal lengthening dorsiflexion contractions four weeks apart. Maximal isometric voluntary toque (MVT) was measured pre- and post-EE. High-density surface electromyography (EMG) signals were recorded during trapezoidal contractions at 50% MVT. These were performed pre-EE, after set 5 (during) and post-EE. EMG signals were decomposed into individual MU discharge timings and were tracked across each time point. Mean MU discharge rate during the plateau of the trapezoidal contractions, along with recruitment and derecruitment thresholds were computed. Changes in outcomes variables within and between bouts were assessed with repeated measures analysis of variance.

RESULTS: Work done (1303 ± 404 vs 1401 ± 474 J; p=0.263) and the decrease in MVT immediately post EE (73 ± 11 vs 79 ± 12%; p=0.702) were similar in both bouts. MU data are reported for a preliminary cohort of 7 participants with a similar population of identified MUs (269 ± 9 vs 257 ± 11; p>0.05) and those tracked per participant in each bout (5 ± 2 vs 5 ± 4; p>0.05). For tracked MUs, the mean discharge rate at plateau increased during, and post the initial bout of EE (16.62 ± 3.60 and 17.32 ± 3.36 pps; p=0.022). The increase in discharge rate was attenuated following the repeated bout (15.09 ± 2.9 and 15.55 ± 3.5 pps; p=0.014). Furthermore, recruitment threshold (%Δ from baseline) was reduced during and post the first bout (–19.45 ± 10.26 and –28.4 ± 10.3%; p=0.011), but no differences were detected between bouts (–6.9 ± 4.83 and –7.7 ± 14.83%; p=0.286). A similar pattern was evident for de-recruitment thresholds, which decreased in the initial bout (–16.5 ± 9.1 and –24 ± 12%; p=0.003). Nevertheless, no difference was demonstrated between bouts (–12.3 ± 10% and –16.6 ± 12%; p=0.386).

CONCLUSION: During an initial bout of EE, increases in firing rate and reductions in recruitment and derecruitment thresholds were demonstrated. However, in a repeated bout, the changes in MU properties are attenuated. Such an adaptive response demonstrates preliminary evidence of a neural strategy to protect damage to skeletal muscle during a repeated bout of EE.

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THE REDUCTION IN H-REFLEX AFTER SHORT MAXIMAL ISOMETRIC CONTRACTIONS IS MEDIATED BY PRESYNAPTIC INHIBITION MECHANISMS

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INTRODUCTION: Short maximal isometric contractions lead to an enhancement of motor performance, better known as Post activation potentiation (PAP). PAP muscle force enhancement can be attributed to different contractile and neural mechanisms. While the contribution of contractile mechanisms to PAP is well described in the literature, the neural mechanisms contributing to PAP are less well-studied. In particular, spinal mechanisms assessed using the H reflex are equivocal. Thus, the study aimed to investigate the effects of short maximal isometric contractions of plantar flexors on spinal mechanisms underpinning PAP.

METHODS: Fourteen males (age 21.9 ± 4.8 years) participated. They were instructed to contract their plantar flexors, exerting their maximal force for 10 s (PAP) or rest for 10 s (REST). Both exercise conditions (PAP and REST) were counterbalanced and conducted in a single visit with a 20 minutes rest between conditions. Soleus H-reflex, D1 presynaptic inhibition and Homonymous Ia facilitation (HF) were assessed in nine time points over 20 minutes after the maximal voluntary contraction. The soleus EMG signal was collected using a 64-channel matrix electrode (GR08MM1305, OT Bioelettronica, Italy). Peak-to-peak amplitudes were extracted from the electrically elicited responses. Data were analysed using repeated measures nested linear mixed effect models.

RESULTS: Immediately after the intervention, the H-reflex was significantly lower in the PAP condition compared to the REST condition ($P < 0.001$). Similarly, the D1 and FAC were, respectively, significantly lower ($P < 0.001$) and higher ($P < 0.001$) compared to the REST condition immediately after the intervention. The observed effects disappeared 2 minutes after the intervention.

CONCLUSION: The short maximal isometric contractions induced a significant drop in H-reflex amplitude, probably modulated by presynaptic inhibition mechanisms as assessed by D1 inhibition. Interestingly, the homonymous Ia facilitation HF was significantly increased. However, two minutes after the contraction, the observed spinal modulation in the PAP condition was not significantly different compared to the REST condition, suggesting that the effects of PAP on spinal modulation are short-lasting. Further analysis of the data from the multichannel electrodes is required to gain more insight into the effects of PAP on the modulation of motor unit firing rates after short maximal isometric contractions.

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TRANSCUTANEOUS SPINAL CORD STIMULATION: PHYSIOLOGICAL SIMILARITIES WITH NERVE STIMULATION CONCERNING THE HPAD PHENOMENON

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INSERM U1093

INTRODUCTION: Transcutaneous spinal cord stimulation (tSCS) elicits reflex responses in all muscles of the lower limb by stimulating the lower thoracic level. These posterior root muscle (PRM) reflexes are thought to share some physiological similarities with the H-reflex [1;2]. For example, they are sensitive to the homosynaptic post activation depression (HPAD) phenomenon when the inter-stimulus interval is very short (50ms) [2;3]. The HPAD results from the repeated solicitation of Ia afferences inducing a decrease in the amount of neurotransmitters available at the synapse and a subsequent decrease in the second reflex amplitude [4]. However, it is still unknown whether the amount of this inhibition is equivalent for the two types of reflexes. The aim of the study was to test whether these responses share the same physiological mechanism related to HPAD phenomenon.

METHODS: Sixteen subjects volunteered to take part in one experimental session consisting of stimulations of the lower thoracic level (to elicit PRM reflexes in the lower limb) and tibial nerve stimulation (to elicit H-reflexes and M-waves in the triceps surae muscles). EMG activity was recorded from the soleus muscle (SOL). Recruitment curves were built at rest for tSCS and tibial nerve stimulation. From these recruitment curves, the intensities permitting to elicit a SOL H-reflex and a SOL PRM reflex of the same amplitude (at the same % of Mmax) were determined. Paired-pulse stimulations were delivered with a 50-ms or 1-s inter-stimulus interval. H-reflexes were conditioned either with an H-reflex or with a PRM reflex of the same amplitude. In the same way, PRM reflexes were conditioned either with a PRM reflex or with an H-reflex of the same amplitude. For all the paired-pulse stimulations, conditioned responses were normalized with respect to the test responses, allowing to determine the degree of depression of the second reflex.

RESULTS: HCOND/HTEST (50ms: 0.05; 1s: 0.45) and PRMCOND/PRMTEST (50ms: 0.05; 1s: 0.51) were significantly lower when they were delivered at 50ms inter stimulus interval compared to 1s ($P<0.01$) but they were not significantly different between them when they were delivered at the same interval ($P>0.05$). For the series of stimulations evoked at 1s interval, the ratios HCOND/HTEST (0.45), PRMTEST/HTEST (0.48), PRMCOND/PRMTEST (0.51) and HTEST/PRMTEST (0.50) were not significantly different ($P>0.05$).

CONCLUSION: PRM reflexes are sensitive to the HPAD phenomenon like H-reflexes. The inhibition is more pronounced at intervals of 50ms than at 1s. For the different ratios at 1s, results show that the amount of inhibition due to HPAD is similar for the two types of responses. These first results corroborate previous findings reporting that tSCS effectively activates Ia afferences, at least for low reflex amplitudes.

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Oral presentations

OP-PN22 HIT – Interval Training

TWELVE WEEKS OF SPRINT INTERVAL TRAINING INCREASES PEAK OXYGEN UPTAKE BUT NOT PEAK CARDIAC OUTPUT IN MALES AND FEMALES

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INTRODUCTION: Sprint interval training (SIT) improves peak oxygen uptake (VO2peak) but the mechanistic basis for this response is unclear. We recently reported that the improvement in VO2peak after 12 weeks of SIT was associated with an increase in peak cardiac output (Qpeak) in a group of young, untrained adults (n=15) (doi:10.1007/s00421-021-04714-4). An exploratory analysis suggested that mean Qpeak increased in the male but not female participants; however, that study was not powered to detect sex-based differences and did not incorporate other controls that are recommended for comparing responses between males and females (doi:10.1007/s40279-021-01435-8). The purpose of the present study was to explicitly compare the response of Qpeak between males and females to 12 weeks of SIT while employing best practice procedures for making sex-based comparisons.

METHODS: An a-priori sample size calculation (G*Power) based on data from our previous study estimated that a total of 14 participants were required to detect a partial eta-squared ($\eta 2p$) of 0.46 with 80% power at $\alpha=0.05$ for a 2x2 (time x group) mixed analysis of variance. A total of 20 participants with similar characteristics as in our previous study were recruited [10 males and 10 females (6 naturally cycling, 4 using a 2nd generation contraceptive)]. Males and females did not differ in baseline VO2peak expressed relative to fat-free mass (FFM; 55.1±9 vs. 49.1±8 ml/kg FFM/min, respectively, $p=0.13$). The two groups performed a similar number of training sessions (33±2) over 12 wk. Each 10-min session involved 3x20-s 'all-out' sprints interspersed with 2 min of unloaded cycling on an ergometer in addition to a brief warm-up and

cool-down. Before and after the intervention, a ramp cycling test to exhaustion was performed to measure VO2peak, followed ~10-min later by a short constant-load cycling bout at 90% peak work rate to determine Qpeak using inert gas rebreathing as in our previous study. Female participants were always tested in the low hormone phase of their cycle.

RESULTS: VO2peak increased after SIT (3.16±1.0 vs 2.89±1.0 L/min, p<0.001) with no sex x time interaction (η2p=0.014, p=0.61). Qpeak was not different after SIT (15.2±3.3 vs 15.1±3.0 L/min, p=0.85), and there was no sex x time interaction (η2p=0.007, p=0.72). Mean heart rate during training sessions was higher in female compared to male participants (83±5 vs 78±4% of peak heart rate elicited during the baseline VO2peak test, p=0.02).

CONCLUSION: In contrast to our previous study, Qpeak was unchanged after 12 weeks of SIT despite an increased VO2peak. The mechanistic basis for these responses warrants further research, but our data suggest that SIT may be associated with an enhanced capacity for oxygen extraction or muscle oxygen diffusion (doi:10.1152/ajpcell.00143.2022).

ClinicalTrials.org registration: NCT05205538. Funding: NSERC

HIGH-INTENSITY INTERVAL TRAINING IMPROVES MITOCHONDRIAL FUNCTION SIMILARLY TO MODERATE-INTENSITY CONTINUOUS TRAINING BUT WITH BETTER ENHANCEMENTS IN VO2PEAK AND INSULIN SENSITIVITY IN TYPE 2 DIABETES

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INTRODUCTION: Type 2 diabetes mellitus (T2D) pathophysiology is characterised by skeletal muscle mitochondria dysfunction and insulin resistance (1). Even though different exercise models have been used in patients with T2D, like high-intensity interval training (HIIT) or moderate-intensity continuous training (MICT), which methodology is more effective on health-related outcomes is still unknown. The present study aimed to compare the effects of two different exercise training on skeletal muscle mitochondrial function, fat oxidation, cardiorespiratory fitness, insulin sensitivity, and body composition in patients with T2D.

METHODS: This study includes preliminary analyses from the EDUGUTION/APETEX/LIPIDOX randomized controlled studies. Twenty participants (55.26±8.92 years) were randomly allocated into HIIT (consisted of 10×1 intervals pedalling at 90% of peak power output, n=10, 4 females) or MICT (consisted of continuous pedalling at 10% above the first ventilatory threshold for 50 minutes, n=10, 4 females) training groups during 12 weeks, 3 times per week. Pre- and post-intervention testing included skeletal muscle mitochondrial leak respiration, state 3 respiration (CI), maximal state 3 respiration (CI+II) (high-resolution respirometry), basal fat oxidation, fat oxidation during exercise, and peak oxygen consumption (indirect calorimetry), insulin sensitivity (oral glucose tolerance test, OGTT), and body composition (bioelectrical bioimpedance). Results were analysed with a mixed factorial ANOVA with Bonferroni post hoc comparisons, significance was set at p<0.05.

RESULTS: All outcomes presented similar values at baseline between groups. The HIIT group significantly improved CI (+16.17±2.27 pmol s−1 [mg w.w.]−1, p<0.001) and CI+II (+34.28±2.64 pmol s−1 [mg w.w.]−1, p<0.001) respiratory states, absolute (+168.10±107.59 ml, p=0.048) and relative (+2.74±1.71 ml*kg-1*min-1, p=0.022) peak oxygen consumption, glucose levels at 180 min of OGTT (-34.50±4.68 1 mg/dl, p=0.027), body mass (-3.57±0.98, LA P), and fat mass (-2.33±0.36 kg, p=0.014; -1.29±0.11 %, p=0.049). The MICT group enhanced CI (+19.85±5.5 pmol s−1 [mg w.w.]−1, p=0.004) and CI+II (+38.54±12.23 pmol s−1 [mg w.w.]−1, p=0.016) respiratory states and fat mass (-2.48±0.82 kg, p=0.049; -1.46±0.28 %, p=0.009) but decreased basal fat oxidation (-12±1.2 mg/min, p=0.014). No time-by-group interactions were found for any of the variables.

CONCLUSION: The HIIT is a time-efficient strategy compared to MICT showing a similar improvement in mitochondrial oxidative phosphorylation and fat mass. Additionally, the 12-week HIIT intervention seems to achieve greater health gains than MICT on cardiorespiratory fitness and insulin sensitivity of adults with T2D.

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ACUTE PHYSIOLOGICAL RESPONSES TO EFFORT-MATCHED HIGH INTENSITY INTERVAL TRAINING WITH AND WITHOUT BLOOD-FLOW RESTRICTION IN WELL-TRAINED CYCLISTS

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INTRODUCTION: Blood flow restriction (BFR) during endurance-type training has been shown to improve cardiopulmonary and muscular parameters [1, 2]. However, most studies have been performed using untrained participants and compared BFR versus a free-flow control condition based on the same absolute exercise intensity. The latter leads to an unrealistically low exercise intensity in the non-BFR condition which does not represent the intensity used during traditional training. Therefore, the aim of this study was to compare the acute metabolic and cardiovascular responses to interval training with BFR to effort-matched interval training without BFR in well-trained cyclists.

METHODS: In a randomized cross-over design, 10 well-trained cyclists (8 men, 2 women, VO2max: 66.1±5.8 and 56.4±7.7 mL/kg/min respectively) performed a session consisting of 6 intervals of 5 min cycling with 2.5 min of rest between each interval, both with BFR and without BFR (TRAD). An individualized occlusion pressure of 60% of full arterial occlusion pres-

sure was applied to the BFR cuffs during the intervals. Participants were free to adjust the power output during the intervals and were instructed to finish with the highest possible average power output across all 6 intervals. Metabolic and cardiovascular parameters were measured during all intervals. After each interval, the blood lactate concentration was measured, and participants were asked to rate the perceived exertion both in the cardiopulmonary system and in the legs. Paired Student's t-tests were performed to test for the differences between conditions. A statistical result of $p<0.05$ was considered significant. All data are presented as mean ± standard deviation.

RESULTS: Cycling power output was 48±4% lower during BFR compared to TRAD (148±31 vs 287±62 W respectively, $p<0.001$). BFR showed a 34±9% lower oxygen consumption compared to TRAD (2752±432 vs 4167±656 mL/min respectively, $p<0.001$) and a lower blood lactate concentration (3.5±0.7 vs 7.1±1.2 mmol/L respectively, $p<0.001$). Perceived exertion in the legs was higher following BFR compared to TRAD (Borg CR10: 8±1 vs 7±0 respectively, $p=0.004$) and overall cardiopulmonary exertion was lower (Borg RPE: 14±1 vs 17±1 respectively, $p<0.001$). The heart rate was 17±7% lower in BFR compared to TRAD (148±31 vs 167±40 bpm respectively, $p<0.001$) and the stroke volume was 10±13% lower (140±13 vs 169±6 mL respectively, $p=0.032$), resulting in a 26±11% lower cardiac output (20.5±3.2 vs 28.3±7.1 L/min respectively, $p<0.001$).

CONCLUSION: Effort-matched interval training with BFR reduced power output by almost 50% which in turn provided an attenuated metabolic and cardiovascular response compared to non-BFR conditions in well-trained cyclists. However, the stimuli for local muscular adaptations might be larger with BFR and further research should be conducted to elucidate this.

EFFECT OF EIGHT-WEEK SPRINT INTERVAL TRAINING ON THE LOCAL MUSCLE OXYGEN METABOLISM AND AEROBIC CAPACITY OF ELITE FEMALE BADMINTON PLAYERS

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INTRODUCTION: Elite badminton players are highly demanded on performing numerous high-intensity multi-shuttles sprints and jumps for saving and attacking. Sprint interval training (SIT) by alternating the interval duration, intensity, and sprinting formats, the specific interval patterns can mimic the intermittent stop-start nature and closely replicate the structure of a typical team and racquet sports game.

One of the critical determinants of aerobic performance is the oxygen utilization ability of skeletal muscles. Whenever an exercise condition creates an imbalance between oxygen supply and consumption (i.e. the use of an aerobic energy system), there are diverse changes in muscle oxygen content. Near-infrared spectroscopy (NIRS) can provide information regarding muscle oxygenation levels, oxygen depletion, and oxygen recovery rates during exercise.

Currently, the study of chronic physiological adaptations to SIT in elite badminton players is lacking. This study aimed to compare the effect of an 8-week SIT and continuous aerobic-based Fartlek endurance training on the aerobic capacity and muscle oxygen contents of elite female badminton players. The empirical findings of this study can inform the coaches and athletes if SIT can be an alternative format to continuous endurance training for aerobic enhancement. Furthermore, the mechanism of improvement is further explained by measuring physiological parameters related to oxygen intake, utilization, and recovery.

METHODS: Sixteen female badminton players volunteered to participate and were randomly assigned to the SIT group (n = 8) and the control (CON) group (n = 8). The SIT group performed SIT three times a week for eight weeks, while the CON group undertook fartlek running three times a week during the same period. All participants finished the incremental exercise test and arterial occlusion test to assess aerobic capacity and muscle oxygen conditions before and after the intervention. The non-clinical magnitude-based decision (MBD) and the precision of estimation were adopted to compare between and within the groups.

RESULTS: The results revealed that both SIT (3.7% and d = 0.49) and CON (1.6% and d = 0.43) enhanced VO2max. SIT induced a moderate decrease in oxyhemoglobin difference (△O2Hb: -8.2% and d = -0.76) and muscle oxygen consumption (mVO2: -8.2% and d = 0.77), and a moderate increase in super-compensation volume (△O2HbS: 8.6% and d = 0.69) as well as a small decrease in recovery time (TR: -4.9% and d = -0.29). CON only showed small decrease in △O2Hb (-2.0% and d = -0.31) and mVO2 (-1.9% and d = -0.29).

CONCLUSION: This study indicates that SIT potentially yields superior performance in local muscle utilization and recovery capabilities, and also the aerobic performance of elite badminton players than continuous Fartlek training. Bike-based SIT might be an alternative to provide trained athletes with an efficient and safe option for aerobic training.

Oral presentations

OP-BM21 Methodological aspects

EFFECT OF DYNAMIC ONSET THRESHOLD ON THE RATE OF FORCE DEVELOPMENT. A NEW PARADIGM.

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INTRODUCTION: The determination of the force onset (FO) can affect the assessment of the rate of force development (RTD) in isometric explosive contractions [1,2]. Typically, a fixed FO either as absolute, relative or arbitrary value is used [1]. As "gold standard" stands the set of FOs manually, with low initial force value, in a non-filtered signal, with a custom-made dynamometer [1,3]. However, many laboratories are using commercial dynamometers with noisy force signal that need to be filtered [4]. Additionally, if numerous trials exist, the manual FO setting is labor intensive, time consuming [5] and could demonstrate poor reproducibility [6]. Furthermore, all fixed FOs, although objective, do not consider the contraction dynamics (velocity, acceleration), hence they do not assure identical dynamic starting condition. Therefore, this study aimed at investigating the effect of different dynamic onsets on maxRTD, time to reach maxRTD (TR) and the variability (coefficient of variation (CV)).

METHODS: Moment-time traces from knee extension contractions were used (trials=120, n=10). Data were filtered and seven dynamic FOs (100:50:400Nm/s) were applied to calculate the RTD from onset, every 1ms, until 250ms (250 intervals). We calculated mean, standard deviation and CV. Friedmans test and Wilcoxon posthoc with a Bonferroni correction was used for TR and maxRTD. Statistical Non-Parametric Mapping (SnPM{F}) with Bonferroni post hoc correction (a=0.0024) was used for the CVs for the different FOs and intervals.

RESULTS: Dynamic onset affected significant the maxRTD and TR (both x^2(6)=716.7, p<.001). Post hoc analysis showed significant increase in maxRTD and decrease in TR in all but for FOs 350vs400Nm/s (p=0.59) (maxRTD: 1633.3±22.9, 1703.4±21.9, 1760.7±21.2, 1804.7±20.9, 1843.5±21.1, 1877.7±21.3, 1905.4±21.2Nm/s and TR: 62.1±17.7, 57.7±15.7, 54.7±15.1, 52.5±14.7, 50.6±14.6, 48.9±14.4, 47.5±14.2 ms for 100:50:400Nm/s respectively). The SnPM{F} CVs comparison showed significant reduction clusters between 0-50, 120-199 and 220-250ms (p=.01). Post hoc comparison SnPM{F} only at 1-100ms area, showed significant lower CV clusters (~1-45ms) between FOs 100:50:400, 150:50:400, 200:300 Nm/s and non-beyond 250Nm/s.

CONCLUSION: The CV did not show any difference after 250Nm/s indicating that any further increase of the FO will not further reduce the CV. As expected, the dynamic FO affects the maxRTD and TR. Additionally, the respective force levels (0.2±1.6, 0.2±1.7, 0.6±1.6, 1.0±1.6, 1.4±1.6, 1.7±1.6, 2.1±1.7 Nm for 100:50:400Nm/s) remained low, indicating that the method can reliably assess RTD. This study provides the first evidence of a dynamic FO that considers also the dynamic status of the contraction.

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AUTOMATED ANALYSIS OF MUSCLE ARCHITECTURE FROM B-MODE ULTRASONOGRAPHY IMAGES USING THE DL_TRACK SOFTWARE

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INTRODUCTION: Apart from acquiring high quality images, a major difficulty in musculoskeletal ultrasonography is image data analysis. To assess muscle thickness, pennation angle and fascicle length in muscle ultrasonography images, often manual analysis is used. Yet, manual analysis is laborious, requires thorough experience and is somewhat subjective. We provide an openly available python package (DL_Track) to automatically analyze muscle architectural parameters in ultrasonography images or videos of human lower limb muscles.

METHODS: We trained two neural networks, one using the classic U-net architecture and the other using a U-net with a VGG16 pre-trained encoder, to detect muscle fascicles and aponeuroses using labeled musculoskeletal ultrasonography images. The images used in the training were collected from four different ultrasonography devices and included the vastus lateralis, gastrocnemius medialis, tibialis anterior, and soleus muscles. In total, 310 images were used for the fascicle model and 570 images for the aponeuroses model, which were augmented to around 1700 images per set. The datasets were randomly split into training and test sets using an 80/20 ratio. The best performing model was determined based on intersection-over-union and binary cross-entropy loss metrics calculated during training. We also compared the

neural networks predictions on an unseen test set of 35 images to manual analysis and two existing semi/automated analysis methods (SMA and Ultratrack).

RESULTS: The mean differences between DL_Track and manual analysis were -2.4 mm for fascicle length (95% compatibility interval = -3.7 to -1.2), 0.6° for pennation angle (-0.2 to 1.4), and -0.6 mm for muscle thickness (-1.2 to 0.002). The corresponding values comparing DL_Track with SMA were 5.2 mm for fascicle length (1.3 to 9.0), -1.4° for pennation angle (-2.6 to -0.4) and -0.9 mm for muscle thickness (-1.5 to -0.3) respectively. ICC values between DL_Track and Ultratrack were 0.19 (0.00 to 0.35) for medial gastrocnemius passive contraction, 0.79 (0.77 to 0.81) for medial gastrocnemius maximal voluntary contraction, 0.88 (0.87 to 0.89) for calf raise, 0.67 (0.07 to 0.86) for medial gastrocnemius during walking, 0.80 (0.79 to 0.82) for tibialis passive plantar and dorsiflexion, and 0.85 (0.83 to 0.86) for tibialis anterior maximum voluntary contraction.

CONCLUSION: The DL_Track python package is an open source, fully automated deep learning-based algorithm able to estimate fascicle length, pennation angle, and muscle thickness from single images or videos of multiple superficial muscles. The results obtained from DL_Track were in agreement with those produced by SMA or manual analysis for single images. Similarly, for videos, there was an overlap between the results produced by Ultratrack and DL_Track. DL_Track analyzes each frame independently of the previous frames, which might explain the observed variability in comparison to Ultratrack.

RELIABILITY OF A NOVEL SIMPLE METHOD FOR ULTRASOUND EXTENDED-FIELD-OF-VIEW IMAGES

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INTRODUCTION: To understand the architecture of a whole muscle, diagnostic imaging is of great importance. The gold standard for muscle visualization is magnetic resonance imaging or computed tomography (1). Both methods are costly and not universally available. Ultrasound (US) could be an alternative, but the probes are usually few centimetres long and therefore visualization of large muscles is difficult (2). Nonetheless, some commercial USs devices offer the extended-field-of-view (EV) option (2,3). AutoStitch is a free software solution to generate EV from multiple images of biological structures (4), but until now not in muscles. Therefore, the aim of this study is to assess the reliability of a new, simple and cost-effective method to generate EV images of human's muscles.

METHODS: We scanned (2x, scanning time ~5s) the vastus lateralis (VL) of 10 individuals from trochanter major to epicondylus lateralis with an US device (Artus ~60 Hz) at rest, in 3 different joint angles (70-90-110°). We placed 4 tape strips orthogonal to the VL line of action and measured the distances (1-2,1-3,1-4) with a measuring tape. We extracted video images, cropped (Irfanview) and stitched them together (AutoStitch) as EV. EVs were digitised (Tracker) and distances were estimated with the build in tool. The measured distance "1-4" was used to calibrate the EVs. We assessed with OneWay Anova the effect of joint rotation on measurement distance, with intraclass correlation coefficient (ICC) the Intrarater reliability and calculated the standard error of measurement (SEM) and the minimal detectable change (MDC95%). With parametric and non-parametric paired test, we assessed differences between measured and digitised distances.

RESULTS: There was no significant effect of joint rotation on the measured distances $F(2,27)=.01$ $p=.99$ $F(2,27)=.06$ $p= .99$ $F(2,27)=.83$ $p=.92$ (1-2,1-3,1-4 respectively). ICC was significant ($p<.001$) high (range .98-.99) for all distances and joint angles. SEM and MDC95% ranged from 0.05-0.16 and 0.13-0.44mm. Paired T-test showed no significant difference between measured and digitised distances (mean: 70°=9.6vs9.9, 18.8vs19, 27.2vs27.2; 90°=9.8vs9.8, 19vs19.1, 27.3vs27.3; 110°=9.7vs9.8, 19vs19.1, 27vs27mm; 1-2, 1-3, 1-4 resp.).

CONCLUSION: The novel EV method showed excellent intrarater reliability, low SEM, high sensitivity (MDC) and it was not affected by the joint rotation. The lack of differences in the distances 1-2, 1-3 indicates absence of image distortion due to image stitching. This method could allow researchers with common US devices to visualise and further understand the function of the whole muscles not only in rest but also under tension. Limitations of this method is the absence of 3D tracking position and the implementation with smaller US probes; however, this could be considered for further research.

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ESTIMATING FASCICLE LENGTH FROM B-MODE ULTRASOUND IMAGES NEEDS RECONSIDERATION BEFORE COMMITTING TO AUTOMATED TRACKING ALGORITHMS

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INTRODUCTION: Static ultrasound (US) imaging is a popular tool when monitoring muscle architectural changes. A common limitation of static imaging is restricted field-of-view (FOV), which can be counteracted by methods which increase both image acquisition and analysis time (e.g., panoramic imaging). With a shift towards automated analysis using computer vision (e.g., deep learning), there is a need to identify the most optimal way of training algorithms to optimise fascicle length (FL) estimations from single static US images.

METHODS: B-mode US images of gastrocnemius medialis were obtained using a 50 mm linear array probe (Acuson P300, Siemens AG, Germany) from the muscle belly, with the probe aligned with the direction of muscle fibres. Twenty-five (from a subset of 301) images were analysed with ImageJ 1.52i (National Institute of Health, USA) to provide FL estimations using five methods: manual linear extrapolation (MLE), the methods of Kawakami (KAWA) et al. [1], Blazevich (BLAZ) et al. [2], and Finni (FIN) et al. [3], and a new approach which uses muscle thickness in the proximal region of the image divided by the sine of the pennation angle obtained from the distal region of the image (the "proximal-distal method" [PD]).

RESULTS: Mean ± Standard Deviation FL values for each method for the subset were: 64.61 ± 8.86 mm (MLE), 59.18 ± 9.81 mm (KAWA), 72.51 ± 14.44 mm (BLAZ), 69.46 ± 15.23 mm (FIN), and 65.20 ± 9.22 mm (PD). When comparing MLE with each of the other methods the PD returned a Bias ± Random Error of –0.59 ± 8.44 mm (ICC 3,1: 0.89), followed by KAWA with 5.43 ± 6.44 mm (ICC: 0.81), FIN with –4.85 ± 15.17 mm (ICC: 0.76), and BLAZ with –7.91 ± 15.03 (ICC: 0.66).

CONCLUSION: The use of two-dimensional US with restricted FOV for FL measurements still poses challenges with accuracy and reliability. The origin of the imprecision arises from the fact that there is not always a true value within the examined image to obtain. Even when a full fascicle is visible, its curvature alongside possible image distortion can affect the measurement. All aforementioned techniques are based on sound logic and geometric principles. Yet, they may provide for the same fascicle differences exceeding at times 20 mm whereas for a series of measurements their level of agreement may range from almost identical to highly dissimilar. The PD method showed overall strongest agreement and lowest systematic bias versus MLE which included several full fascicles in view. There could be a range of technical and anatomical of reasons for this, for example we scanned the gastrocnemius medialis whereas past studies established their estimation techniques on different muscles. As we are moving into the markerless era, more robust and streamlined ways of training tracking algorithms are needed.

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RELIABILITY AND MEASUREMENT ERROR OF A MAXIMAL VOLUNTARY TOE PLANTARFLEXION MEASUREMENT PROCESS

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INTRODUCTION: There has been a growing interest in the role of toe plantar flexor muscles in different contexts and populations such as sport performance (1) and older adults (2). However, directly measuring the force of the intrinsic muscles is impossible due to the extrinsic muscles' contribution in metatarsophalangeal toe flexion. Thus, measuring both is the best compromise according to the literature. This work aimed to investigate the test-retest reliability and measurement error of maximal voluntary isometric toe plantarflexion force (MVIF) and rate of force development (RFD) in healthy adults.

METHODS: A total of 26 (19 males) healthy adults participated in four sessions separated by 5 to 7 days. MVIF and RFD were measured at each session with a custom-built dynamometer. Using manual onset, RFD was quantified by both the impulse and the slope over 0-50ms, 0-100ms, 0-150ms, 0-200ms and 0-250ms time windows. For each outcome, we estimated the intraclass correlation coefficient (ICC) and standard error of measurement (SEM) from the agreement and consistency models. The bootstrap technique was used to provide the confidence interval for the standard error of the measurement and when the normality assumption was not met.

RESULTS: The ICC and the SEM agreement for MVIF along the perpendicular axis (Fz) were respectively 0.87 (95%CI: 0.76, 0.93) and 27 N (95%CI: 22, 32), while along the resultant of the perpendicular and anterior posterior axis they were 0.85 (0.73, 0.92) and 29 N (23, 35). We had some concerns about the normality assumption in the agreement models for Fz, hence we calculated the bias corrected accelerated confidence interval (BCACI) for ICCa, resulting in (0.65,0.93). The results of the consistency model were almost identical as the estimated variance for session was closer to zero. In addition, we found systematic bias on the mean between session 1 and 3, indicating a learning effect.

CONCLUSION: The measurement process was found reliable to assess MVIF but not RFD. In comparison to the relevant literature, the lower ICC agreement could be explained by the fact that the present study lasted longer. In fact, previous experiments used two sessions within one day [3], 1-5 days [4] and two weeks [5]. Considering the violation of the normality assumption, the uncertainty behind the ICCa estimate increased substantially, in fact the BCACI were sensibly wider. Finally, should the MVIFTOE method be used, a familiarization session is recommended to avoid bias induced by the learning effect and to reproduce the reliability of the present investigation. We emphasize that the results are population specific, e.g. they need to be confirmed in less coordinated (e.g. aging population) individuals.

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Oral presentations

OP-MH03 Physiotherapy

LOW-LOAD BLOOD FLOW RESTRICTION TRAINING AND HEAVY SLOW RESISTANCE TRAINING IMPROVE CLINICAL OUTCOMES EQUALLY IN MALES WITH UNILATERAL PATELLAR TENDINOPATHY – A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Patellar tendinopathy (PT) is a debilitating overuse injury that is particularly prevalent in 'jumping sports' such as e.g., volleyball and basketball. PT is also one of the primary causes of reduced physical activity, which may contribute to reduced quality of life and lifestyle diseases. The current best treatment is heavy slow resistance training (HSRT); however, not all patients can cope with heavy exercise loads. Even with HSRT, the time to improve clinically from tendinopathy might be as long as 3-12 months. The use of low-load resistance training in combination with blood flow restriction (LL-BFRT) has been advocated as a clinically relevant rehabilitation tool since it does not require the large joint and tissue forces and because it might accelerate recovery. In this RCT, we investigated the rehabilitative effect of LL-BFRT compared with HSRT at 3, 6, 12 (primary endpoint) and 52 weeks (data still being collected) in males with chronic (> 3 months) unilateral patellar tendinopathy.

METHODS: Adult males were randomized to a 12-week rehabilitation program based on either LL-BFRT (n=16) or HSRT (n=20). Participants performed 3 weekly training sessions of which one was supervised by experienced sports physiotherapists. LL-BFRT exercised at 30% 1-RM but increased their arterial occlusion pressure (AOP) from 50% AOP at baseline to 80% AOP at 9 weeks. HSRT exercised at 55% of 1-RM with loads increasing to 80% of 1-RM at 9 weeks. Primary outcome was pain (numerical rating scale NRS, 1-10) during single-leg decline squatting (SLDS). Secondary outcome variables were Victorian Institute of Sports Assessment-Patella questionnaire (VISA-P) on function and symptoms and pain pressure threshold (PPT) measured by pressure algometry at 3, 6, and 12 (primary endpoint) weeks. A linear mixed effects model was used to analyze longitudinal changes in all outcome variables.

RESULTS: LL-BFRT and HSRT both improved based on the NRS SLDS. Values are reported as change from baseline [95% CI] to 3 weeks (LL-BFRT -0.8 [95% CI -1.6 – -0.1] vs. HSRT -1.1 [95% CI -1.6 – -0.7], 6 weeks (LL-BFRT -1.6 [95% CI -2.5 – -0.7] vs. HSRT -1.7 [95% CI -2.3 – -1.1]) and 12 weeks (LL-BFRT -1.9 [95% CI -2.7 – -1.0] vs. HSRT -2.0 [95% CI -2.7 – -1.2]) with no between-group differences. Similarly, VISA-P score improved with no between-group differences at 3, 6 and 12 weeks. PPT (symptomatic tendon) showed a non-significant decrease from baseline to 3 weeks but showed a significant increase from 3 to 6 weeks and 6 to 12 weeks with no group interaction at any timepoint.

CONCLUSION: LL-BFRT was not superior to HSRT but achieved comparable clinical improvements in the short- to mid-term. These results are comparable with other studies investigating exercise (HSRT) in the rehabilitation of chronic patellar tendinopathy. LL-BFRT is therefore a viable rehabilitation tool in the treatment of chronic patellar tendinopathy, and as an alternative to reduce peak loads.

ULTRASOUND CHARACTERISTICS OF THE SOFT TISSUES AROUND SACROILIAC JOINTS AND LUMBAR REGION IN PATIENTS WITH ANKYLOSING SPONDYLITIS

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INTRODUCTION: Ankylosing spondylitis (AS) is a type of axial spondyloarthropathy involves immune-mediated inflammation in the sacroiliac, vertebral, peripheral joints and entheses. Patients with AS typically present limited movement in the lumbar spine and thoracic cage, which may cause decreased physical activity. Masi proposed a pathogenesis that suggests the potential for maladaptation in response to mechanical stress in the soft tissues after the overactivation of immune response [1]. Previous ultrasonographic studies indicate that the maladaptation may be reflected in changes in morphological or mechanical profiles of the Achilles tendon at the enthesis, and the changes can serve as a powerful index for distinguishing spondyloarthropathy [2]. The morphomechanical properties of the ligaments and muscles in the lumbopelvic region may, therefore, potentially contribute to AS early diagnoses as these soft tissues are located near the sacroiliac joint where patients with AS first experience symptoms and are responsible for transmitting or producing mechanical forces that act on the posterior kinetic chain [3]. Therefore, the aims of this study were to investigate the musculoskeletal morphomechanical properties (i.e., the thickness and elastic modulus) and the total count of power Doppler signals near the sacroiliac joints in patients with AS and non-AS individuals.

METHODS: Twenty participants with AS [median age (interquartile range): 31.7 (11.04) years] and 19 controls [36.3 (10.5) years] with no AS history were recruited. Bilateral ultrasound image acquisition was performed, including the short posterior sacroiliac ligament, interosseous sacroiliac ligament, long posterior sacroiliac ligament, iliolumbar ligament, proximal piriformis muscle, and sacrotuberous ligament. The intraclass correlation coefficients (ICC) of ultrasound parameters, laboratory test results of human leukocyte antigen B27, C-reactive protein, and erythrocyte sedimentation rate, and self-reported physical and disease activity scores were also obtained.

RESULTS: The ligaments and piriformis muscle were thicker and stiffer (greater elastic modulus) in participants with AS than in non-AS participants (all p<0.01). The measurements showed good or excellent reliability (all ICC(3,1)>0.85). The numbers of power Doppler signals detected in the iliolumbar ligament, proximal piriformis muscle, and sacrotuberous ligament were higher in participants with AS than in non-AS participants (all p<0.001). A correlation was identified between disease duration and the elastic modulus of the piriformis muscle (r=0.640, p=0.003).

CONCLUSION: We conclude that the ligaments and proximal piriformis muscle of AS participants have increased thickness, elastic modulus, and power Doppler signal than those of non-AS individuals. These reliable findings may serve as potential markers for the early diagnosis of AS and for assessing medication effects.

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SYSTEMATIC ULTRASOUND EVALUATION OF TENDON RECOVERY IN PATIENTS AFTER FINGER FLEXOR TENDON REPAIR

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INTRODUCTION: Ruptures of the finger flexor tendon (FFT) are commonly known to cause hand disability, and postoperative tendon recovery is critical for restoring hand functions [1]. However, few studies have reported the physiological characteristics of the repaired FFT during its healing processes, such as gross morphology, mechanical property, mobility, and vascular status, which are considered important in the systematic ultrasound evaluation of Achilles tendon recovery [2] and may be related to functional outcomes. We hypothesized that the repaired FFT would show a larger size, weaker mechanical properties, poor mobility, and a more frequent blood flow signal than the healthy side under systematic ultrasound evaluation. We also hypothesized that the pinch strength and total range of motion (TROM) of the finger joints of the repaired FFT would be less than those of the healthy side, which would be correlated to the ultrasound parameters.

METHODS: This cross-sectional study recruited 10 adults (age: 37±14 years) who underwent unilateral single FFT repair within the past 6 to 22 months. B-mode images, shear wave elastography, radiofrequency data, and power Doppler images were collected from the bilateral FFTs for analyzing tendon thickness (millimeter), Youngs modulus (kilopascal), tendon gliding (millimeter), and the presence of blood flow signal. Functional outcomes, including pinch strength (kilogram) and TROM (degree), were also measured on both sides. The Wilcoxon sign-rank test was used to test the difference in all parameters (median [interquartile range]) between the sides, except for the blood flow signal (Fisher test). The Spearman correlation was used to determine the association between the ultrasound parameters and functional outcomes.

RESULTS: The affected side showed greater tendon thickness (4.3 [2.2] vs. 2.9 [1.0] mm, p=0.007), less tendon gliding (5.5 [3.3] vs. 9.7 [5.9] mm, p=0.009), more frequent blood flow signal (p=0.003), lesser pinch strength (7.0 [4.4] vs. 8.1 [5.4] kg, p=0.028), and lesser TROM (237.5 [43.8] vs. 287.5 [80] °, p=0.024) than did the healthy side. A strong correlation between the TROM and tendon gliding was found on the healthy side (ρ=0.742, p=0.014) but not on the affected side (ρ=0.195, p=0.590).

CONCLUSION: Except for the mechanical properties, the repaired tendons showed different physiological characteristics and poor functional outcomes from the healthy side, which is consistent with our hypothesis. The lack of correlation between tendon gliding and the TROM on the affected side may be attributed to postoperative adhesion, which interrupts the force transmission through the tendon. A longitudinal study with more participants is necessary to compare the physiological characteristics among different healing statuses.

ACHILLES TENDINOPATHY ALTERS THE LINK BETWEEN MUSCLE FORCE-SHARING AND SUBTENDON NON-UNIFORMITY

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INTRODUCTION: The Achilles tendon is the strongest and largest tendon in the human body and is connected and mechanically loaded through the force production of two individual muscles: the soleus (SOL) and the gastrocnemius (GAS). These muscles have shown independent actions on each subtendon with differential muscle force-sharing strategies [1] . Additionally, at the level of the Achilles tendon non-uniform displacement between tendon layers has been identified with the use of ultrasound speckle tracking [2]. The aim of this study was to investigate the influence of Achilles tendinopathy (AT) on the muscle-tendon interaction.

METHODS: Eight participants (4 AT: 1F & 3M, 4 healthy: 4M) performed a submaximal contraction (30%) of their maximal torque generating capacity with the foot fixated in 5 degrees of plantar flexion in neutral, abduction and adduction positions, while collecting intratendinous displacement by ultrasound speckle tracking. To gain insights into the muscle force distributions, dynamic bilateral heel raises -neutral, abduction and adduction positions- were performed. Triceps surae muscle forces were analyzed at 5 degrees of plantar flexion through experimentally measured kinematics and kinetics, and a dynamic optimization method (musculoskeletal modelling). The muscle-tendon interaction was estimated by the ratio between muscle force-sharing (SOL-to-GAS contribution) and the relative subtendon displacement (deep-to-

superficial). A value of 1 means that the imbalance of force produced by the SOL compared to the GAS generated a similar imbalance of intratendinous displacement. Shifting away from 1 represent a larger (<1) or smaller (>1) non-uniformity within the tendon compared to the muscle force imbalances.

RESULTS: An altered muscle-tendon interaction was found between the AT group and the healthy group. Patients with AT show more Achilles tendon non-uniformity than muscle force-sharing imbalances in the neutral (0.76 ± 0.36 [AT]; 0.86 ± 0.10 [healthy]), abduction (0.46 ± 0.21 [AT]; 0.81 ± 0.17 [healthy]) and adduction (0.97 ± 0.44 [AT]; 1.34 ± 0.42 [healthy]) positions. At the tendon level, less relative subtendon displacement was present in the AT group for all positions: neutral: 1.01 ± 0.23 mm [AT] vs 1.98 ± 1.28 mm [healthy], abduction: 1.31 ± 0.57 mm [AT] vs 1.50 ± 1.24 mm [healthy], and adduction: 1.60 ± 0.56 mm [AT] vs 1.99 ± 1.21 mm [healthy]. Additionally, a lower SOL-to-GAS contribution was found in AT (1.34 ± 0.92) compared to the healthy group (1.66 ± 0.58).

CONCLUSION: Patients with AT have less intratendinous shearing leading to an altered interaction of the muscle force-sharing and the pathological Achilles subtendons, which are known to function independently and individually. The influence of other factors on Achilles tendon functioning, such as the subtendon twist or the subtendons' mechanical properties remain unknown.

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EFFECTS OF DIFFERENT HIP FLEXION ANGLES ON THE EXCURSION AND GLIDING OF THE PATELLAR TENDON LAYERS: PRELIMINARY RESULTS

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INTRODUCTION: Patellar tendinopathy (PTe) has high incidence and recurrence rates in jumping athletes and is often accompanied by pain and functional limitations. It is associated with excessive relative excursion and gliding between the layers of the patellar tendon (PT) [1]. The superficial layer of the PT is the extension of the rectus femoris coursing across the hip and knee joints. We hypothesized that controlling the hip flexion angle would affect the kinetics of the knee joint [2] and the excursion and gliding of the PT layers. Ultrasound speckle tracking (UST) can provide non-invasive and real-time soft-tissue images during dynamic motion [3]. Thus, we utilized UST to measure tendon motion in different hip joint flexion angles during knee flexion eccentric contraction. The results could provide insights into the etiology of PTe and help in the development of future clinical evaluation and treatment.

METHODS: Ten healthy men (age: 22.8±1.7 years) were enrolled. All of them were asked to perform knee flexion eccentric contraction in sitting and lying positions individually on an isokinetic dynamometer, with an ultrasound probe's upper edge placed against the patellar apex and parallel to the PT . The following parameters were compared: (1)excursion and gliding of the proximal superficial and deep layers of the PT (millimeter), (2) knee extension moment (newton meter), and (3) PT force (newton). Two-way repeated-measure ANOVA was utilized to compare the excursion and gliding values in the different layers and hip joint positions. A paired t-test was used to compare the biomechanical values between the two hip joint positions.

RESULTS: There was no significant difference in the excursion and gliding between the superficial and deep layers of the PT in the sitting position (p=0.54). In the lying position, there were significantly more distal excursion and gliding of the superficial layers than of the deep layers (p=0.015). In the kinetics analysis, there was no significant difference in the knee extension moment (p=0.155) and PT force (p= 0.165) between the two hip joint positions.

CONCLUSION: Changes in the hip flexion angle affected not only the kinetics but also the relative excursion and gliding of the PT. There were more relative excursion and gliding between the PT layers in the lying position during knee flexion eccentric contraction. Considering relative excursion as a mechanism of PTe, patients with PTe should avoid hip extension positions during rehabilitation programs.

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Oral presentations

OP-SH02 Physical Education and Pedagogics

DETERIORATING EQUIVALENCE IN PHYSICAL EDUCATION IN SWEDEN? USING SIBLING CORRELATION TO ESTIMATE THE EFFECT OF FAMILY BACKGROUND ON GRADES IN PHYSICAL EDUCATION BETWEEN 2000 – 2017

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Introduction

In physical education (PE), equivalence is a central goal in welfare states around the world. In Sweden, this means that the subject of PE should be equal and that schools are to compensate for students' different backgrounds, such as family background, socioeconomic and migration background. However, even if equivalence is a central goal, little is known about how equivalence in PE in Sweden has changed both during the last decades and in comparison to the students' average grade from all school subjects (so-called merit value). One well-established approach to examine equivalence in educational research is to analyze the correlation between full siblings' grades. Although this is a valuable approach to examine equivalence, no studies have used it in PE (Jansson et al., 2022). Using this approach, the aim of this study is to analyze how equivalence in PE in Sweden has changed, both over the last two decades and in relation to the students' merit value.

Methods

This study includes the total population of students (N=6,961,173) that were enrolled in Swedish schools between 2000-2017 in school year 6 and 9. The method is based on analyzing the correlation between full siblings that are born within a three-year period and their annually standardized grades in PE and merit value, using variance decomposition. One main advantage with this measure is that it considers all the aspects that full siblings share (e.g., socioeconomic, upbringing, living conditions and parenting). The analysis provides information about the extent of the total variation in PE grades and merit value that are explained by the family background of the students.

Results

In relation to the total variation in students' grades in PE and merit value, the proportion explained by variation between full siblings has increased between the years 2000-2017. Consequently, the results indicate that the importance of students' family background, over the past two decades, has become more important for both students' grades in PE and their merit value. However, the importance of family background has increased considerably more for students grades in PE, compared to their merit value. Furthermore, the largest increase in sibling correlation is found within the group of students born abroad.

Discussion

Preliminary findings indicate that equivalence in PE in Sweden has deteriorated between 2000 and 2017. Possible explanations are that: 1) schools, and in particular PE, has become worse at compensating for students with different backgrounds (e.g., socioeconomic); and 2) the students have become more heterogeneous, and as such making it more difficult to compensate for students' different backgrounds.

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THE PERCEIVED FUNCTION OF PHYSICAL ACTIVITY DURING THE SCHOOL DAY AMONG SWEDISH PRIMARY SCHOOL CHILDREN

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Introduction

Alarming reports of decreasing levels of physical activity (PA) among children has led to more interventions targeting children, not least in school. Such intrusions into children's lives are considered justified based on adults' knowledge about future risks that accompany lack of PA. However, children are not only future adults; they are also individuals with rights. There are studies highlighting children's perspectives, but these have mainly focused on children's experiences of PA. Much less explored are the functions children attribute to PA. The purpose of the study was therefore to investigate how a group of primary school children in Sweden characterise their use of PA during the school day.

Methods

The study builds on qualitative data from 15 focus groups with a total of 63 participating children aged 8-13 years. Participants were recruited from schools in four different locations in central Sweden. The analysis, which was carried out using reflexive thematic analysis, was based on the phenomenological idea of corporeality as a spectrum between corporeal objectivity and subjectivity.

Results

Three overarching themes were constructed to illustrate how children characterise their use of PA in the school context: PA for a healthy body (the body as object), the body calling for attention (the body as subject) and the moving body and the healthy mind (between subject and object). When the body was presented as an object, the children's statements about the use of PA reflected discourses about the importance of movement for their health, in the short and long term. When the body was discussed as a subject, the children stressed how movement became their response to bodily sensations such as "ants in their pants" that arose during extended periods of sitting still. In the children's descriptions of needing to move in order to, for instance, "clear their thoughts" or "not go crazy", the body was located in the space between object and subject.

Discussion

Results show that children perceive that PA can be used both to satisfy their direct bodily desires and to promote their health, cognition and well-being. The children in the study are in a period of life where one foot is clearly planted in a child's physicality, where they are reminded through their bodies of the need for movement in order to develop. The second foot, meanwhile, is stepping through a socialization process in which the body is increasingly regarded as needing care and discipline. A consequence of interventions focusing too heavily on the body as an object is that children risk being alienated from their bodies, thus preventing them from learning to use their bodies to interact with the environment. In light of the increased need for efforts to promote children's PA, it is important to create conditions for PA that affirm children's bodily subjectivity.

PUPILS' PERSPECTIVES ON RACISM AND ANTI-RACISM IN PHYSICAL EDUCATION: FINDINGS AND RECOMMENDATIONS FROM A SYSTEMATIC LITERATURE REVIEW

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Introduction

Sport in all social forms is characterized by racist structures and incidents, also experienced by children and youth. Physical education (PE) can be an area to fight racism but can also be an environment where racism is (re)produced. The perspective of pupils is crucial in teaching research as they are the primary individuals experiencing teaching and learning. As a result, they can offer valuable insight into both successes and challenges encountered. The objective of this study was to conduct a systematic review to find out the extent and quality of national (German) and international publications on racism and anti-racism in PE, considering pupils' perspectives.

Methodology

The procedure of the systematic review, following the PRISMA standard, had a four-step approach: (1) Searching for publications in 11 electronic databases with 12 keyword combinations, in German and English. (2) Selecting studies based on five inclusion criteria a) peer-reviewed journals b) English or German full texts; c) participants were pupils, teachers, or researchers; d) publications involved racism or anti-racism in PE e) considering a pupils' perspective. (3) Quality assessment using Critical Appraisal Skills Programme (CASP) and Mixed Methods Appraisal Tool (MMAT) and, thus, (4) descriptive analysis and thematic analysis (i.e., template analysis and elements of reflexive thematic analysis).

Results

A total of 5213 publications was found of which 16 qualified for inclusion. Two of them had a theoretical approach, 13 used qualitative methods, and one source had a mixed-method approach. All publications came from English-speaking countries and different approaches on how to define racism were found. Every publication could be attached to the top two out of three quality categories using CASP and MMAT. During the thematic analysis, five themes could be constructed, of which the 2 most prominent are now presented here: (1) "Racism in PE: What pupils experience". Pupils report their (racist) experiences of discrimination in PE, sport, and everyday life. These are often classified by the researchers as racial stereotypes and prejudices, everyday racism. (2) „What PE teachers can/should do?" The articles contain ideas and demands on how teachers can meet the challenge of racism in PE. These range from concrete recommendations for teachers to demands for nationwide teacher training and curriculum reforms.

Discussion

Enlightening international literature was found, but despite Germanys historical responsibility in this matter, no national (German) publication was found. Since the global phenomenon of racism differs locally, it seems necessary to conduct a survey with pupils in Germany as well, to identify their racist experiences, racist knowledge, and anti-racist potential, too. This would allow to formulate demands on teacher training and politics in Germany.

EXPLORING ADOPTION OF GAMES-BASED PHYSICAL LITERACY CONCEPTS IN PRACTITIONERS ACROSS THE UK

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INTRODUCTION: It is widely proposed that practitioner education could mitigate declining Physical Literacy (PL) and Physical Activity (PA) levels [1]. Boing is a workshop-based intervention that aims to help practitioners develop children's PL through active play. Preliminary studies indicated improvements following the workshop in key attributes: perceived knowledge and confidence [2]. It is unknown if these improvements were retained longitudinally and led to adoption of the intervention's concepts in various organisations. Therefore, the aim of this study was to complete a post workshop

follow-up to explore the perceived knowledge of and confidence to deliver PL and if these variables related to adoption in different organisations.

METHODS: 926 practitioners from 45 organisations were recruited. Two sequential validated questionnaires that explored perceived knowledge and confidence were previously completed prior to and immediately post a 90-minute interactive online workshop. A follow up questionnaire 6-months post intervention was implemented to explore improvements longitudinally. Variables were scored on a Likert scale (1-very poor, 5-very good). Potential changes elicited were assessed using Wilcoxon signed-rank tests for non-parametric data. Rank-biserial correlation [r] was utilised to calculate the effect size based on existing criteria [3]. Chi-square tests explored differences between organisations post/follow-up and pre/follow-up. The alpha level was set at 0.05 a priori.

RESULTS: 738 participants completed pre/post questionnaires, 185 participants (25%) completed all questionnaires (organisations: community focused n=26, sport n=17, education providers n=124, wider facilitators n=18). Statistically significant decreases in post/follow-up perceived knowledge (r= 0.87 [95% CI = 0.80 – 0.92]) and confidence (r= 0.55 [95% CI = 0.36– 0.70]) were evident. However, perceived knowledge and confidence 6-months post remained higher than pre-workshop levels with statistically significant increases ($p<0.001$) and large positive effect sizes evident: perceived knowledge (r= 0.86 [95% CI = 0.80 – 0.91]) and confidence (r= 0.81 [95% CI = 0.72 – 0.90]). Overall, 90% of participants intended to adopt post workshop with 65% stating adoption had occurred by 6 months. Significant differences in adoption were reported between organisational groups ($p=0.01$) where sports organisations reported the highest adoption rate (90%).

CONCLUSION: Perceived knowledge and confidence was retained 6-months after the intervention however decreases were evident. Post intervention support may be required to address this decline. Importantly the workshop resulted in adoption of PL concepts, particularly in sports organisations. However, 35% of participants who intended to adopt did not. Further investigation is needed explore reasons for the decrease in perceived knowledge/confidence longitudinally and the differences between organisations in adoption if the intervention is to be implemented and maintained.

ITALIAN VALIDATION AND STANDARDIZATION OF TGMD-3: A TOOL FOR ASSESSING AND PLANNING TEACHING

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INTRODUCTION: Gross motor skills play a crucial role in the growth and development of children. These skills refer to goal-directed movement patterns involving locomotion, large whole-body movements and stretches. By evaluating a childs gross motor skills, it is possible to detect any potential delays and implement effective programs. The purpose of this research was to validate and standardise the Test of Gross Motor Development-3 (TGMD-3) in a large sample of Italian pre-school and primary school students.

METHODS: The study included 8,500 children (250 males and 250 females in each group) aged 3-11 years in 17 age groups (6-month intervals except last group with 9-month interval). The study included children over the age of 11 years to encompass the entire primary school cycle and provide a benchmark of gross motor skills for the incoming assessment in secondary school. The TGMD-3 assesses gross motor skills across two domains: locomotor skills and ball skills. Participants completed one practice trial and two formal trials, observed by two testers (agreement rate over 95%). The study evaluated the validity and reliability of the TGMD-3 and investigated gender differences through ANOVA analysis ($p<.05$).

RESULTS: The results of both exploratory and confirmatory factor analyses confirmed the two-factor structure of the TGMD-3, with all factor loadings being significant at $p < .001$. Additionally, the study found strong positive correlations between the test and retest of the TGMD-3s sub-scale, with ICC values ranging from .979 to .997 for each age groups. The one-way ANOVA analysis revealed significant differences for most of the age groups. As a result, the table converting raw scores into percentile ranks, scalar scores, and confidence intervals was divided by gender for both subtests, in contrast to only the "Ball skills" subtest in the American version.

This study was published by Erickson (2023) in an academic book that includes a digital platform (TEO-Test Erickson Online) that provides support in the notation and scoring process through a "Wizard" feature. The platform generates a final report for each child evaluated, including descriptive terms for standard scores. The manual offers guidance for interpreting evaluation data, to identify strengths and weaknesses to design effective learning environments.

CONCLUSION: The TGMD-3 has strong validity and reliability for measuring gross motor skills in children across age groups. It assesses childrens competence in specific skills, sub-scales, and overall, and can aid in creating personalized educational programs and informed curricular decisions.

Oral presentations

OP-AP09 New Olympic Sports

SPORT CLIMBING DETERMINANTS AND FUNCTIONAL TESTING METHODS: A SYSTEMATIC REVIEW-BASED PROPOSAL FOR STANDARDISED FUNCTIONAL PERFORMANCE ASSESSMENT

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INTRODUCTION: Lead climbing, bouldering and speed climbing are becoming incredibly popular both in the general population and among athletes. Indeed, sport climbing made its debut in the 2021 Olympics Games in Tokyo. However, no consensus exists regarding evidence-based sport-specific performance evaluation; therefore, the present systematic review aims to provide an overview of climbing performance determinants and evaluation methods by analysing climbers of different ability levels.

METHODS: A systematic search of PubMed, Scopus, and Web of Science was performed. Studies providing the self-reported climbing ability associated with different functional outcomes in groups of climbers of contiguous performance levels were included. Functional components of interest were cardiorespiratory endurance, muscular strength, muscular endurance, muscular power, flexibility, balance, and anthropometric characteristics assessed by general or climbing-specific functional tests. Concurrent and construct validity as well as reliability have been evaluated for qualitative test assessment.

RESULTS: A total of 1789 articles was retrieved and 70 studies were finally included. Various methods have been proposed to evaluate determinants of sport climbing. While test validity evaluations were available, reliability measures have been rarely provided. Climbing-specific assessments were able to discriminate better climbers of different levels when compared to general functional tests. Validity resulted high for climbing-specific cardiorespiratory endurance, muscular -strength, -endurance and -power, although the reliability analysis of the former was insufficient. Climbing-specific assessment of flexibility resulted in high reliability, but moderate validity, whereas balance showed low validity. Regarding anthropometric characteristics, huge conflicting evidence is depicted since many studies found results not supporting a significant impact of these parameters on climbing performance.

CONCLUSION: While some conclusive evidence can be drawn for cardiorespiratory endurance, muscular -strength, -endurance, and -power assessment, by contrast flexibility, balance, and anthropometric characteristics are still far to be topic on fire in sport climbing and need further specific scientific evaluations. This review also provides a proposal for an evidence-based functional performance assessment protocol for sport climbers, which considers (i) the available test validity and (ii) reliability for the broadest range of climbing performance levels, (iii) the simplicity of standardisation of testing procedures, and (iv) the minimum financial and equipment constraints. While athletes and coaches may engage in evidence-based and standardised evaluation methods, researchers should design specific large-scale trials as a resource in providing additional, homogenous, and comparable data in order to improve scientific evidence and professionalism in this popular sport discipline.

SMART TRUCK: CLASSIFYING SKATEBOARD TRICKS WITH A CONVOLUTIONAL NEURAL NETWORK BASED ON MOTION DATA

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INTRODUCTION: In the fitness community, quantifying activities with apps and wearables rose in popularity throughout the last decade. In sports like running or cycling, these digital technologies are ubiquitous while fun sports are not yet as present. The Smart Truck project aims to change that for skateboarding by enabling the classification of tricks. Studies on motivation behind fitness app usage show that achievement oriented members of the running community benefit most from the tracking features of such apps [1]. Skaters could use this technology to keep track of their skill progression or to compete in challenges.

METHODS: In an experiment, motion data of the rear axis of a skateboard was recorded with an IMU at a sample rate of 120Hz while skaters were performing the following tricks: "Ollie", "180 Front-side", "180 Back-side", "360-flip", and "Kick-flip". While performing the tricks, orientation, angular velocity and magnetic flux density were recorded. In the post-processing phase, the relevant data around the pop was extracted to an array with the dimensions of 9x120 elements. The 9 rows represent orientation, acceleration and magnetic flux density for all axis. The 20 data-points prior and the 100 data-points after the pop are saved to a .csv file. The dataset was split into parts containing 80% and 20% of the samples for training and testing respectively. To classify each trick, the neural network was designed with a combination of linear, max pooling, and one dimensional convolution layers. For optimization, the Adam optimizer was used [2].

RESULTS: The accuracy score of the model created for this project amounts to 96.84%. With a batch size of 10 samples per step and 80 steps per epoch, 5 subsequent loss values of lower than 0.2 were achieved after 6 epochs. The tricks with the lowest and highest mean confidence scores respectively are the "360-flip" with 77% and the "Kick-flip" with 95%. The tricks "180 front-side" and "180 back-side" ranked lowest in precision both with a score of 94% compared to the tricks "Ollie" and "Kick-flip", both with a score of 100%.

CONCLUSION: The results show that it is possible to create a model that is capable of classifying skateboarding tricks based on motion data. Although the model performs classification with sufficient accuracy, the results have limitations. The major limitation is the dataset, as it was unbalanced and of limited variety. In the future the dataset could be improved by including more recordings from a broader demography of skaters. As the project was intended as a proof of concept, the results achieved with the current dataset were able to demonstrate the feasibility of a digital gamification platform for skateboarding. This outcome could inspire similar products, leading to a stronger representation of funsports in the digital market.

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COMPETITIVE SKATEBOARDING– INTERDISCIPLINARY PERSPECTIVES ON THE DISCIPLINE PARK

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Theory

As a theoretical figure, Skateboarding stands as an informal subculture building around the movement patterns of a roll sport in connection to the attribution of urban spaces, where the mostly adolescent participants reproduce an associated lifestyle (Borden, 2019). However, the integration into the Olympic Summer Games 2020 (2021) in Tokyo has triggered ongoing tendencies around the subculture's "sportisation" (Kilberth & Schwier, p. 11) resulting in the incorporation of existing sports associations as well as the establishment of training facilities and programmes. Ongoing debates not only cover the partial transformation of the informal practice into more standardised and competitive log-ic of sport, but furthermore focus on the particularities of the newly evolved differentia-tions (Atencio et al., 2018).

Method

Focusing on the olympic discipline Park, research focuses on the terrain's structure con-cerning the form and arrangement of ramps, obstacles and intersections, as well as the adaptive movement patterns in 45-second runs during which the athletes aim to perform a condensed presentation of a variety of tricks.

The WST Park World Championship 2022 (executed in February 2023) was analysed, data was collected from the public results (rawmotion.com/WSTWC22S).

Mean values of age and number of nationality participant was calculated for each phase (qualifiers, quarter, semi-final, final). R Studio was used to performed the statistical anal-ysis. Kruskall Wallis test was chosen to compare the mean values because data was non parametric.

Results

183 Athletes (65 F and 126 M) participated at the WST with four pressed athletes directly qualified directly to quarter final. Female athletes were younger that male athletes (16.6 □□3.62 vs. 21.1□□6.89, p<0.001□□□Nationality have an influence in the final score for male (F=73.2, p<0.01,□2= 0.40) and female (F=37.5, p<0.05,□2= 0.37). Only 3 nations were rep-resented at the final (M: USA, AUS and BRA, F: GBR, JPN and USA).

Discussion

Skateboarding is growing around the world, especially among young female athletes whose total number is lower than of male athletes. There were more nationalities repre-sented (39 vs. 22) despite the nations obtaining the best score were the nations where the skateboard culture was largely represented. Countries need funding for new skate-parks matching Olympic norms to help athletes to improve training programmes and pre-pare for the competition. Stakeholders in each country need to continue to develop train-ing programs and promote the young talents in skateboarding competition.

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DOES THE SUCCESS RATE OF OFFENSIVE PLAYS IN 3X3 BASKETBALL VARY WITH THE TYPE OF OFFENSE AND AGE/SEX CATEGORIES?

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INTRODUCTION: 3x3 is a new basketball discipline that has become one of the Olympic sports since the Tokyo 2020 Olympic Games. While the number of studies on 3x3 basketball has been growing in recent years [1-4], research in this field is still in its infancy. More in-depth studies will help to develop this relatively new sport. The purpose of this study was to compare the success rate of offensive plays in 3x3 basketball by the type of offense and age/sex categories.

METHODS: This study analyzed the FIBA 3x3 World Cup 2019 and the FIBA 3x3 Under-18 World Cup 2019. Each play was coded by the researcher from game footage using a notational analysis method. All offensive plays were classified as a transition offensive play (TOP), a check-ball offensive play (CBOP), or an offensive rebound offensive play (OROP). An offensive play that resulted in a successful field goal or earned a free throw was considered successful. A Pearson's chi-squared test was used to compare the success rates of the offensive plays. Multiplicity was adjusted by the Benjamini & Hochberg method to maintain a significance level of $P < 0.05$.

RESULTS: In all four categories (senior men, senior women, under-18 men, and under-18 women), TOP occurred with the highest frequency (55.1-57.5% of the totals), followed by CBOP (28.1-31.2%) and OROP (11.9-14.7%). The success rate of OROP (39.2-49.2%) was significantly higher ($P < 0.05$; effect size = 0.07-0.14) than that of the TOP (28.5-36.4%) and CBOP (32.1-35.0%) in all four categories. While the success rate of CBOP did not differ among the four categories, the success rate of TOP was significantly higher ($P < 0.05$; effect size = 0.04-0.09) in the men's tournament (34.6-36.4%) than in the women's tournament (28.5-31.1%). The success rate of OROP was significantly lower ($P < 0.05$; effect size = 0.08-0.10) in the under-18 women's tournament (39.2%) than in the other three categories' tournaments (47.3-49.2%).

CONCLUSION: Increasing the success rate of TOP is essential for winning a game because TOP accounts for more than half of the total offensive plays. The success rate of TOP was lower in the women's tournament than in the men's tournament; however, the lack of sex differences in the success rate of CBOP suggests that there is still room for women to increase the success rate of TOP.

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Oral presentations

OP-PN25 Nutrition II

EFFECTS OF PROTEIN SUPPLEMENTATION, COMBINED WITH HIGH-INTENSITY FUNCTIONAL TRAINING, ON THE PLASMA AMINO ACID PROFILE, BIOCHEMICAL AND HEMATOLOGICAL PARAMETERS IN TRAINED MEN AND WOMEN

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INTRODUCTION: High-intensity functional training (HIFT) is an effective form of training that includes multijoint aerobic and resistance exercises. Despite its popularity, few studies have examined adaptations to HIFT and even less is known regarding dietary guidelines to optimize HIFT. Protein supplementation has been extensively investigated in resistance training, but there is limited evidence regarding its effectiveness in HIFT. Additionally, few studies have examined egg white as a protein source. Hence, the aim of this study was to examine the effects of two forms of protein supplementation (egg white and whey), combined with HIFT, on the plasma amino acid profile, biochemical and hematological parameters of trained individuals.

METHODS: Thirty trained volunteers (20 men and 10 women), aged 23-55, underwent 6 weeks of HIFT while receiving 0.6 g/kg/day of egg white protein (E), whey protein (W), or maltodextrin (placebo, P) in a single-blinded, randomized, triple-crossover, and counterbalanced design, with 2 weeks of washout between supplements. Participants received isoenergetic dietary plans providing 1 g/kg/day of protein throughout the study. Before and after each intervention period, participants provided fasting venous blood samples at rest. Full blood count, serum glucose, triacylglycerols, total cholesterol (TC), HDL cholesterol, LDL cholesterol, urea, creatinine, creatine kinase, γ-glutamyltransferase, cortisol and testosterone were measured in automated analyzers. Plasma amino acids were measured with liquid chromatography – mass spectrometry. Data were analyzed by 3-way ANOVA (supplement x time x sex) with repeated measures on supplement and time. Statistical significance was set at $p < 0.05$.

RESULTS: Urea and TC differed between supplements, with urea being higher in E and W, compared to P, and TC being higher in P compared to W. Leukocyte and platelet counts increased, whereas erythrocyte count, hemoglobin, hematocrit and glucose decreased with training. There were also expected differences between sexes in hematologic and biochemical parameters. Regarding the plasma amino acid concentrations and percentage distribution, there were no differences between supplements. However, there were many effects of training (including increases in Leu, Pro and Trp, and decreases in Arg, Asn, Gln, Gly and Lys, in terms of both concentration and percentage) and differences between sexes, including a higher total plasma amino acid concentration in men compared to women (2.57 ± 0.50 vs 2.35 ± 0.46 mmol/L, mean ± SD).

CONCLUSION: Short-term HIFT caused several changes in hematologic and clinical-chemistry parameters of trained men and women (notably hemodilution), whereas protein supplementation affected only serum, urea and TC. Additionally, training, but not supplementation, had profound effects on the plasma amino acid profile. These novel findings show that training is a stronger modifier of blood biochemistry and, in particular, amino acid metabolism than nutrition.

EFFECTS OF A MULTI-INGREDIENT PROTEIN, Ω3 FATTY ACID, AND VITAMIN D SUPPLEMENT, COMBINED WITH HIGH-INTENSITY FUNCTIONAL TRAINING, ON EXERCISE PERFORMANCE AND THE BLOOD FATTY ACID PROFILE

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INTRODUCTION: High-intensity functional training (HIFT) is a relatively new training modality, based on the CrossFit training principle, which emphasizes functional movements via aerobic and resistance exercises. HIFT has been reported to improve muscle performance. Whether dietary supplements improve adaptations to HIFT has not been adequately researched. Protein supplementation is well documented as an ergogenic aid in resistance training. Additionally, there is some evidence that ω3 fatty acids and vitamin D, in addition to their beneficial effects on health, may increase performance. However, there is no evidence for their effectiveness in combination with HIFT. As part of a broader project, the aim of the present study was to investigate the effects of HIFT in combination with a multi-ingredient supplement containing protein, ω3 fatty acids, and vitamin D, on exercise performance and the blood fatty acid profile.

METHODS: Twenty-one trained adults (13 women and 8 men), aged 19-35, underwent 6 weeks of HIFT while receiving the experimental supplement (E; 0.6 g fish protein/kg body mass, 1.8 g ω3 fatty acids, and 20 μg vitamin D daily), whey protein (W; 0.6 g/kg/day), or maltodextrin as placebo (P; 0.6 g/kg/day) in a single-blinded, randomized, triple-crossover, and counterbalanced design, with 2 weeks of washout between supplements. Participants performed HIFT 3 times a week, while following a mixed, isoenergetic diet providing 1 g/kg/day protein throughout the entire study period. The internal load of training sessions was assessed during the first and last week of supplementation by heart rate (HR) telemetry. The blood fatty acid profile was determined pre- and post-supplementation using gas chromatography. Data were analyzed by repeated-measures 3-way ANOVA (supplement x time x sex). Statistical significance was set at $p < 0.05$.

RESULTS: Exercise time during each session increased from 37.3 ± 6.4 min at the beginning to 39.7 ± 7.6 min at the end of each intervention period ($p = 0.014$) due to more repetitions to exhaustion, with no significant change in any HR parameter (time in five intensity zones from 50 to 100% of maximal HR). The blood ω3 fatty acid percentage (specifically, 20:5ω3, 22:5ω3, 22:6ω3, and total ω3) was higher in E compared to W and P, whereas the ω6 fatty acids percentage (specifically, 20:3ω6, 20:4ω6, 22:4ω6, and 22:5ω6) was lower in E compared to W and P ($p < 0.05$). As a result, the ω6/ω3 ratio was lower ($p < 0.05$) with E (7.74 ± 2.74) compared to W (9.50 ± 2.92) and P (9.84 ± 3.06).

CONCLUSION: Short-term HIFT increased training-session time independent of supplementation. Supplementation with E had positive effects on the blood fatty acids profile by increasing ω3 content, which may be beneficial for health and other training adaptations.

THE COLLAGEN SYNTHESIS RESPONSE TO LEG PRESS EXERCISE IN RESISTANCE-TRAINED MIDDLE-AGED MEN IS AUGMENTED WITH 15-30 G HYDROLYSED COLLAGEN SUPPLEMENTATION

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INTRODUCTION: Nutrition and exercise prescription to support muscle-tendon unit (MTU) health and function in middle-age are often overlooked. Resistance training has, however, long been established as a potent stimulus to improve MTU function and reduce injury risk [1], and resistance exercise (RE) stimulates collagen synthesis in human muscle and tendon [2]. Recent data suggest that collagen supplementation may support exercise-driven adaptations of the MTU in young adults but the acute effects of RE combined with dietary collagen during middle-age remain unknown. We therefore hypothesised that collagen synthesis would increase in response to RE, and this effect would be augmented in a dose-dependent manner with hydrolysed collagen supplementation in middle-aged men.

METHODS: Nine resistance-trained men (age, 49±8 years; height, 178±2 cm; body mass, 90±4 kg), completed three trials in a double-blind, repeated measures crossover design. Each trial was conducted after an overnight fast. Participants consumed either 0g, 15g, or 30g vitamin C-enriched hydrolysed collagen in a randomised order 1-h prior to high-intensity leg-press RE. Venous blood samples were collected for the duration of each trial and assessed for a serum marker of type 1 collagen synthesis (N-terminal propeptide of type 1 pro-collagen, PINP), and plasma β-isomerized C-terminal telopeptide of type 1 collagen (β-CTx, a marker of collagen breakdown). The concentration × time total area under the curve (AUC) for serum PINP and plasma β-CTx were compared between trials.

RESULTS: There was a main effect of dose ($P=0.0018$) and a dose×time interaction ($P=0.0421$) for serum PINP concentration, with concentration in the 0g trial remaining similar to baseline (9.4±6.8 ng/mL) throughout the trial but increasing in both the 15 and 30g trials. PINP concentration×time AUC for the 15 and 30g trials were 122±60 and 141±70 ng/mL×h, respectively, which did not differ from each other ($P=0.314$) but were both higher than the 0g trial (74±45 ng/mL×h, $P=0.012$, $P=0.010$). β-CTx decreased by 30% after RE in all three trials and remained lower for the duration of each trial ($P<0.0001$), with no effect of dose ($P=0.940$) and no interaction ($P=0.899$). β-CTx AUC did not differ between trials (2.4±0.5, 2.6±0.7, 2.5±0.6 μg/L×h for 0g, 15g and 30g, respectively, $P=0.306$).

CONCLUSION: Ingestion of 15-30g hydrolysed collagen appears to augment collagen synthesis following RE in middle-aged, resistance-trained men without affecting collagen breakdown. This could be a viable strategy to improve MTU health and function over the long term in middle-aged individuals.

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THE COLLAGEN SYNTHESIS RESPONSE TO HIGH-INTENSITY BACK SQUAT EXERCISE IN RESISTANCE-TRAINED YOUNG MEN IS GREATER WHEN INGESTING 30 G VERSUS 15 G HYDROLYSED COLLAGEN

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INTRODUCTION: Jump-rope exercise with gelatine supplementation increases collagen synthesis in a dose-response manner, with 15g gelatine stimulating a greater response than 5 and 0g [1]. However, it is unknown whether >15g hydrolysed collagen (HC) supplementation would further increase collagen synthesis following resistance exercise (RE), which is known to increase collagen synthesis in muscle and tendon [2].

METHODS: Using a double-blind, randomised cross-over design, 10 resistance-trained male participants (age:26±3years; height:1.77±0.04m; mass:79.7±7.0kg; 4.0±3.3years of RE experience) ingested 0g, 15g or 30g HC with 50mg vitamin C, in a random order, prior to performing four sets' barbell back-squat at 10-repetition maximum load, after which they rested for six hours. Six venous blood samples were collected throughout each trial (at rest prior to HC ingestion (-1h) and post RE at +0.5h, +1h, +2h, +4h, and +6h) to analyse serum procollagen type I N-terminal propeptide (P I NP) concentration, a marker of collagen synthesis, and the concentration of amino acids comprising collagen. Plasma β-isomerized C-terminal telopeptide of type I collagen (β-CTX) concentration, a marker of collagen breakdown, was analysed at -1h and +6h.

RESULTS: The serum P I NP concentration×time area-under-the-curve was greater for 30g (267±79 ng·mL-1×hour) HC than 15g (235±70 ng·mL-1×hour, P=0.039) and 0g (219±88 ng·mL-1×hour, P=0.005) but there was no difference between 0g and 15g HC (P=0.675). Serum concentration of glycine, proline and hydroxyproline each showed a dose×time interaction (P<0.05) and a main effect of dose (P<0.05), with glycine and proline concentration higher in 30g than 15g HC (P<0.05). Plasma β-CTX concentration decreased from -1h (0.8±0.3 µg·L-1) to +6h (0.6±0.1 µg·L-1, P=0.007), with no effect of HC dose (P=0.287) or dose×time interaction (P=0.754).

CONCLUSION: These data suggest that, in resistance-trained young men, 30g HC augments collagen synthesis more than 15g and 0g HC following a single bout of high-intensity RE, whereas HC did not affect collagen breakdown. This has implications for improving physical performance, as augmented collagen synthesis may increase tendon stiffness [3], which is related to the rate of force development [4].

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THE EFFECTS OF ACTOVEGIN AND HIIT ON BODY WEIGHT, BLOOD GLUCOSE AND LIVER MITOCHONDRIAL FUNCTION IN HEALTHY MICE

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INTRODUCTION: Actovegin (Act) has previously been shown to increase mitochondrial respiration acutely in human skeletal muscle[1] and in rat liver[2]. Act has also demonstrated insulin-like effects on glucose metabolism[3]. Likewise, physical activity has been shown to improve glycemic control[4] and liver mitochondrial function[5]. The aim of this on-going study is to investigate the effects of Act and aerobic exercise training on body weight, blood glucose and liver mitochondrial function in mice.

METHODS: A total of 40 healthy adult male mice were included in this study. The mice were divided into 4 groups; Act (A), controls (C), trained Act (AT) and trained controls (CT). All mice were treated for 14 days, with injections of either 0.1 ml Act (10mg/ml) or saline every other day. The training intervention consisted of a HIIT protocol, performed every other day by the trained groups (5 bouts of 1 min at 85-95 % of maximal running speed with 2 min active recovery at 60-65 % of maximal running speed between intervals). Body weight was measured every other day and blood glucose was measured on day 1, 7 and 14 of the intervention period. High resolution respirometry (Oroboros, O2K) was used to assess liver mitochondrial respiration after the intervention. Both state 2 (LEAK respiration) and state 3 (Maximal ADP stimulated respiration)

was assessed with the following protocol: 1mM Malate + 10mM Glutamate – 5µM Cytochrome C – 5mM ADP – 10mM Succinate – FCCP titration with steps of 0.25µM. One and Two-way ANOVA was used for the statistical analysis, with Tukey's multiple comparisons test post hoc with an alpha-level of 0.05.

RESULTS: All groups showed a loss of body weight ($p < 0.01$ for all groups) and drop in blood glucose ($p < 0.05$ for all groups) as a result of the intervention. Mitochondrial complex I LEAK respiration (State 2) was significantly lower in the CT group compared to both the C ($p < 0.05$) and A group ($p < 0.01$). No effects were found on mitochondrial respiratory capacity (State 3) or efficiency measured as RCR (State 3/State 2).

CONCLUSION: To our knowledge, this is the first study investigating the combined effects of Act and exercise training on liver mitochondrial respiration. Body weight and blood glucose declined uniformly in all groups, likely due to intervention induced stress rather than as an effect of Act or training. HIIT resulted in decreased LEAK respiration in the CT group, but overall Act and HIIT displayed limited effects on liver mitochondrial function, possibly due to the mice being fit and healthy. Act has been shown to affect mitochondrial function in skeletal muscle in healthy mice, suggesting Act may induce selective effects on different tissues.

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Oral presentations

OP-SH22 Stress-recovery and anxiety

LINK BETWEEN THE STRESS-RECOVERY BALANCE AND MINDFULNESS IN YOUNG ELITE BMX RIDERS

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Introduction

The stress-recovery balance refers to the quality of adjustment of recovery strategies that one mobilizes according to his or her stress states (Kellmann, 2010). Maintaining this balance plays an important part for the athletes and the coaches to reach an optimal performance. Currently, the scientific literature tries to develop the knowledge about psychological strategies of recovery among which, mindfulness has captured in interest (Blevins et al., 2021). From a biopsychosocial perspective, the aim of the study was to explore the links between mindfulness and the stress-recovery balance.

Method

24 young elite BMX riders from a National Training Center were followed-up during two weeks of intensive precompetition training. First, they completed the Mindfulness Inventory for Sport (MIS) and the Five Facets Mindfulness Questionnaire (FFMQ) to assess their mindfulness dispositions. The follow-up of the stress-recovery balance was made by psycho-physio measures: (1) they had to complete every morning the Short Recovery and Stress Scale (SRSS) and the Recovery Stress Questionnaire for Athletes (RESTQ) twice a week, and (2) heart rate variability was measured twice a week. After every training, riders rated their mindfulness states during training. By using the R package labeled lme4, multilevel growth curve analyses were used to examine the linear and/or quadratic trajectories of athletes stress-recovery variables and the scores of dispositional mindfulness and mindfulness states.

Results

Concerning mindfulness dispositions, results showed no significant effect with stress-recovery states, while a significant positive linear interaction effects of time on RMSSD (ß =7.67, . P < .05) was found. Regarding mindfulness states, results showed a significant negative linear interaction effects of time on stress (ß =- .25, . P < .05) and a significant positive quadratic interaction effect of time on recovery (ß = .38, . P < .001). No significant interaction effect with RMSSD was found.

Discussion

These results offer a better understanding of the links between mindfulness, as a disposition or a state, and stress-recovery balance. The study brings new applied and research perspectives. In particular, mindfulness could be considered as a recovery strategy. Future interventional studies should confirm its effects.

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THE RELATION BETWEEN ATHLETES' NEGATIVE PERFORMANCE STRESS AND VIGOUR: A MODERATED MEDIATION ANALYSIS INCLUDING RUMINATION AND PSYCHOLOGICAL CAPITAL

BALK, Y.A., EHREN, M.

UNIVERSITY OF AMSTERDAM

Mentally disconnecting from sport is an important psychological recovery experience for athletes to cope with the demands of training and competition. Yet, those same sport-related demands can potentially interfere with athletes' ability to disconnect. Specifically, negative feedback, substandard performances, or mistakes could evoke ruminative thoughts, which likely impairs psychological recovery and might lead to impaired well-being. However, athletes' psychological capital (PsyCap) might help them to effectively deal with negative performance stress, thereby limiting its impact on rumination and subsequent well-being (i.e., vigour). The first aim of this study was to therefore investigate whether sport-related rumination mediates the relation between negative performance stress and vigour. The second aim was to examine whether athletes' psychological capital moderates the relation between 1) negative performance stress and rumination and 2) negative performance stress and vigour.

A total sample of 169 amateur athletes (n = 77), semi-professional athletes (n = 42) and professional athletes (n = 50) filled in an online survey (mean age = 22.62, SD = 5.18, 50% male, 50% female). Analyses using PROCESS showed a positive relation between negative performance stress and vigour (B = -.15, SE = .06, t(166) = -2.56, p = .011, 95% CI [-.27, -.03]). Negative performance stress was positively related to rumination (B = .44, SE = .06, t(166) = 7.34, p < .001, 95% CI [.32, .56]). Furthermore, rumination was negatively related to vigour (B = -.16, SE = .08, t(166) = -2.12, p = .035, 95%CI [- .31, -.01]). Results also revealed a significant indirect effect of rumination between negative performance stress and vigour (B = -.07, 95% CI [- .150, -.002]). As the direct effect of negative performance stress on vigour became was not significant (B = -.08, p = .231, 95% CI [-.21, .05]), rumination fully mediated the relation between negative performance stress and vigour. Finally, psychological capital was negatively associated with rumination (B = -.28, SE = .13, t(166) = -2.24, p = .026, 95% CI [-.52, -.03]) and positively associated with vigour (B = .53, SE = .12, t(166) = 4.53, p < .001, 95% CI [.30, .77]). However, psychological capital did not moderate the relations between negative performance stress and rumination or vigour (p's > .17). Thus, the mediated moderation model was not supported.

Taken together, these findings show that negative performance stress experienced by athletes is negatively associated with vigour, through increased rumination about their sport. PsyCap did not attenuate these relations, although it appears to benefit athletes' general levels of rumination and well-being. Coaches and sport psychologists should be aware of how athletes cope with negative performance stress and assist them in reducing ruminative thoughts to optimize psychological recovery processes and well-being.

THE IMPACT OF COACHING ON ATHLETES' COPING AND AFFECTIVE STATES EXPERIENCED IN COMPETITIVE SETTINGS

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Introduction

Coaching practices have revealed a salient impact on athletes coping and affective experience in sports. Consequently, there is an increasing necessity to examine how coaching practices may influence coping and the affective experience in the competition, especially due to the link of the mentioned variables with sports performance. As such, the present work will be divided into two distinct studies that address coaching from two different theoretical backgrounds. In study 1, the goal was to examine whether the coach athlete-relationship predicted: "coping" and "intensity and direction of positive affects and negative affects" experienced before and during competition. In study 2, it was aimed to examine whether coach leadership behaviours predicted: the intensity and direction of positive and negative affects experienced during competition, controlling for affects experienced within two hours before competition.

Methods

Two samples of 306 and 296 French athletes participated in two distinct studies and completed a series of self-report questionnaires. In both studies, a partial least square path modelling (PLS-PM) approach was used to examine the relationships between the variables.

Results

Study 1: The analysis revealed that coach-athlete commitment positively predicted task-oriented coping before the competition, disengagement-oriented coping before the competition, distraction oriented-coping before the competition, and negatively predicted the direction of negative affects during competition. Besides, the coach-athlete complementarity negatively predicted disengagement-oriented coping before the competition, positively predicted intensity of positive affects before the competition and marginally positively predicted intensity of negative affects during the competition.

Study 2: The results showed that coach social support significantly positively predicted the direction of negative affects during competition controlling for pre-competitive negative affect direction. Besides, results revealed that coach democratic behaviour marginally and negatively predicted Negative Affects direction during competition whereas coach autocratic behaviour marginally and negatively predicted Positive Affects intensity.

Conclusion

These outcomes should take the attention of practitioners to emphasize positive social support interrelation between coach and athlete as well as do not emphasize excessive commitment in coaches, especially in the precompetitive parts of the competition.

DO ATHLETES RESIST BETTER TO FAILURE WHEN THE "I" OR THE "WE" MATTERS MOST? THE IMPORTANCE OF THE FAILLURE TYPE

PELLET, J., LAURIN, R., CAMPO, M.

UNIVERSITY OF BURGUNDY

Introduction

Literature reported studies exploring individual collapsing through the scope of self-image threat (Mesagno & Beckmann, 2017). However, in team-based sports, individual collapsing may be conceptualized as an affective approach/avoidance response, and may be influenced by group identification, and the collective stakes associated with it (Haslam et al., 2020).

To our knowledge, no model investigated the influence of identity processes on players' withdrawal during competition. Accordingly, we propose to investigate this effect by considering a perception of an individual or collective failure context

Method

Student in sport sciences (N=149) were divided into a 2x2 design manipulating identity levels (social SI vs individual PI) and failure type (personal vs collective failure). Participants had to perform a speed-accuracy task of basket-ball throwing aiming at targets. Procedure involved (a) a training task, (b) a stake induction, (c) an identity manipulation, and (d) the main task with a failure manipulation. Participants did not have access to their performance, allowing us to always give them rigged feedbacks of faillure. Following each feedback, participants had to make the choice to continue or stop.

Results

The dependent variable is the number of repetitions performed. A factorial ANOVA revealed an interaction effect between the type of failure and the identity level. Post-hoc tests revealed a significant difference between PI and SI in the collective failure scenario. A tendential difference between PI and SI in the individual failure scenario was also revealed. This means a greater tendency for participants to withdraw when they considered themselves as group member in a collective faillure scenario, and when they considered themselves as individual in an individual faillure scenario.

Discussion

Failure seems to be threatening only when it concerns the athlete salient identity level, therefore triggering avoidance processes and behaviors. As failure is not something socially valued in an achievement context, these results are consistent with the self-esteem preservation hypothesis proposed by Tajfel and Turner, echoing current knowledge on perception of an identity threat provokes negative emotions that may lead to avoidance behaviours (Hunger et al., 2015).

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13:45 - 15:00

Invited symposia

IS-PN02 Exercise and nutrition to support healthy aging

SARCOPENIA: CAUSES, CONSEQUENCES, AND TREATMENT OPTIONS

VERDIJK, L.

MAASTRICHT UNIVERSITY MEDICAL CENTRE

Sarcopenia is defined as the progressive loss of muscle mass and function with increasing age. Whether a direct consequence of aging per se, or more indirectly associated with age-related disease, sarcopenia goes hand in hand with a number of physical and metabolic derangements, underscoring the need for effective countermeasures. Muscle mass maintenance is determined by the intricate balance between muscle protein synthesis and muscle protein breakdown rates. It has been well established that physical activity and food intake (primarily protein intake) represent the two main anabolic stimuli affecting this balance and, as such, play an essential role in muscle maintenance throughout life. Though the etiology of sarcopenia is likely multifactorial, recent work suggests that a diminished response to protein intake and

physical activity in elderly versus young individuals may be a key factor driving the loss of skeletal muscle tissue throughout the aging process. This phenomenon has been termed □anabolic resistance□. Such anabolic resistance is even more profound in certain disease conditions and during periods of physical inactivity such as during hospitalization, further accelerating the loss of muscle mass and function in those situations.

In this lecture, an overview will be given on the causes, consequences and treatment options for sarcopenia, with a focus on exercise and nutrition to improve muscle mass and function and support overall health in the aging population. Apart from presenting current knowledge, we will also identify challenges that should be addressed in future research.

SARCOPENIC OBESITY

BOIRIE, Y.
CLERMONT-FERRAND UNIVERSITY HOSPITAL

Apart from the age-related decline in muscle mass and function, many older individuals struggle to maintain body weight within healthy limits, resulting in a high prevalence of overweight and obesity. Importantly, the presence of excess body fat (along with e.g. associated insulin resistance and inflammation) has multiple negative effects on muscle tissue, and may further enhance the anabolic resistance already present in senescent muscle. As such, age-related functional and metabolic deteriorations are further enhanced with so-called 'sarcopenic obesity'. Sarcopenic obesity is a new clinical entity that also raises new clinical and scientific questions. It leads us to rethink the management of sarcopenia where excessive adiposity and muscle deficit can coexist. In particular, the role of ectopic muscle adiposity or more directly of lipotoxicity on muscle signaling pathways is a promising area of research, particularly in the context of chronic diseases in order to preserve the mobility and quality of life of patients. This lecture will describe the etiology of sarcopenic obesity, and the targeted approach needed to better preserve muscle mass and function in this chronic disease situation.

RESISTANCE TRAINING AND PROTEIN INTAKE IN OLDER PEOPLE: HOW TO BRING SCIENCE TO PRACTICE?

DE GROOT, L.
WAGENINGEN UNIVERSITY

Clinical studies show that sufficient protein intake combined with resistance exercise can maintain or improve muscle health and function in older adults. Based on this concept, an innovative and evidence-based lifestyle program for vulnerable older people was developed and daily implementation of the program was evaluated in terms of cost-effectiveness to improve independency as well as quality of life of the elderly. This lecture will describe the outcomes of this 'ProMuscle in Practice' project which consisted of three phases. In phase one, an effective clinical trial was adapted to fit the real-life practice setting using input from health care professionals, the target group (elderly people) and researchers. This resulted in protocols that can be used by physiotherapists and dieticians to implement this program. In the second phase, a pilot implementation project was performed in which community-dwelling elderly received progressive resistance exercise in small groups, guided by physiotherapists, as well as advice on how to increase their daily protein intake by dieticians. Finally, a large-scale multi-centre intervention study was conducted to investigate the implementation process and (cost-) effectiveness of 'ProMuscle in Practice' in 5 different care and community settings. As such, the project is exemplary for translation of science into practice, establishing whether the adapted program is effective in supporting healthy aging in the community.

Oral presentations

OP-PN14 Oxygenation

ACUTE MUSCLE OXYGEN SATURATION AND PERCEPTUAL RESPONSES BETWEEN LUNGE AND RUNNING EXERCISES VARIATIONS

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INTRODUCTION: Over the past decades there has been an exponential increase in the use of high-precision devices to monitor training, assuming itself as an unquestionable factor for the success of athletes (1). Near-infrared spectroscopy (NIRS) is considered a non-invasive viable way to analyse the kinetics of muscle oxygen saturation (SmO2), both at rest and during exercise (2), allowing a more specific observation of the physiological response to exercise. This study aimed to compare the effect of six variations of lunge (LUN) and running (RUN) exercises in SmO2, heart rate (HR), and perceived exertion (RPE).

METHODS: Were recruited 16 participants and divided into two exercise groups: the LUN (n=8; age=26.3±3.8 yrs) comprised isometric, jumping, walking, cross, bulgarian, and side terra-core lunge exercise variations, and the RUN (n=8; age=34.5±12.0 yrs) comprised high-knees, shoulder wide, tethered, treadmill (0%), slope treadmill (6%), and shoulder-wide coreboard run exercise variations. Each variation lasted 90s with a 5-min rest interval between each one. Average and minimum SmO2 (SmO2avg and SmO2min, respectively) of vastus lateralis (VL) and gastrocnemius medialis (GM)

muscles, and average HR (HRavg) were assessed through the session, and RPE immediately after each variation. A one-way ANOVA (or Kruskal-Wallis) and Tukey's post-hoc were used to find differences among the studied exercise variations.

RESULTS: Significant differences were found between exercises variations in HRavg, F(11,84)=2.86, p=0.003, n2=0.27, with higher values in jumping LUN vs coreboard RUN (145.8±18.8 vs 116.3±14.5 bpm, p=0.027), and in high-knees RUN (146.3±12.1 bpm) vs isometric lunge LUN (117.7±23.0 bpm, p=0.038). Significant differences in SmO2avg in GM muscle were identified, F(11,72)=17.71, p<0.001, n2=0.73, with almost all variations of LUN showing higher values vs RUN, except for coreboard RUN variation. The SmO2min in GM muscle showed significant differences, F(11,66)=15.38, p<0.001, n2=0.72, with RUN variations presenting lower values relative to LUN variations, except in coreboard RUN vs jumping lunge LUN (p=0.188). The overall and muscular RPE exhibited higher values in RUN compared to LUN variations.

CONCLUSION: The findings revealed that in general RUN exercises promoted higher HRavg and lower SmO2, except for coreboard RUN exercise when compared to jumping LUN. These two exercises were selected due to their applicability in the training context, making it possible to better understand both general and specific physiological responses combining HR with SmO2 and RPE.

1) Thornton et al., Int J Sports Physiol Perform, 2019

2) Perrey & Ferrari, Sports Med, 2018

Funding: HEALTH-UNORTE: Setting-up biobanks and regenerative medicine strategies to boost research in cardiovascular, musculoskeletal, neurological, oncological, immunological and infectious diseases (NORTE-01-0145-FEDER-000039), financed by European Regional Development Fund by NORTE 2020 (North Regional Operational Programme 2014/2020).

A DIVE INTO THE PHYSIOLOGY OF O2 AND CO2 TABLES IN APNEA NOVICES

DECLERCQ, L.1, BOUTEN, J.1, HEYSE, B.2, BOONE, J.1, BOURGOIS, J.G.1,3

GHENT UNIVERSITY

INTRODUCTION: During apnea, bradycardia and peripheral vasoconstriction characterize the cardiovascular diving response aimed to protect the brain from oxygen deprivation. The diving response has already been studied intensively during maximal apneas, but information on training protocols of submaximal apneas is lacking. O2 and CO2 tables are timed repeated submaximal breath-holds used by free divers to improve apnea duration. The aim of this study was to describe the physiological responses during maximal apneas, O2 and CO2 tables in order to determine the most feasible training method to improve apnea duration in apnea novices.

METHODS: 28 physically active individuals (23 ± 3 years old; 175 ± 9 cm; 69.7 ± 7.9 kg) naïve to apnea performed 3 apnea protocols in random order: traditional based training session (maximal apneas), O2 table (increasing apneic time, long rest periods), CO2 table (short apneas, decreasing rest periods). Heart rate (HR), muscle and cerebral oxygenation (by NIRS) and arterial oxygen saturation (SaO2) were measured continuously during apnea. RM ANOVA's were used to compare acute changes between protocols throughout the final apnea for ΔHR, peripheral (ΔmTOI) and cerebral (ΔcTOI) tissue oxygenation index and ΔSaO2.

RESULTS: Decrease in ΔHR and ΔmTOI did not significantly differ between protocols (p=0.662; p=0.545). ΔcTOI remained close to baseline at the end of the final apnea in CO2 tables (-1 ± 9%), while a significant drop was seen in O2 tables (-6 ± 10%) and the maximal apnea protocol (-14 ± 15%) (p=0.012). ΔSaO2 decreased significantly more during maximal apneas (-15 ± 4%) compared to O2 tables (-5 ± 2%) and CO2 tables (-4 ± 2%) (p=0.004).

CONCLUSION: Despite a similar cardiovascular diving response in the three protocols, arterial oxygen saturation and brain oxygenation decreased to a greater extend during the maximal apnea protocol. Compared to the maximal apnea protocol, O2 and CO2 tables provide less physiological strain on the body. A combination of all three protocols seems most feasible to improve apnea duration in apnea novices.

POST-ISCHEMIA MICROVASCULAR REACTIVITY DURING ACUTE HYPOXIC EXPOSURE IN TRAINED AND UNTRAINED MALES AND FEMALES

MANFERDELLI, G.1, RABERIN, A.1, SCHORDERET, F.1, MILLET, G.P.1

1: UNIVERSITY OF LAUSANNE

INTRODUCTION: Sex-specific differences in vascular function have been widely investigated but contrasting findings have been reported. Recent evidence showed greater skeletal muscle resting oxidative metabolism in trained males and females compared to their untrained peers, as well as in males compared to females. Hypoxia is also known to affect skeletal muscle environment by inducing local vasodilation, but the combined influence of sex, fitness level and acute hypoxic exposure on microvascular reactivity remains unclear. Preliminary results suggest that, under hypoxic conditions, females have lower peripheral limitations during exercise compared to males. This study investigated sex and fitness level differences in acute microvascular responses to ischemia and compared endurance trained vs untrained, female vs male young adults in normoxia vs normobaric hypoxia.

METHODS: Fifty young healthy participants were divided in four groups according to their sex and aerobic fitness; trained females (TF, n=12, VO2peak=54.9±4.0 ml·min-1·kg-1), control females (CF, n=11, 46.3±3.8 ml·min-1·kg-1), trained males (TM, n=12, 68.0±6.8 ml·min-1·kg-1) and control males (CM, n=15, 54.3±4.3 ml·min-1·kg-1). Participants performed two incremental cycling tests to exhaustion, one in normoxia and the other in normobaric hypoxia (FIO2=0.141), to determine peak oxygen uptake (by metabolic cart). Before each test, resting skeletal muscle oxidative metabolism and post-ischemia

microvascular responsiveness in normoxia and hypoxia were evaluated by combining Near-Infrared Spectroscopy and the vascular occlusion test on the vastus lateralis muscle.

RESULTS: Hypoxia lowered VO2peak in all participants (P<0.001), though the magnitude of the decrease was greater in males compared to females (P<0.001) and in trained compared to untrained (P<0.001). Baseline tissue saturation index (TSI) was lower in males compared to females (P<0.001), in trained compared to untrained participants (P=0.011), and in hypoxia compared to normoxia (P=0.010). The desaturation rate (calculated as the linear regression during the first 60-secs of occlusion) and the reperfusion rate (calculated as the linear regression of the first 10-secs post-occlusion) were lower in females compared to males (P<0.001 and P<0.001, respectively) and in hypoxia compared to normoxia (P<0.001 and P=0.048). When the reperfusion rate was normalized for the ischemic stimulus (i.e., minimum TSI reached during the 5-min occlusion), females showed a lower reperfusion rate compared to males (P<0.011), with no effects of fitness level or hypoxia.

CONCLUSION: In conclusion, young female adults demonstrated reduced resting skeletal muscle oxidative metabolism and microvascular responsiveness compared to males, but without differences between fitness levels nor influence of hypoxic exposure.

MUSCLE OXYGENATION UNDULATES DURING EACH REPETITION OF RESISTANCE EXERCISE

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ARISTOTLE UNIVERSITY OF THESSALONIKI

INTRODUCTION: Although near-infrared spectroscopy (NIRS) has been widely used in studying muscle oxygenation in endurance exercise, its use in resistance exercise is limited (Miranda-Fuentes et al., 2021). Muscle oxygenation during resistance exercise depends on intensity, volume, rest interval between sets, duration of each repetition, type of muscle activity, and muscle being evaluated. Data separating the eccentric and concentric phases of dynamic resistance exercise are lacking. Thus, the aim of this study was to examine the oxygenation of three quadriceps muscles [vastus lateralis (VL), vastus medialis (VM) and rectus femoris (RF)] during the eccentric and concentric phases of the parallel high-bar back squat.

METHODS: Eighteen young resistance-trained males performed 5 sets of parallel high-bar back squat in a Smith machine, with 15 repetitions each: two warm-up sets [at 14% and 45% of 15-repetition-maximum (15RM)] and 3 main sets at 100% 15RM. Participants exercised while watching a model video, so that the duration of the descending (eccentric) and ascending (concentric) phases be exactly 1.5 s each. Rest interval between sets was 2 min. Three NIRS devices were attached to VL, VM and RF of the dominant leg and recorded muscle oxygen saturation (SmO2) at a frequency of 2 Hz, thus producing three values per phase. Blood lactate concentration was measured after each set. Data are presented as mean ± SD. SmO2 data were analyzed by repeated-measure two-way ANOVA (muscle x set), and lactate data were analyzed by one-way ANOVA.

RESULTS: In all three muscles, SmO2 dropped during each set and was reinstated during recovery. The drop from start to end of each set differed between muscles (65.5 ± 7.0, 63.2 ± 8.0% and 36.2 ± 21.2 for VL, VM and RF, respectively, $p < 0.001$) and sets (in sequence, 34.8 ± 13.8, 53.5 ± 10.1, 59.8 ± 8.6, 64.6 ± 9.0 and 64.8 ± 8.0%, $p < 0.001$). Importantly, SmO2 undulated during each repetition, increasing during the descending phase and decreasing during the ascending phase. The average amplitude of SmO2 undulation was 4% in VL, 10% in VM and 8% in RF, reaching at times two-thirds of the average SmO2. The half-time of muscle reoxygenation was 28 ± 8 s after each set. Blood lactate increased linear from set to set ($p < 0.001$), reaching 9.9 ± 3.9 mmol/L at the end.

CONCLUSION: Quadriceps muscle oxygen was largely depleted and rapidly repleted during exhausting squatting exercise. This, combined with the modest lactate values, suggests a high aerobic energy contribution. For the first time, we report that SmO2 undulated during each repetition in a way corresponding to the magnitude of the instantaneous energy demands, that is, increasing while lowering the weight and decreasing while lifting the weight. This indicates a quick response of the circulatory system in providing as much oxygen as possible to the exercising muscles.

REFERENCE:

Miranda-Fuentes C, et al. (2021). Int J Environ Res Public Health 18: 4293.

THE INFLUENCE OF SEX ON PULMONARY OXYGEN UPTAKE AND DEOXYHEMOGLOBIN KINETICS DURING MODERATE AND SUPRAMAXIMAL INTENSITY RUNNING

CURTO, D.1,2, NICOLAU, M.1, ESPADA, M.3, MONTEIRO, C.1,2, MATIAS, C.4, MORGADO, J.4, ALVES, F.1,2, REIS, 1,2,5

1- FACULDADE DE MOTRICIDADE HUMANA, UNIVERSIDADE DE LISBOA, PORTUGAL; 2- CIPER, FMH, UL, PORTUGAL 3- IPS, SETUBAL, PORTUGAL 4- CIDEFE, LISBOA PORTUGAL 5- LQRC-CIEQV, RIO MAIOR, PORTUGAL

INTRODUCTION: Women have smaller hearts, cardiac outputs, hemoglobin concentrations (1) and higher O2 extraction for the same relative exercise intensity than men while presenting a less effective matching of the O2 delivery and utilization (2). These sex differences in the ability to deliver and to use oxygen by the working muscle could potentially influence pulmonary oxygen uptake (VO2) and deoxyhemoglobin ([HHb]) kinetics at different exercise intensities. However, research has produced conflicting results with studies showing faster VO2 kinetics in males whereas other found no differences. Also, the literature that simultaneously evaluated VO2 and [HHb] kinetics are scarce. Therefore, we aimed to compare the

VO2 and [HHb] kinetics at moderate and supramaximal intensity running between physically active adult men (M) and women (W).

METHODS: Twenty seven participants (14 M; 27.43 ± 5.69 years; 71.95 ± 7.56 kg and 13 W; 22.85 ± 4.22 years; 56.25 ± 5.97 kg) completed one incremental test to exhaustion to determine VO2max, first ventilatory threshold (VT1), second ventilatory threshold (VT2) and maximal aerobic velocity (MAV), and square wave transitions for moderate (80% of VT1) and supramaximal (110% of MAV) intensities. VO2 was collected breath-by-breath and [HHb] of the vastus lateralis was determined by near-infrared spectroscopy. The parameters of the VO2k and [HHb] kinetics were determined using a monoexponential model. Data was compared between sexes by an independent samples T Test, with significance level set at < 0.05.

RESULTS: No significant differences were observed between groups, in the time constant of the primary component of the VO2 and HHb kinetics neither for moderate (M: 30.75 ± 8.54 s; W: 31.52 ± 6.71 s and M: 19.39 ± 7.02 s; W: 24.73 ± 18.76 s, respectively) nor supramaximal running (M: 23.51 ± 10.19 s; W: 19.56 ± 6.73 s and W: 17.73 ± 9.81 s; F: 18.02 ± 16.97 s, respectively). However, men presented higher VO2 kinetics amplitude in supramaximal exercise than women (M: 44.69 ± 7.97 ml.kg-1.min-1; W: 39.25 ± 4.03 ml.kg-1.min-1). Men also had higher body mass (M: 71.95 ± 7.56 kg; W: 56.25 ± 5.97 kg) , and velocity associated with VT1, VT2, and MAV (M: 8.93 ± 1.07 km.h-1; W: 7.62 ± 0.87 km.h-1; M:11.62 ± 1.04 km.h-1; W: 10.31 ± 0.95 km.h-1; M: 14.82 ± 1.23 km.h-1; W: 12.96 ± 1.03 km.h-1, respectively).

CONCLUSION: Although men presented higher velocities associated with traditional endurance parameters, namely ventilatory thresholds and MAV, the time constant for VO2 and [HHb] kinetics were not different between sexes in moderate and supramaximal intensities. On the other hand, we observed higher amplitudes in men at supramaximal intensities suggesting a higher rate of increase of oxygen uptake per second in men and consequently a quicker onset at higher exercise intensities. References: 1.Wiebe et al., (1998); 2.Murias et al. (2011).

Oral presentations

OP-AP03 Training and Testing: Power and strength

ECCENTRIC HAMSTRINGS TORQUE PRODUCTION AND ELECTROMYOGRAPHIC ACTIVITY OF THE POSTERIOR MUSCLE CHAIN DURING UNASSISTED VERSUS ASSISTED NORDIC HAMSTRING EXERCISE

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UNIVERSITÉ CÔTE DAZUR

INTRODUCTION: The deficit of maximal hamstrings eccentric torque is considered as a major risk factor of hamstring strain injury (1). As a result, many eccentric exercises have been developed, with the Nordic Hamstring Exercise (NHE) being among the most effective in improving eccentric torque and prevent muscle injuries. However, some athletes are not able to withstand the load imposed by this exercise. Assisted NHE has recently been investigated to enhance hamstrings strength at long muscle length (2). However, it remains unknown whether assisted NHE would result in greater eccentric torque production and/or activities of posterior muscle chain than classical NHE, i.e. unassisted NHE. In this line, our study was designed to compare hamstrings eccentric torque production and electromyographic (EMG) activities of the posterior muscle chain during unassisted NHE and four different assisted NHEs.

METHODS: Twelve voluntary participants (9 males, 3 females, age: 24.6 ± 4.5 years) performed five different NHE at maximal eccentric intensity and at the same controlled knee angular velocity. One was the classical unassisted NHE. Two assisted NHEs were performed to replicate the unassisted NHE (constant hip flexion of 0°), bilaterally and unilaterally (NHE0B and NHE0U, respectively). The two other assisted NHEs were performed unilaterally and reproduced the most common hamstring strain injury mechanisms. The first one reproduced the over-stretch mechanism, with constant 90° of hip flexion during the movement (NHE90U), and the second one reproduced the sprint-related hamstring strain mechanism, with knee and hip kinematics based on the late swing phase of the sprint step cycle (NHELSU). Maximal hamstrings eccentric torque production (Tmax), time-torque integral (TTi) and EMG integral (iEMG) of seven muscles of the posterior muscle chain were calculated during each NHE.

RESULTS: Unassisted NHE resulted in significantly lower Tmax ($p<0.05$) and TTi ($p<0.001$) than all assisted NHEs, as well as a lower iEMG in majority of measured muscles ($p<0.05$). In addition, for injury specific assisted NHEs, only NHELSU showed a significantly greater Tmax ($p<0.01$) than during NHE0U. However, no significant difference was reported in hamstrings iEMG between NHELSU and NHE0U.

CONCLUSION: Assisted NHE results in a greater time under tension and muscle length of hamstrings at the end of the movement. This could explain the greater eccentric torque production and higher integrated EMG activities of posterior muscle chain during assisted NHEs. In addition, eccentric torque could be maximized during NHELSU due to the continuous shift in hip flexion. To maximize hamstrings eccentric torque and activation, our results suggest that assisted NHE should be preferred over unassisted NHE. Assisted NHE replicating the sprint-related hamstring strain mechanism could be considered as the preferred modality for hamstring eccentric training or hamstring strain injury prevention.

REFERENCES:

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(2) Alt et al., 2021

THE ACUTE EFFECTS OF TRANSCRANIAL DIRECT CURRENT STIMULATION ON THE PERFORMANCE OF VELOCITY-BASED SQUAT TRAINING

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INTRODUCTION: Transcranial direct current stimulation (tDCS) was found to increase the number of repetitions, maintain movement velocity, and lower perceived exertion while performing strength training until exhaustion (1). Before reaching a defined velocity loss, tDCS may enhance the number of repetitions with a lower perceived effort. Hence, tDCS may modulate the performance of velocity-based training. Therefore, the aim of this study was to examine the effects of tDCS on the number of repetitions, movement velocity, and rating of perceived exertion (RPE) in squat exercise when the velocity loss is less than 15%.

METHODS: Eight healthy men (age 22 ± 3.4 years) were subjected to 20 min of 2.0 mA anodal tDCS over either [1] the bilateral primary motor cortex (M1) or [2] the dorsolateral prefrontal cortex (DLPFC), or 20 min of [3] a SHAM stimulus in a crossover randomized controlled trial manner. The direct current was imposed on a pair of square electrode pads (7.6cm × 7.6cm). Immediately after each stimulus, the first set of repeated explosive (only in the concentric phase) squats was performed until a 15% decrease in the mean propulsive velocities (MPV); the number of repetitions and MPV were assessed, and the RPEs before and after each repeated squats were recorded in OMNI-RES scale. After 90 s, the following four consecutive sets were conducted in the same manner with 90 s intervals. The data were compared by repeated measures ANOVA.

RESULTS: Immediately after the stimuli over M1 and DLPFC, the number of repetitions (8.4±2.5 and 8.3±3.3, respectively) was higher than those after a SHAM stimulus (6.6±3.2; p= 0.25 and 0.29 against M1 and DLPFC, respectively). After 90 s interval, the number of repetitions decreased to 7.0±2.6 (for M1, p=0.04 vs. SHAM), 6.5±2.6 (for DLPFC, p= 0.1 vs. SHAM), and 4.6±1.1 (for sham). After the first two training sets and intervals, the effects of tDCS on the number of repetitions were not apparent (the 3rd set: 6.0±1.9 for M1, 5.6±2.4 for DLPFC, 5.8±1.7 for sham). For the MPV, the M1 stimulus resulted in a persistently higher velocity (0.61±0.05 m/s, p=0.25 vs. SHAM) than the DLPFC (0.59±0.04 m/s, p=0.69 vs. SHAM) and sham (0.58±0.05 m/s) for all five sets. The RPEs for all three stimuli increased from four (the first set) to eight (the fifth set) in a similar manner.

CONCLUSION: The tDCS induced an enhancing effect on the MPV of the explosive concentric phase of squats, and the improved performance in the number of repetitions (especially in the first two sets) could be conducted with similar RPEs. Therefore, the ergogenic effect of tDCS on explosive exercise is not only perceptual, it did exert realistic positive influences on physical performance.

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EVIDENCE FOR HUMAN MUSCLE MASS REALLOCATION IN RESPONSE TO RESISTANCE TRAINING

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INTRODUCTION: Human skeletal muscle has the profound ability to hypertrophy in response to resistance training. Yet, muscle mass accretion has a high energy and protein cost (1) and is mainly restricted to recruited muscles. To date, it remains largely unknown what happens with non-recruited muscles during chronic resistance training, especially in relation to dietary energy and protein availability. Using advanced MRI- and AI-based approaches for muscle segmentation, we investigated the volume changes of upper arm muscles and all leg muscles, both those recruited and non-recruited, during a single-joint resistance training program.

METHODS: Eleven male and 10 female young, resistance training novices performed 10 weeks of knee extensions, knee flexions, arm extensions and arm flexions to failure 3x/week. Volume changes of the recruited (n = 17) and non-recruited (n = 13) upper arm and leg muscles were measured by MRI-based 3D segmentation. Daily energy (kcal/kg fat free mass) and protein (g/kg body mass) intake were measured thrice by self-reported diaries. Subjects were post-hoc divided into a HIGH (n = 11) or LOW (n = 10) energy intake group. Training-induced volume changes (paired sample t-tests) and differences between the HIGH/LOW energy intake groups (ANCOVAs, sex as covariate) were assessed. Pearson correlations examined relationships between energy/protein intake and volume changes.

RESULTS: The training program induced significant hypertrophy in all recruited arm and leg muscles (range: +2 to +17%). In contrast, the non-recruited adductor magnus (-1.5 ± 3.1%, p = 0.04) and soleus (-2.4 ± 2.3%, p <0.001) significantly decreased in size. Positive correlations were found between energy intake and changes in adductor magnus (r = 0.61, p <0.01) and soleus volume (r = 0.43, p = 0.05) and between protein intake and changes in adductor magnus (r = 0.45, p = 0.04), gastrocnemius medial head (r = 0.43, p = 0.05) and tibialis posterior volume (r = 0.43, p = 0.05). The LOW energy intake group showed atrophy in the adductor longus (-4.7 ± 4.0%, p <0.01), soleus (-3.4 ± 2.0%, p <0.01), adductor magnus (-2.9 ± 2.3%, p <0.01) and fibulari (-2.2 ± 2.6%, p = 0.04) while no volume loss was observed in any individual muscle of the HIGH energy intake group.

CONCLUSION: To our knowledge, this is the first study to document the basic but surprising finding that some non-trained muscles significantly atrophy in a period of resistance training. Our data therefore suggest muscle mass reallocation, i.e. that muscle hypertrophy in recruited muscles takes place at the expense of muscle atrophy in non-recruited muscles, especially when energy and/or protein availability is limited. This could be important to understand the evolutionary advantage of maintaining the hypertrophy potential in states of low energy availability (e.g. famine) and could have modern-day applications for sport science (e.g. training while weight cutting) and health-related resistance training.

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DOES THE TRAINING BREAK MATTER? UPPER AND LOWER LIMB MUSCLE STRENGTH FOLLOWING 20-WEEK INTERMITTED VS. CONTINUOUS RESISTANCE TRAINING

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INTRODUCTION: In everyday life, people face challenges implementing systematic resistance training (RT). Health problems, work commitments, etc., can prevent RT for a period, which can compromise achieving the benefits of regular RT. This study aimed to examine the effect of a detraining period in the middle of the RT intervention on maximal upper and lower limb strength response.

METHODS: 42 healthy, previously untrained men and women volunteers (32 (5) years) participated in a 32-week intervention. Participants were randomized (stratified by sex, age, and BMI) into intermitted (TraDeRe, n=20) and continuous training groups (ConTra, n=22). TraDeRe group conducted a 10-week RT period followed by a 10-week detraining period. After that, a 10-week RT was repeated like the first period. ConTra started with a 10-week non-training period followed by a 20-week RT. The RT protocol was the same for both groups, with equal volume load for the elbow flexors and knee extensors. The supervised RT was carried out twice per week, and the program included 3x10 bench presses and 4 sets of 10 repetitions of leg presses, knee extensions, biceps curls, and seated back row. The last set of the training week was continued until failure, and the RT loads for the following week were determined accordingly. One repetition maximum (1RM) of barbell biceps curl (BC) and horizontal concentric leg press (LP) was tested 2 weeks before the intervention, before the first study period (Pre), and after each study period.

RESULTS: Technical error of measurement was 5.4% and 8.7% between -2 and 0 weeks in LP and BC, respectively. LP increased ($p < 0.001$) by 22 (9) % and 29 (11) % in ConTra and 22 (13) % and 29 (16) % in TraDeRe after the first and second 10-week RT period, respectively. BC increased ($p < 0.001$) by 22 (11) % and 34 (15) % in ConTra and 25 (19) % and 35 (21) % in TraDeRe after the first and second 10-week RT period, respectively. No statistically significant differences were observed between the groups. Detraining induced a -5 (4) % ($p < 0.001$) and -4 (7) % ($p < 0.05$) decrease in LP and BC, respectively. The gains in LP and BC did not correlate after the intervention ($r = 0.272$, $p = 0.083$). In TraDeRe, gains in the first and second 10-week RT period correlated in LP ($r = 0.720$, $p < 0.001$) but not in BC ($r = 0.360$, $p < 0.119$).

CONCLUSION: A 10-week detraining period between two 10-week RT periods did not compromise the improvement in maximal strength compared to continuous RT. Thus, at least during the first few months of RT, a 10-week break from training may only delay the increase in strength achieved with RT. Non-significant correlation between LP and BC strength increases indicates that RT-induced strength gains may not occur similarly in the upper and lower limb muscles. The association observed in TraDeRe in the improvements in LP strength between the first and second 10 weeks of RT indicates that the strength responses to RT can be reproducible and, thus, mainly driven by physiological factors.

HYPERTROPHIC LOADING-INDUCED AVERAGE CONCENTRIC POWER AND ELECTROMYOGRAPHIC RESPONSES DIFFER IN LEG PRESS VS. SMITH-MACHINE BACK SQUAT

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INTRODUCTION: Back squat and leg press exercises involve the same major muscle groups, but they differ in their biomechanical properties [1,2]. These differences may affect, e.g., the magnitude of activated muscle mass and muscle activation strategies during resistance exercise [1-3]. Thus, we examined how Smith-machine back squat vs. leg press exercises affected the progression of neuromuscular fatigue within typical hypertrophic loadings.

METHODS: 10 recreationally active males performed hypertrophic loadings (5x10-RM, rest 1.5 min) in Smith-machine back squat (SS) and leg press (LP). Average concentric power (AP), and electromyographic activity of vastus lateralis (VL), vastus medialis (VM), rectus femoris (RF), quadriceps femoris, i.e., the averaged activity of VL, VM and RF (QF), biceps femoris (BF) and gluteus maximus (GLU) muscles were recorded during the concentric phases of selected repetitions within all loading sets. Blood lactate concentrations (BL) were measured before, after SET3 (MID) and after the loadings.

RESULTS: The total work performed during SS was significantly higher ($p<0.001$), and a greater relative decrease in AP (-21¬±3%) occurred during SS ($p<0.05$). Significant effects for loading were observed in QF, VM, VL, GLU and BF ($F(1,9)>6.390$, $p<0.05$, $\eta p2>0.415$), so that normalized sEMG values were significantly greater during SS ($p<0.05$). Significant loading × set interactions were observed in VL ($F(2,18)=4.433$, $p<0.05$, $\eta p2=0.295$), RF ($F(1.1,9.9)=8.830$, $p<0.05$, $\eta p2=0.495$) and QF ($F(2,18)=5.453$, $p<0.05$, $\eta p2=0.377$) indicating greater relative increases during LP within SET5 in VL (+31±13%, $p<0.05$) and SET3 and SET5 in both RF (+17±6 and +46±15%, respectively) and QF (+18±6 and +33±12%, respectively, $p<0.05$). Significant loading × set × repetition interaction for RF was found ($F(4,36)=2.680$, $p<0.05$, $\eta p2=0.229$) indi-

cating greater relative increases in RF during the repetitions of SET5 of LP. A significant loading × time interaction was found in BL ($F(1.7,18.3)=4.610$, $p<0.05$, $\eta p2=0.295$), so that BL was significantly higher in MID of SS ($p<0.01$).

CONCLUSION: The greater total work performed during SS was accompanied by greater muscle activation measured by normalized sEMG set-to-set. These factors resulted also in larger acute neuromuscular fatigue observed as a greater decrement in AP during SS. This acute neuromuscular fatigue may explain even decreased sEMG during the latter part of SS. The different hip joint positions between the exercises could also explain differences in sEMG. In LP, the hip joint remains flexed, and thus hip extensors (e.g., GLU) are unable to produce force optimally and possibly placing a greater demand for QF to complete work observed as greater relative increases in sEMG [2,4]. The flexed hip position may also enable RF to act as a knee extensor and take a greater role in force production while fatigue accumulates during LP [5].

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Oral presentations

OP-BM02 Neuromuscular Physiology: Fatigue

MOTOR UNIT BEHAVIOUR ADJUSTMENTS DIFFER DURING INTERMITTENT AND SUSTAINED ISOMETRIC KNEE EXTENSION TASKS TO FAILURE

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INTRODUCTION: Performance fatigability is associated with adjustments in motor unit (MU) discharge behaviour (1, 2). Whilst fatigability is known to vary with task demands (3), it remains unclear whether the associated modulation in MU discharge is also task dependent. This study examined and compared MU behaviour adjustments during two different submaximal isometric tasks to failure.

METHODS: Nine participants (1 female) completed an intermittent (INT; 11 seconds ramp contraction, 4 seconds rest) and a sustained (SUS) isometric knee-extension task to failure at 50 and 20% of maximal voluntary contraction (MVC) force, respectively. MVCs were performed before and immediately after each task, with voluntary activation (VA) and quadriceps-potentiated resting twitch force (Qtw) assessed using femoral nerve stimulation. During each task, high-density surface electromyography (EMG) signals were recorded from vastus lateralis (VL) and medialis (VM) and decomposed into discharge timings (4) in nonoverlapping windows of 3 contractions or 30 seconds for INT and SUS, respectively. Identified MUs were tracked from recruitment to task failure using an iterative process of MU filter optimisation and application (5) in overlapping windows across task duration. Mean discharge rates (MUDR) at target force, and recruitment (MURT) and derecruitment (MUDRT) thresholds during each contraction in INT were quantified for tracked MUs. Global EMG amplitude and force steadiness were also quantified at the target force throughout each task. All variables were averaged within ten windows of 10% of the time to task failure (TTF). Linear mixed models were used to assess whether the outcome variables are predicted by TTF, muscle, and task.

RESULTS: TTF was 531±134 and 217±82 seconds for INT and SUS, respectively. MVC force, VA, and Qtw decreased at task failure ($p\leq0.0001$), with similar decrements in both tasks. Global EMG amplitude increased ($p<0.0001$) to a similar degree during both tasks ($p=0.4912$). Force steadiness decreased with time ($p<0.0001$), with a greater decrease during SUS compared to INT ($p=0.0147$). VL and VM MUDR was modulated during both tasks ($p<0.0001$), with different, distinct patterns found between the two tasks ($p<0.0001$). During SUS, MUDR was decreased between 40% to 80% TTF ($p<0.010$) before returning to baseline, whereas during INT, MUDR remained stable until 50% TTF, after which it increased above baseline and continued to increase until task failure ($p<0.010$). During INT, both VL and VM MURTs and MUDRTs gradually decreased with time (both $p<0.0001$).

CONCLUSION: Our results provide evidence that adjustments in MU discharge behaviour during submaximal isometric contractions to task failure depend on task demands.

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SEX DIFFERENCES IN MUSCLE FATIGUE DEVELOPMENT AND INTRAMUSCULAR METABOLIC PERTURBATIONS DURING INTERMITTENT ISOMETRIC EXERCISE

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INTRODUCTION: Women are more muscle fatigue resistant than men during isometric tasks (3). Studies have suggested that a number of physiological factors lead to slower fatigue development in women than men during exercise, ultimately prolonging time to task failure in women at the same relative intensity (1,3). It remains unknown whether exercise-related accumulation of metabolites within skeletal muscle differentially affects fatigue development in women and men. The aim of this study was to investigate sex-specific differences in intramuscular metabolic perturbations during exhaustive intermittent isometric knee-extensor exercise.

METHODS: Fourteen males (M) (26±2ys) and 14 eumenorrheic women (W) (24±3ys) visited the laboratory twice. In visit 1, isometric knee-extensors critical torque (CT) was estimated by a 5-min all-out test (3s on/2s off) (2). In visit 2 (W in luteal phase), participants performed intermittent isometric knee-extensor exercise to task failure at 110% of CT. To determine knee-extensors fatigability maximal voluntary isometric contraction (MVIC), voluntary activation (VA), evoked high-frequency doublet (Db100) and potentiated twitches (St) were evaluated before (PRE), at 9 min (MID), and at task failure (POST). At the same time points, intramuscular levels of pH, ATP, PCr and Cr were determined in vastus lateralis muscle biopsies. Within-time and between-sex differences were evaluated by 2-way repeated measures ANOVA.

RESULTS: At PRE, MVIC torque was higher in M than W (259±70 vs 152±24Nm; P<.001). At MID, MVIC torque was decreased more in M than W (-43±9 vs -34±8% from PRE; P<.05). At POST, no differences in MVIC torque loss were observed between M and W (-55±7 vs -53±6% from PRE), while time to task failure was shorter in M than W (1017±498 vs 1511±506s; P<.01). VA and Db100 decreased over time (P<.001) to a similar extent in M and W. St torque loss was higher in M than W (-45±13% vs -37±15%; P<.05) at MID, whereas no sex-specific differences were observed at POST. No changes in muscle [ATP] were found over time. Muscle pH decreased and [Cr] increased over time (P<.001) without sex-specific differences. From PRE (M:64±19 and W:64±21mmol*kgDW-1) muscle [PCr] declined during exercise in M (MID: 45±13; POST: 34±13mmol*kgDW-1, both P<.05) but not in W (MID: 55±13; POST: 50±16 mmol*kgDW-1).

CONCLUSION: Women and men showed similar exercise-induced torque loss and intramuscular metabolic perturbations after intermittent isometric knee-extensor exercise performed at same relative target force. However, women can sustain the task for longer duration and are better to preserve muscle [PCr] during the task. These results indicate that a faster depletion of muscle PCr and, hence, accumulation of intramuscular inorganic phosphate may contribute to the faster fatigue development in men than women during submaximal intermittent isometric exercise.

MIND OVER MUSCLE? A DECEPTIVE STUDY ON NEUROPHYSIOLOGICAL MECHANISMS ASSOCIATED WITH STOPPING EFFORT

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INTRODUCTION: While physical performance has long been thought to be limited only by physiological factors, many experiments denote that psychological ones can also influence it (1). An interesting paradigm to study the influence of psychological factors on performance is manipulating them without participants' awareness (2). Using this methodology, previous results (3) showed a performance improvement during a cycling task performed to exhaustion when the clock was covertly slowed down by 10% compared to a condition where the clock was normal. However, the neurophysiological mechanisms underlying this performance improvement remain unclear to date. Therefore, the purpose of the current study was to investigate the neurophysiological adaptations associated with improved performance when the clock is unconsciously slowed down.

METHODS: Twenty-four subjects participated in five identical sessions during which they had to maintain an isometric knee extension against a fixed resistance (20% of their maximal torque) for as long as possible. A digital clock was continuously displayed in front of them to keep them constantly informed on their performance (i.e., holding time). During one of the two last sessions, clock calibration was slowed down at 90% of its actual speed (i.e., 100 s displayed = 111 s real), unbeknownst to the subjects. Neuromuscular fatigue was assessed over these last two sessions – defined as Normal and Biased respective to the clock calibration – by pre- to post-exercise changes in quadriceps maximal voluntary torque (MVT), voluntary activation level (VAL), and potentiated twitch (Tw). The kinetics of neuromuscular fatigue accumulation during the task were quantified using the root mean square of quadriceps electromyographic activity (RMS-EMG).

RESULTS: Real holding time was significantly higher in the Biased session compared to the Normal session ($p < 0.05$). Neuromuscular fatigue, assessed by MVT, VAL, and Tw pre-post comparison, was present in both Normal and Biased sessions ($p < 0.05$ for all) but without difference in magnitude between sessions ($p > 0.05$ and $BF < 0.3$ for all). Further analyses (using computational modeling) on intra-task RMS-EMG data revealed a neuromuscular fatigue accumulation following subjective rather than real time for individuals whose performance strictly improved when the clock was slowed down (N = 16).

CONCLUSION: Our study showed a significant performance improvement when the clock was slowed down without increasing the associated neuromuscular fatigue. This specific pattern relies on a fatigue accumulation dependent on subjective rather than real time for participants who improved their performance when the clock was slowed down. These

results support a psychological influence on neuromuscular processes, thus expanding the literature on mind-body influence.

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AETIOLOGY OF NEUROMUSCULAR FATIGUE DURING REPEATED SPRINTS IN SYSTEMIC VS LOCALIZED HYPOXIA.

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INTRODUCTION: Systemic hypoxia (SH) and blood flow restriction (BFR) are two methods used to improve the ability to repeat sprints [1,2]. Previous research explored the impact of these altitude-simulation modalities on neuromuscular fatigue (NMF) during upper-limb repeated sprint exercise (RSE)[3], but, methodological considerations such as time between cessation of exercise to measurement and the lack of individualization of exercise modalities are still preventing observations in the lower limbs. The aim of this study was to compare the impact of SH and BFR on the kinetics and aetiology of NMF during lower limb cycling RSE, using an innovative instrumented cycle-ergometer allowing measurements between sprints.

METHODS: 15 healthy males (22±4 yrs; 70±8 kg) performed 2 trials of RSE (10-sec sprint / 28-sec recovery) on a custom ergometer until an individualized task-failure criteria (i.e. 30% decrease in sprint mean power). Exercises were done in 2 randomized hypoxic conditions: BFR (45% of arterial occlusion) and SH (FiO2=0.13) Maximum voluntary contraction of the quadriceps (MVC), central [voluntary activation (VA)] and peripheral alterations [twitch (Pt)] were evaluated pre and immediately (i.e. no delay) post each sprint. For each RSE, sprints were expressed as a percentage of the total number achieved until task-failure. Individual data were extrapolated at 0, 25, 50, 75 and 100% of the RSE. Throughout the protocol, peripheral oxygen saturation (SpO2 by pulse oximetry) and quadriceps muscle oxygenation (TSI by near-infrared spectroscopy) were recorded. Repeated measure ANOVAs and Holm correction for post-hoc tests were performed.

RESULTS: Subjects completed 8 ± 4 sprints with BFR and 7 ± 3 sprints in SH, with no significant difference between conditions. MVC and VA were decreased in both conditions but perturbations were exacerbated in BFR (e.g. MVC pre-post: -46±14% BFR vs -24±12% SH, $p<0.001$; VA pre-post -19±15% BFR vs -5±8% SH, $p<0.001$, respectively $F(1,14)=23$ & $F(1,14)=12$). For MVC & VA, condition effects were significant from 50% to 100% ($p<0.05$). Pt similarly decreased from 0 to 75% in both conditions (-35±26% BFR vs -30±20% SH) and then plateaued ($F(1,14)=0.1$; $p=0.902$). Decreases in SpO2 (pre-post: -3±2% BFR vs. -30±8% SH; $p<0.001$) and TSI (pre-post: -23±4% BFR vs. -27±5% SH; $p<0.001$) were impacted to a greater extent in SH.

CONCLUSION: The number of sprints performed during RSE until an individualized task-failure threshold was similar under SH and BFR but NMF and its aetiology differed. Peripheral alterations occurred from the beginning to 75% of the exercise duration and were similar in both hypoxic modalities, while the exacerbated decline in MVC under BFR from mid-exercise was concomitant with additional central alterations that may be due to higher III/IV afferents activity. Finally, BFR did not emphasize localized hypoxia compared to SH.

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IMMEDIATE AND PROLONGED EFFECTS OF SUBMAXIMAL ECCENTRIC VS. CONCENTRIC FATIGUING PROTOCOLS ON HAMSTRINGS NEUROMUSCULAR FUNCTION

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INTRODUCTION: Repetition of intense hamstrings contractions, such as during maximal sprints, induce hamstrings neuromuscular fatigue from peripheral and central origin [1]. However, it is unknown whether such fatigue is mainly determined by the repetition of eccentric (ECC) or concentric (CON) hamstrings contractions during exercise and whether it is a short or long-lasting phenomenon. Given that neuromuscular fatigue is considered as a risk factor for hamstrings strain injuries [1], determining the effects of separate repeated ECC and CON contractions during fatiguing exercise is crucial to better understand the etiology of hamstrings neuromuscular fatigue. Our study was thus designed to compare the immediate and prolonged effects of unilateral ECC or CON repeated contractions on hamstrings neuromuscular function.

METHODS: On separate days, sixteen men repeated sets of five unilateral hamstrings contractions at 80% of the ECC or CON 1 repetition maximum (1RM) with a voluntary controlled knee angular velocity (i.e., ~ 10°/s). Contractions were performed on a dedicated hamstrings ergometer until a 20% decrement in maximal voluntary isometric contraction (MVC) torque was reached. Each set was separated by 25-s at rest during which hamstrings neuromuscular function was assessed. Exercise-induced hamstrings fatigue was quantified using pre- to immediately after (POST) and 24 hours (POST 24)

after exercise changes in high and low frequency potentiated paired twitches torques (T100 and T10, respectively) as well as voluntary activation level (VA). T100 and T10 were evoked by electrical myostimulations and VA was measured using the interpolated twitch technique.

RESULTS: Compared to baseline, independently of the contraction type, significant reductions in T100 (ECC: -13.3%; CON: -9.7%; $p < 0.001$), T10 (ECC: -5.1%; CON: -11.8%; $p < 0.05$) and VA (ECC: -3.0 %; CON: -2.4%; $p < 0.001$) were found at POST. However, these reductions did not persist at POST24.

CONCLUSION: For the same MVC torque drop (i.e., ~ 20%), repeated ECC or CON contractions provoked similar levels of peripheral and central hamstrings neuromuscular fatigue. This suggests that the etiology of hamstrings neuromuscular fatigue during such exercise does not depend on contraction type. These findings may find applications in hamstrings injury prevention methods. Indeed, while solely ECC strengthening is usually prescribed on the field to improve hamstrings force and fatigue resistance [3], the combination of ECC and CON strengthening protocols should also be considered because fatigue during repeated sprints likely arises from the repetition of both contraction type.

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Invited symposia

IS-SH01 Sport and climate change: challenges and opportunities

OUTDOOR SPORTS AND THE ENVIRONMENT: BALANCING ACCESSIBILITY AND SUSTAINABILITY

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Current environmental issues raise questions about the relationship between man and the environment. This relationship is at the basis of outdoor sports, which have enabled people to discover and explore exceptional places through sport. There is a certain constancy for the aesthetic admiration of places. But the efforts to make the sites accessible, which are inseparable from tourism, have contributed to altering the sites before the emergence of ecological or sustainable development ideas have led practitioners to adopt a more responsible approach. The purpose of this paper is, through examples taken from several physical activities, to show the evolution of the relationship with the natural environment and the transformations between admiration, understanding and protection that practitioners have been able to put forward in their activities.

SUSTAINABILITY THROUGH TECHNOLOGY? POTENTIALS, RISKS, AND PARADOXES IN SPORT ORGANISATIONS' SUSTAINABLE TECHNOLOGY STRATEGIES

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Technology is a vital enabler in sport organisations' efforts to contribute to sustainable development and the mitigation of climate change. For instance, technology enables the development of new sports apparel and equipment made from sustainable materials. Technology also enables new digital forms of sport participation and consumption that may reduce sports' carbon emissions. Additionally, new 'smart stadiums' use sustainable technology strategies to make sport events resource-saving and minimize emissions. The aim of this paper is to examine the role of technological innovation in sport organisations' strategies to mitigate climate risk and become more ecologically sustainable. The main argument in the paper is that the relationship between technology and sustainability in sports is often simplified. Using empirical examples such as Bodø/Glimt's plans for a new 'smart' football stadium, the green sport event EcoTrail Oslo, and Nofir's project of recycling fishing nets to goal netting in team sports, the paper highlights potentials, risks, and paradoxes in sport organisations' sustainable technology strategies.

PERFORMANCE OR SUSTAINABILITY? TENSIONS BETWEEN (ELITE) SPORT LOGICS OF PERFORMANCE AND REDUCING ENVIRONMENTAL IMPACT

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In the face of climate change, and driven by the logic of sportification, many sport landscapes have become more dependent on advanced technology. In this paper, we analyze how sport practitioners view the landscapes in which they conduct their training and competitions. Specifically, we explore the role of technology in balancing performance and environmental sustainability by analyzing two cases that are both impacted by climate change. The first case focuses on the role of sustainable development among individuals who have alpine skiing as their profession and lifestyle, primarily as ski instructors. Their relation to sport landscapes and seasonality over two decades explain how the environment and

climate has changed and affected the possibility to ski and having skiing as a living (or not). There is a tension between the importance of technology in artificial snow production to sustain a full season, and a more caring attitude towards the nature and mountains. The desire to work with skiing is strong and, to some extent, work towards environmental sustainability. The second case zooms in on cross-country skiers, and the tensions between (elite) sport logics of performance and reducing the environmental impact (Backman & Svensson, 2022). We argue that the tension between performance and environmental sustainability becomes explicit in relation to climate change, and that sport with its long tradition of regimentation and standardization regarding technology and performance (Loland, 2018) has the potential to become a driving force in climate-related adaptations.

Oral presentations

OP-AP19 Swimming: Training and Testing

THE INTERPLAY BETWEEN ACTIVE DRAG, ARM STROKE EFFICIENCY AND PROPULSIVE POWER AS DETERMINANTS OF FRONT CRAWL SPRINT PERFORMANCE

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INTRODUCTION: Swimming performance depends on the balance between mechanics and energetics. Athletes must maximize propulsion (thus increasing the metabolic input) while minimizing hydrodynamic resistance (thus decreasing the energy cost) (1). Moreover, identifying key predictors of performance obtained from field tests is of particular interest for coaches, performance analysts and athletes. Therefore, the aim of this study was to verify in-field the association between active drag coefficient, propulsive power, propelling efficiency, and maximal sprint performance in front crawl.

METHODS: Male and female competitive swimmers of different levels participated in this study (n=51). They performed four all-out semi-tethered front crawl sprints with increasing loads (0.1, 2.0, 4.0, and 6.0 kg) using an electromechanical device (1080 Sprint, Sweden). To avoid major changes in the duration of each trial as the load increased, swimmers were asked to swim 25 m in the first trial (0.1 kg), 25 m in the second trial (2.0 kg), 20 m in the third trial (4.0 kg), and 15 m in the fourth trial (6.0 kg). Average swimming speed and semi-tethered force were obtained from ~10-20 m in the unloaded trial. The number of strokes executed before and within this window was computed and used as a reference to calculate the average speed and semi-tethered force in the other trials (i.e., 2.0-6.0 kg). A linear regression of the semi-tethered force vs swimming speed relationship was used to obtain input parameters to be included in the calculation of Drag, drag coefficient, and propulsive power using the Velocity Perturbation Method (2). The arm stroke efficiency was obtained from the ratio of the average forward speed and the average tangential hand speed (1,3). A stepwise regression was used to identify the association between the selected parameters and maximal sprint performance in front crawl swimming (α=5%).

RESULTS: Two models predicting front crawl sprint performance were obtained from the stepwise regression: (i) including propulsive power (R^2=0.797; p<0.001), (ii) including propulsive power and active drag coefficient (R^2=0.965; p<0.001). The arm stroke efficiency was excluded by the stepwise regression and, individually, presented a negligible correlation with maximal swimming speed (r=-0.274; p=0.026).

CONCLUSION: Propulsive power and active drag coefficient obtained using a coach-friendly semi-tethered swimming protocol are strongly related to maximal front crawl sprint performance. Despite its importance in converting the total mechanical power into useful propulsive power, and its known correlation with swimming economy (an important determinant of performance in longer distances) the arm stroke efficiency was not a strong predictor of sprint performance in front crawl.

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HAND THRUST DURING FREE AND TETHERED SWIMMING: AN ANALYSIS OF ASYMMETRY

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INTRODUCTION: Analyzing athletes' parameters, such as forces during swimming, is essential to enhance performance (1,2).

The use of wearable sensors could facilitate this process due to their cost-effectiveness, ease of use, and ecological approach.

In this research, we investigated how hand thrust forces vary according to two swimming tests (tethered vs. free) and between the two hands (dominant vs. non-dominant). We hypothesized larger forces in terms of average force (Fmean),

impulse (I), and peak force (Fpeak) in tethered compared with the free swimming and in the dominant compared with the non-dominant hand.

METHODS: Eleven skilled swimming athletes (age = 15.4 ± 0.5y.; body mass = 58.0 ± 7.1Kg; stature = 168.4 ± 5.0 cm) performed a 10-second tethered front crawl only arms test (Tet), and 10 seconds free front crawl only arms test (Free) wearing two wearable pressure sensors, one for each hand. The thrust force of each hand was estimated as the product of differential pressure (palmar minus dorsal side) and hand surface. Considering circle-shaped hand kinematics, only the horizontal component of hand thrust force was used for the analysis. Average force (FMEAN), impulse (I), average peak (FPEAK), and instantaneous (by means of Statistical Parametric Mapping, SPM) were analyzed as a function of swimming condition and dominant/non-dominant hand. The symmetry index (SI) was analyzed as a function of swimming conditions.

RESULTS: Results indicated larger Fmean, Fpeak, and I during Tet compared to the Free condition ($F > 4.23$, $p < .05$; Fmean: Tet = 34.0 ± 9.7 N vs. Free = 28.7 ± 7.8 N; Fpeak: Tet = 74.6 ± 22.0 N vs. Free = 66.8 ± 15.2 N; I: Tet = 28.0 ± 5.3 Ns vs. Free = 22.0 ± 5.3 Ns). Whereas SI was non-significant. SPM highlighted a larger Fmean in Tet condition only at the beginning of the stroke (entry phase, from 7 to 28% of the cycle).

In addition, non-significant differences were observed for Fmean between the hands ($p > .05$), and SPM confirmed these results ($p > .05$). However, larger Fpeak and I in the dominant compared with the non-dominant hand were found ($F > 11.11$, $p < .05$; Fpeak: dominant = 65.3 ± 15.9 N vs. non-dominant = 62.7 ± 14.4 N; I: dominant = 26.3 ± 8.0 Ns vs. non-dominant = 23.5 ± 5.6 Ns).

CONCLUSION: The swimmer appears to exert larger hand propulsion in tethered- than free- swimming. However, our findings of the symmetry model and the hand-propelling balance during tethered- and free-swimming were not conclusive, and further investigations could help in better understanding this phenomenon (3).

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APPLYING SEVERE AND EXTREME INTENSITY SWIMMING TRAINING IN THE SAME SESSION: EFFECT OF SET SEQUENCE ON PHYSIOLOGICAL RESPONSES AND PERFORMANCE

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INTRODUCTION: Swimming training may include sets in various intensities that applied concurrently and with varied order. The sequence of training sets may affect performance and physiological response of the whole session and in each set separately. The aim of this study was to investigate the effect of set sequence on performance and physiological responses in a training session and in each set separately.

METHODS: Twelve swimmers (18.7±3.4 years) performed 50 and 400 m maximal efforts to estimate maximal speed and maximal aerobic speed (MAS), respectively. Training sets of 8x100 m at MAS (set A - severe) and 8x50 m at 95% of the maximal speed (set B - extreme) were planned, both including 30 s of recovery between repetitions. In two randomized order sessions swimmers completed the following set sequences: i) set A - set B (A-B), ii) set B - set A (B-A) with 10 min of passive recovery between sets. Time to complete each repetition and heart rate (HR) were recorded continuously. Lactate concentration [La-] was determined at the start, middle and end of each set and the mean [La-] was calculated. Blood pH, base excess (BE) and bicarbonate (HCO3) were determined before and after each set. Plasma volume percentage changes (ΔPV) after each training set was calculated based on hematocrit and hemoglobin changes. R-R intervals were recorded the night after each session and HRV was calculated. The logarithm of root mean square successive difference (LnRMSSD) was used to examine the effect of the entire session on autonomic nervous system.

RESULTS: Performance in each set separately was not different between sessions regardless of sets sequence ($p>0.05$). Mean HR was not different between sessions in each set ($p>0.05$). Mean [La-] in set A was higher in B-A condition compared to the reverse order (A-B: 6.0±2.4, B-A: 9.0±1.8 mmol·L-1, $p<0.05$). However, in set B, [La-] was similar between sessions ($p>0.05$). Mean pH of the entire A-B session was higher and BE and HCO3 were lower compared to B-A session (pH: A-B: 7.336±0.046, B-A: 7.303±0.033, BE: A-B: -6.6±2.8, B-A: -9.2±2.3 mmol/L, HCO3: A-B: 19.3±2.2, B-A:17.2±1.8 mmol/L, $p<0.05$). However, acid-base parameters in each set separately did not change irrespective to the set sequence ($p>0.05$). ΔPV did not differ between sessions and did not change in each set irrespective to the set sequence ($p>0.05$). Nocturnal LnRMSSD did not differ between sessions and in each set independent of the applied sequence ($p>0.05$).

CONCLUSION: Training sets sequence does not affect performance in each set separately but may influence the entire set physiological responses. The overall effect of the entire training session in parameters determining acid-base balance is magnified when a near-maximum intensity set is followed by a set at MAS compared to the reverse order.

INFLUENCE OF AN INTENSIVE 6-DAY TRAINING PERIOD ON A SUBMAXIMAL PERFORMANCE TEST IN NATIONAL LEVEL YOUTH SWIMMERS

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INTRODUCTION: Previous studies have reported that the Lamberts and Lambert Submaximal Cycling test (LSCT) can be used to predict performance(1) and monitor fatigue/fitness(2). However, to our knowledge there is no sport specific submaximal test which can be applied for these purposes in swimming so far. Therefore, the aim of the current study was to assess whether a modified swim-specific version of the LSCT (LSCTmod) is responsive to an intensive 6-day training period.

METHODS: Seventeen, German and Dutch national swimmers participated in an 8-day training camp. At day 1 (Pre) and 8 (Post), the LSCTmod was conducted in a 50 m pool. Between day 1 and 8, an intensive 6-day training period was carried out. Before the test, participants were asked for their 400 m personal best time. The LSCTmod consisted of three submaximal stages aiming at 60% (stage 1; 500 m), 80% (stage 2; 500 m) and 90% (stage 3; 200 m) of personal 400 m best times. Participants were provided with an individual 100 m target time corresponding to the intensity of each stage. In between stages there was a 30-second break, during which heart rate (HR) and Borg's rating of perceived exertion (RPE) were obtained. Effects on HR and RPE during the LSCTmod were analysed using a two-way analysis of variance (ANOVA). Results are presented as means±SD for HR and time and median [interquartile range] for RPE. Partial eta squared was calculated as effect size.

RESULTS: For the LSCTmod, 100 m target times were set at 113±7 s for stage 1, 85±5 s for stage 2 and 76±5 s for stage 3. Comparing day 8 to day 1, change in HR was -6±12 bpm, -7±20 bpm and -5±20 bpm and change in RPE was 0 [1], -1 [2] and 0 [2]at stage 1, 2 and 3, respectively. There was no significant main effect of the training camp on HR ($F1,16=3.36$; $P=.070$; $\eta2p=0.03$) nor RPE ($F1,16=1.12$; $P=.292$; $\eta2p=0.01$). A decrease in HR coincided with an equal/increased RPE in 11/18 participants at stage 1, 2/18 participants at stage 2, and 5/18 participants at stage 3.

CONCLUSION: The findings of the current study show that an intensive 6-day training period resulted in a decrease in HR, albeit not significant, and no change in RPE during the LSCTmod. Although, a lower HR and a similar/higher RPE was found in most participants in stage 1, none of them displayed this pattern over all three stages. However, the reliability of the LSCTmod has not yet been investigated and the lack of familiarization might partly explain the results.

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EFFECTS OF 12-WEEK CONCURRENT TRAINING ON GENERAL ATHLETIC ABILITY AND SPECIFIC ATHLETIC PERFORMANCE OF PREADOLESCENT SWIMMERS

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INTRODUCTION: Concurrent training (CT) refers to simultaneous strength training and aerobic endurance training within a training cycle(Wilson, et al. 2012). Due to differences in anthropometric and physiological differences between children and adults, some previous research conclusions cannot be directly applied to children. Hence, the main aim of this study was to analyze and explore the changes of prepubertal swimmers anthropometrics, general motor abilities and swimming performance before and after the concurrent training intervention.

METHODS: In this study, 36 pre-adolescent swimmers were randomly divided into experimental group (EXP, N=40; age = 9.9 ± 0.90 yr.) and control group (CON, N=18; age = 10.0 ±0.60 yr.) from the local Swimming School in Huangpu District. During the 12-week intervention period, the EXP performed water swimming endurance training, 80%-85% 1RM strength and plyometric training, while the CON group performed specific-swimming endurance and land-specific endurance training. After the intervention training, a post-test was conducted on all subjects, and the tests and process were exactly the same as the pre-test.

In addition to static jump(SJ) and countermovement jump(CMJ), all swimmers performed general motor abilities tests consisting of 20m sprinting(SP), 40s sit-up(SU), 40s push-up(PU), standing long jump(SLJ), 15s jumping sidewards (JS), 6min running(RU) from six subtests of Deutscher Motorik-Test 6–18 (Bös and Schlenker 2011), while 50m and 400m freestyle performance was measured in the swimming pool before and after the implementation of CT program.

A 2 (group: EXP, CON) by 2 (time: pre, post) analysis of variance (ANOVA) for repeated measures was executed to determine whether there were a significant interaction and/ or significant differences among swimmers' Repeated Measures of all types of motor tests and freestyle performance, comparing training modalities (EXP group versus CON group)

RESULTS: The test result showed that there were significant interaction for two training groups in regard to repeated measures of SJ($F (1,34)=9.75, P=0.005$), CMJ($F (1,34)=24.74$, $P=0.000$), SLJ($F (1,34)=11.18$,$P=0.003$), JS($F (1,34)=8.2, P=0.009$) and 50m freestyle performance[$F (1, 34) = 4.42$, $p = 0.47$]. After 12 weeks of training, the performance of SJ ($\Delta MD=1.05$, $p=0.037$, $ES=0.83$), CMJ ($\Delta MD =2.0$, $p<0.001$, $ES=1.08$), SLJ ($\Delta MD =0.62$, $p<0.001$, $ES=2.10$), SU($\Delta MD =0.69$, $p<0.001$,

ES=3.0), PU(ΔMD =0.28, p<0.001, ES=1.10), SP(ΔMD =0.28, p<0.001, ES=0.8), JS(ΔMD=0.28, p<0.078, ES=2.23), RU(ΔMD =0.21, p<0.001, ES=0.58), and 50m freestyle(ΔMD =-1.17, p<0.001, ES=0.60) were all improved in EXP compared to before.

CONCLUSION: Concurrent 12-week training was more effective in improving lower-body power, core endurance, coordination, and 50-meter freestyle performance in prepubertal swimmers than specific-swimming endurance training alone. It shows that without increasing the amount of training, the same period of training is more efficient than individual specific endurance training.

Oral presentations

OP-AP21 Combat Sports: Training and Testing

ASSESSING THE KEY PHYSICAL CAPABILITIES IN STRIKING COMBAT SPORTS: RELIABILITY AND REPRODUCIBILITY OF A NEW TEST.

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INTRODUCTION: The rules and technical aspects of combat sports make it difficult to determine key performance indicators [1]. It is well established that striking actions require a combination of explosive strength, power, and speed alongside a well-developed cardiovascular system, particularly the anaerobic system [1, 2]. The Force-Velocity-Power (FVP) and anaerobic assessments used in combat sports were generally upper or lower body dominant [2]. In striking combat sports, the Landmine Punch Exercise (LPE) has a high transfer potential due to similarities with striking skills. Therefore, the main focus of this study was to investigate the reliability and reproducibility of the LPE as a specific neuromuscular and anaerobic assessment for striking combat sports. The second purpose was to compare the FVP obtained by the multiple-points (MP) versus the two-points (TP) method.

METHODS: Ten high-level boxers performed three trials consisting of FVP (both TP and MP methods) and fatigue tests using the LPE. The FVP test consisted of incremental loading (20%, 30%, 40%, and 50% of the body mass) using ballistic bar throws (i.e. LPE). After performing FVP profiles, the load eliciting Pmax was applied for a 30-s all-out LPE effort. A 3D accelerometer (Microgate Gyko Repower, Bolzano, Italy) was used to determine biomechanical variables from the assessments: maximal theoretical force (F0), velocity (V0), power (Pmax), the slope of the relationship (Sfv), peak power (Ppeak), mean power (Pmean), minimal power (Pmin) and a fatigue index (FI%). Analyses of variance and reliability plus reproducibility were tested through intraclass correlation coefficients (ICCs), coefficients of variation (CVs), effect size (ES), and coefficient of correlation while comparisons between the TP and the MP methods were carried out through, paired t-tests, ES, coefficient of correlation and Bland-Altman plots.

RESULTS: Analyses of variance and paired t-tests didn't reveal significant differences for test-retest sessions and methods comparisons, respectively. This was associated with high within-subject intra-session and inter-session reliability and reproducibility, found for both FVP and fatigue test parameters (CVs<10%, ICCs>0.67, ES < 0.2 for F0, V0, Pmax, Sfv, Ppeak, Pmean, Pmin and FI% and r > 0.88) [3, 4]. In addition, the TP and MP methods showed high validity and agreement (F0: r = 0.88, V0: r = 0.95, Pmax: r = 0.96, Sfv: r = 0.93 and all ES were <0.11).

CONCLUSION: The novel LPE test presented in this pilot study is a highly reproducible tool for evaluating both neuromuscular and anaerobic components specific to the discipline. Alongside that main result, athletes and coaches may preferentially use the TP method to reduce fatigue and the time required to perform the testing procedure and to better understand striking performance in combat sports.

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NEUROMUSCULAR, PHYSICAL FITNESS, AND COMPETITIVE PERFORMANCE IN HIGH-LEVEL JUDO ATHLETES

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INTRODUCTION: Judo is a combat sport that requires elevated levels of muscle power, aerobic fitness, strength-endurance and speed for optimal competitive performance [1]. However, little is known about these aspects during the tapering phase and their relationship with competitive performance. Therefore, this study aimed to compare muscle power, aerobic power, strength-endurance, and speed-related variables in male and female judo athletes who won medals (MW) and those who did not (NMW) in a national competition.

METHODS: Nineteen high-level judo athletes (9 males, 23 (22;29) years of age, 81 (73;100) kg of body mass, 4 MW; and 10 females, 22 (20;24) years of age, 63 (53;68) kg of body mass, 5 MW) who were preparing for a Brazilian national-level tournament took part in this study. During the tapering period, athletes executed tests (between 13 and 3 days before competition) to determine peak power for squat and bench press exercises (using loads between 30% and 80% of their one-repetition maximum), long-standing jump, maximal number of repetitions during a chin-up test gripping the judogi, maximum speed in a 5-s uchi-komi test, and maximum aerobic speed in judo uchi-komi test. Values are presented as median and interquartile intervals. Mann-Whitney U-test was utilized to compare MW and NMW within each group. Significance level was set at 5%.

RESULTS: MW and NMW did not differ (p>0.05) in any performance-related variables: squat (W) – male: MW = 914 (900;974); NMW = 878 (751;1007); female: MW = 593 (580;627); NMW = 576 (567;611); bench press (W) – male: MW = 712 (624;789); NMW = 677 (666;697); female: MW = 359 (333;392); NMW = 372 (359;384); long standing jump – male (cm): MW = 259 (243;277); NMW = 270 (263;282); female: MW = 216 (212;222); NMW = 224 (218;225); chin-up (rep) – male: MW = 17 (12;23); NMW = 19 (17;22); female: MW = 13 (12;17); NMW = 9 (8;13); maximum uchi-komi speed (rep/min) - male: MW = 87.7 (87.3;109.7); NMW = 92.5 (86.5;94.4); female: MW = 86.8 (79.2;95.1); NMW = 93.0 (86.1;95.0); uchi-komi maximum aerobic speed (rep/min) - male: MW = 65.3 (62.2;66.7); NMW = 61.2 (55.9;65.1); female: MW = 64.3 (62.2;65.2); NMW = 60.7 (58.5;62.1).

CONCLUSION: Neuromuscular and physical fitness variables during the tapering period did not differ between male or female MW and NMW. It is likely that well-developed neuromuscular and physical fitness are necessary but not sufficient abilities for top-level judo performance.

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PILOT DATA OF THE EFFECTS OF MIXED MARTIAL ARTS SPARRING ON AUTONOMIC BRAIN FUNCTION

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INTRODUCTION: Automated pupil light reflex (PLR) is a valid indicator of reduced autonomic brain function with and without loss of consciousness. Feasibility of PLR to identify acute changes in autonomic brain function has not yet been examined in a sports setting. As a combat sport featuring repeated sub concussive head impacts, mixed martial arts (MMA) sparring may provide a model to understand acute PLR changes in response to such trauma. Therefore, the purpose of this pilot study was to explore changes in automated PLR following MMA sparring.

METHODS: 7 MMA athletes (age = 24±3 years; mass = 76.5±9 kg; stature = 176.4±8.5 cm) took part in their regular sparring sessions (8 rounds x 3 mins:1 min recovery). PLR of both eyes was measured (NPi-300, Neuroptics, USA) immediately pre and post sparring. Variables measured were min and max pupil diameter (mm), constriction velocity (CV, mm·s-1), dilation velocity (DV, mm·s-1), PLR latency (s) and 'NPi' (AU) - a proprietary variable representing overall pupil response. Pre-post comparisons were made for: left eye (L); right eye (R); both eyes averaged together; differences between left and right eyes. Statistical differences were indicated by Bayes factors (BF10) ≥3 on paired samples t tests and Cohen's d.

RESULTS: L NPi improved following sparring (BF10 = 5, d = 1.2; PRE = 4.07±0.3 AU; POST = 4.19±0.3 AU). Minimum L pupil size reduced (BF10 = 8, d = 1.5; PRE = 5.6±1.1 mm; POST = 5.2±1.1 mm). There were no changes in R. Both eyes averaged together displayed improved NPi (BF10 = 4; d = 1.2; PRE = 4.1±0.3 AU; POST= 4.2±0.3 AU), decreased max pupil size (BF10 = 3; d = 1; PRE = 5.8±1.1 mm; POST = 5.4±1 mm), decreased min pupil size (BF10 = 4; d = 1.2; PRE = 3.8±0.9 mm; POST = 3.4±0.7 mm) and reduced PLR latency (BF10 = 3; d = 1.1; PRE = 0.23±0.02s; POST = 0.21±0.01s). Each eye had different min sizes both pre (BF10 = 4 d = 1; L = 3.7±0.9 mm; R = 3.9±0.9 mm) and post sparring (BF10 = 4; d = 1.2; L = 3.3±0.7mm; R = 3.5±0.7 mm). Each eye also had different max sizes (BF10 = 3; d = 1.1; L = 5.2±1 mm; R = 5.6±1 mm) and max CV (BF10 = 3; d = 1.1; L = 4.8±1.1 mm·s-1; R = 5.3±0.8mm·s-1) post sparring.

CONCLUSION: Acute improvements to PLR but increased anisocoria occurs following MMA sparring. Improved PLR may result from high intensity exercise arousal. Future studies require repeat series measurements following MMA sparring to measure the decay of these changes and any PLR decrements potentially masked by arousal.

PHYSIOLOGICAL RESPONSES AND ENERGY SYSTEM PROFILING DURING THE SIMULATION OF EPÉE COMPETITIONS IN ELITE FENCERS

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INTRODUCTION: To determine sport-specific characteristics, this study aimed to evaluate physiological responses and energy system contributions during simulated epée competitions in elite fencers.

METHODS: Ten elite male fencers participated in this study. They performed simulated epée (direct elimination; DE) matches. Simulated epée matches consisted of three rounds of three min each, with one min rest between each round. During these competitions, physiological parameters such as heart rate (HRpeak and HRmean), oxygen uptake (V ̇O2peak and V ̇O2mean), metabolic equivalents (METs in V ̇O2peak and V ̇O2mean), and blood lactate concentrations (Peak La– and delta La–; ΔLa–) were determined. Furthermore, energy system contributions (oxidative; WOxi, glycolytic; WGly, and phosphagen; WPCr) using the PCr- La–-O2 method and time-motion parameters were calculated.

RESULTS: Values of HRpeak, HRmean, and WOxi (%) were significantly higher in the second and third rounds compared with the first round ($p < 0.05$, $p < 0.0001$, $p < 0.01$, and $p < 0.0001$, respectively). Values of V ̇O2peak and METs in V ̇O2peak were significantly higher in the first round compared with the third round ($p < 0.05$, respectively). Values of ΔLa–, and WGly (kJ and %) were significantly lower in the second and third rounds compared with the first round ($p < 0.01$, respectively). V ̇O2mean and METs in V ̇O2mean were significantly higher in the second round compared with the third round ($p < 0.05$, respectively). Furthermore, WOxi (kJ and %) was significantly higher in all bouts compared with WPCR and WGly ($p < 0.0001$, respectively). Low positive and negative correlations were seen between WOxi, V ̇O2mean, and sum of attacks and defence times (ADT) and the sum of time without attacks and defences (STWAD) (WOxi vs ADT: r = 0.48; R2 =

0.23, V̇O2mean vs ADT: r = 0.45; R2 = 0.20, WOxi vs STWAD: r = –0.49; R2 = 0.24, and V̇O2mean vs STWAD: r = –0.45; R2 = 0.20, respectively).

CONCLUSION: Direct elimination epée matches include high-intensity intermittent exercise and the oxidative energy contribution is 80 to 90% of the total energy demand. Improving aerobic performance such as the increased ability of energy recovery may support high-intensity intermittent actions during entire epée matches (3 rounds) in elite fencers.

FORCE-VELOCITY-POWER PROFILING USING ISOMETRIC AND DYNAMIC PERFORMANCE TESTING

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INTRODUCTION: The dynamic strength index (DSI) (also known as the explosive strength deficit or dynamic strength deficit) is a ratio between the peak force obtained during a ballistic movement and isometric peak force. In practice, DSI has been described as reliable in athletes and is theoretically able to provide insights about strength training prescription. For example, the resultant DSI could indicate whether an athlete should prioritize force (high-load, low-velocity) or velocity (low-load, high-velocity) training, but DSI is only a single variable that is based on the relationship between two types of peak force, and there is apparently a lack of relationships between DSI and other common performance variables (1). However, maximal isometric strength could be combined with several other maximal dynamic strength (MDS) variables (i.e., kinetic or kinematic variables that can be extracted from jump data) that may better express neuromuscular functioning during performance-related tasks such as jump height (JH) and takeoff momentum. Therefore, we aimed to investigate the relationship between variables obtained from maximal isometric strength combined with fast MDS and jump performance.

METHODS: Fifteen male combat sports athletes (27 ± 5 years, 77 ± 9 kg, 1.76 ± 0.1 m, 14 ± 6% body fat) participated in 2 testing sessions. The first session involved testing familiarization procedures, while during the second session, isometric mid-thigh pull F0 (N), peak force (N), and mean force (N) were measured. Additionally, mean velocity (m/s), JH (m), and takeoff momentum (kgm/s) were gathered from a squat jump (SJ). We then calculated a linear relationship between force and velocity, which allowed us to obtain the slope of the relationship (SFV) and the theoretical velocity at zero force (V0) and Pmax as a function of F0V0·4-1 (2). Pearson's correlations were used to assess the relationships between JH and takeoff momentum with F0, V0, SFV, Pmax, and DSI.

RESULTS: Large relationships existed between takeoff momentum and F0 ($r = 0.54$, $p = .038$) and Pmax ($r = 0.81$, $p < .001$) as well as between JH and V0 ($r = 0.75$, $p = .001$) and SFV ($r = 0.52$, $p = .045$). In contrast, no relationship existed between DSI and jump performance.

CONCLUSION: Maximal isometric strength can be combined with other fast MDS variables that derive from a dynamic task to provide force-velocity-power profiling, which was largely correlated with vertical jump performance in this study.

Oral presentations

IS-EX03 JSPFSM-ECSS exchange: Complex effects of acute exercise on cognition

THE MODERATING ROLE OF PRE-TEST PERFORMANCE ON THE AFTEREFFECTS OF ACUTE AEROBIC EXERCISE ON COGNITIVE PERFORMANCE

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An increasing number of studies has focused on the aftereffects of a single dose (i.e., bout) of acute aerobic exercise on cognitive function. Studies on this topic are considered particularly important, as positive findings may motivate sedentary individuals to start exercising (or adhere to an exercise regimen), since repeated daily exposure to acute exercise could lead to long-term cognitive as well as physical health benefits. However, our recent systematic review (Ishihara et al., 2021) found that more than one-third of previous studies did not determine any beneficial effects of acute aerobic exercise on cognitive performance. To identify possible factors underlying the lack of consensus in the literature, we focused on individual differences in pre-test (i.e., baseline) cognitive performance.

In the first study, we conducted a meta-analysis using individual participant data (IPD meta-analysis) to demonstrate that individual differences in pre-test cognitive performance can affect the aftereffects of acute aerobic exercise (Ishihara et al., 2021). Specifically, the beneficial aftereffects of acute aerobic exercise on cognitive performance were greater in participants with lower cognitive performance at pre-test. The second study focused on intraindividual changes in cognitive performance. Specifically, we examined whether the aftereffects of acute aerobic exercise would change depending on circadian rhythms of cognitive performance. The results indicated that the aftereffects of acute aerobic exercise on cognitive performance differ by time of day, with greater beneficial effects following afternoon exercise, starting at 2 or 3 pm, than morning exercise, starting at 10 or 11 am (preliminary data). The post-lunch dip is a well-established phenomenon of decreased cognitive performance between 2 and 4 pm. Therefore, the beneficial aftereffects of acute aerobic exercise are likely to be greater when the level of cognitive performance is low due to circadian rhythms.

Collectively, these findings demonstrate that pre-test performance strongly moderates the aftereffects of acute aerobic exercise on cognitive performance. Accordingly, in acute exercise studies, we should consider pre-test performance, such

as by manipulating task difficulty and/or by controlling for pre-test performance in statistical analyses. Future studies should attempt to create a gold standard for assessing cognitive performance in acute exercise studies.

Ishihara, T., Drollette, E. S., Ludyga, S., Hillman, C. H., & Kamijo, K. (2021). The effects of acute aerobic exercise on executive function: A systematic review and meta-analysis of individual participant data. Neurosci Biobehav Rev, 128, 258-269.

THE INTERACTION OF ACUTE EXERCISE, STRESS AND COGNITION IN CHILDREN AND PREADOLESCENTS

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The number of children and adolescents reporting moderate to high stress increased over the last decades, with evaluation stress they face in the school setting being one of the underlying causes. While high stress is known to impair cognitive performance, acute exercise has been reported to elicit transient cognitive benefits. Consequently, antecedent exercise has the potential to protect from the negative consequences of stress on cognitive performance. In turn, stress might also influence the temporary effects of acute exercise on cognitive performance. We aim to provide insights into the complex interplay of exercise, stress and cognition by a series of experimental studies.

In the CASPA trial, preadolescent children completed a single, moderately-intense exercise bout on a cycling ergometer or a control task, followed by a the Trier Social Stress Test for Children. The Stroop task was administered in regular intervals. The stress response was measured from salivary cortisol. The results showed that stress affected performance on trials with low inhibitory demand (low difficulty), with a more pronounced slowing of reaction time in participants, who performed an antecedent exercise bout. In the FARADISE trial, we used a randomized cross-over design to investigate the influence of stress on the effects of acute exercise in children with Autism Spectrum Disorder. Participants performed tasks assessing executive function (Affective Go/NoGo paradigm) and social-cognitive abilities (Face and object categorization paradigm) before and after a single, moderately-intense exercise bout on a cycling ergometer or a control condition (remain seated on a cycling ergometer with no pedal movement). Salivary cortisol and heart rate variability were collected in regular intervals throughout both conditions. Our results showed that exercise led to increased levels of stress and at the same time, impaired the ability to detect faces. In contrast, response inhibition was not affected by the acute exercise bout and remained unchanged.

Our findings provide insights into the complex interplay of stress, exercise and cognitive performance in children and preadolescents. Acute exercise seems to elicit a psychophysiological state, during which the negative influence of stress on specific cognitive functions is increased. This indicates that antecedent exercise does not protect from stress and should be avoided prior to a stressful situation. Moreover, an exercise-induced increase in stress may cancel benefits for higher-order cognition and even impair specific social-cognitive abilities in children with Autism Spectrum Disorder. Consequently, exercise may not always improve cognitive performance, especially when exercise is associated with stress.

THE IMPACT OF PARTICIPANT CHARACTERISTICS ON THE BENEFICIAL EFFECTS OF ACUTE EXERCISE IN CHILDREN

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Obesity is an epidemic, affecting more than 340 million children and adolescents worldwide. This occurs alongside decreased rates of physical activity (PA). Unfortunately, a growing body of research (ours included) suggests these problems were made worse with the COVID-19 pandemic. Obesity and physical inactivity are related to increased risk of developing diabetes, cardiovascular diseases, cognitive decline, and a variety of other health challenges. Fortunately, acute exercise has been shown to benefit cognitive health and academic achievement. Interestingly, these benefits may be enhanced or blunted based on participant characteristics.

For example, 47 children (15 females, 9.64±0.12 years) completed two, randomized and counterbalanced 20-minute interventions: acute PA (treadmill walking at ~65% HRmax) and seated rest (control) on separate days, followed by an educational lesson in a VR classroom. Children then completed a quiz about this lesson. Quiz performance was z-scored across interventions by lesson. Results suggested that children learn better following acute PA (z-score= 0.16±0.13) compared to seated rest (z-score=-0.16±0.14; t=2.29, p=0.026)) and indicate that a single bout of PA may positively impact learning outcomes. We subsequently bifurcated children by IQ and found that those with lower IQ had a significantly greater benefit of exercise compared to their higher IQ peers (p=0.04). This suggests that acute PA may not only improve learning outcomes, but that it may be particularly beneficial for certain children. In a similar study (Raine et al., 2020), we investigated the impact of acute PA on children's performance on a cognitive task. This investigation included 116 children (51 females, 9.88±0.06 years). Analyses indicated improved task performance (p's=0.001) following the acute PA intervention (20 minutes of treadmill walking at ~65% HRmax) compared to the control condition, with selectively greater benefits for the more challenging task condition. Interestingly, further analyses revealed that greater BMI was related to decreased performance following acute PA (p=0.001); an association not observed following the control condition (p's=0.11). These results suggest that BMI may negatively influence the effect of acute exercise on cognitive performance.

As rates of childhood obesity and physical inactivity continue to increase worldwide, these results have implications for the health and wellness of children. Together these findings demonstrate that acute PA may have differential effects on children based on a variety of health and demographic factors. Findings continue to demonstrate the beneficial effects of acute PA on cognitive tasks as well as learning outcomes. These beneficial effects of PA appear to be blunted in children

with higher BMI and enhanced in children with lower IQ. Thus, future studies should attempt to better understand these differences in order to leverage the benefits of acute PA for children.

Oral presentations

OP-MH08 Exercise therapy/HIIT

HOME-BASED HIIT AND TRADITIONAL MICT PRESCRIPTIONS IMPROVE CARDIORESPIRATORY FITNESS TO A SIMILAR EXTENT WITHIN AN EXERCISE REFERRAL SCHEME FOR AT-RISK INDIVIDUALS

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INTRODUCTION: Exercise referral schemes (ERS) are used to promote physical activity within primary care, however adherence to ERS is often poor. Traditionally, ERS are conducted in a gym or leisure centre setting, with exercise prescriptions based on moderate-intensity continuous training (MICT). Home-based high-intensity interval training (Home-based HIIT) has the potential to reduce perceived barriers to exercise, including lack of time and access to facilities, compared to traditional MICT prescription used with ERS and improve health related outcomes. We hypothesized that Home-based HIIT would mediate greater improvement in cardiorespiratory fitness (CRF) by virtue of greater adherence and compliance to the exercise prescription, compared to MICT.

METHODS: Patients enrolled on an ERS (Liverpool, United Kingdom) were recruited for a pragmatic trial. Participants self-selected either 12 weeks of MICT (45-135 min/week at 50-70% HRmax) or Home-based HIIT (4-9 min × 1 min intervals at ≥80% of HRmax, interspersed with 1 min rest). The primary outcome was change in CRF (VO2 peak) at follow-up (3-month post intervention), using intention-to-treat analysis. Secondary outcomes included blood pressure, body composition (DXA) and insulin sensitivity. An online survey, using open ended questions exploring feasibility and acceptability of Home-based HIT, analysed using a framework approach, was completed post-intervention to explore patient experiences.

RESULTS: 154 participants (age 48 ± 10y; BMI 30.5 ± 6.1 kg/m2) were recruited between October 2017 and March 2019, 87 (56%) participants chose Home-based HIIT and 67 (44%) MICT. VO2peak increased post-intervention in both groups (MICT 3.9 ± 6.0 ml.kg-1.min-1, Home-based HIIT 2.8 ± 4.5 ml.kg-1.min-1, P < 0.001), and was maintained at follow-up (P < 0.001). Fat mass was only reduced post MICT (MICT -1.5 ± 6.3 kg, P = 0.010, Home-based HIIT -0.2 ± 2.0 kg, P = 1.00), but the reduction was not maintained at follow-up (MICT -0.6 ± 5.1 kg, P =0.684, Home-based HIIT 0.0 ± 2.2 kg, P = 1.00). Adherence to the prescribed programs was similar (MICT 48 ± 35%, Home-based HIIT 39 ± 36%, P = 0.77). Qualitative perceptions of Home-based HIT were generally positive, especially its convenience. Interestingly, family providing social support during Home-based HIIT was perceived as a facilitator to adherence.

CONCLUSION: This is the first study to evaluate the use of Home-based HIIT for at-risk individuals enrolled in an exercise referral scheme. Contrary to our hypothesis adherence was poor regardless of exercise prescription. Despite this, CRF improved to a similar extent in both groups and was maintained at 3-month follow-up. We provide evidence that, although not superior, Home-based HIIT could be an effective and popular additional exercise choice for patients within primary care based ERS.

IMPACT OF A 12-WEEK HIGH-INTENSITY INTERVAL TRAINING SCHEME ON CARDIAC STRUCTURE AND FUNCTION AFTER COVID-19

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CENTRE FOR PHYSICAL ACTIVITY RESEARCH

INTRODUCTION: A large proportion of patients suffer from a persistent reduction in cardiorespiratory fitness after recovery from COVID-19, of which the effects on the heart may potentially be reversed through the effect of high-intensity interval training (HIIT).

METHODS: 28 patients recently admitted to hospitals for COVID-19 were recruited for this investigator-blinded randomized study with a 12-week intervention. Patients were block-randomised to either supervised HIIT exercise group (4x4 minutes, three times a week, n=xx) or standard care (control group, n=xx=). Patients underwent cardiac magnetic resonance imaging scan and a maximal oxygen consumption test (VO2max). The continuous outcomes were analyzed using constrained baseline longitudinal analyses via linear mixed models.

RESULTS: A total of 28 patients were included (HIIT: 58±11 years, 4 females; standard care: 57±9 years, 5 females), LVM increased in the HIIT vs. standard care group with a between-group difference of 6.8 g [95%CI: 0.8; 12.8, ; p=0.029]. Relative VO2peak increased in both groups, by 6.17 mL/kg/min [95% CI: 3.56 to 8.79] (p<0.001) in the HIIT group and by 3.08 mL/kg/min [95% CI: 0.12, 6.04, p=0.042]in the standard care group, with no between-group difference (p=0.11).

CONCLUSION: HIIT is an efficacious rehabilitation tool that specifically targets the heart by increasing LVM in patients previously hospitalized for COVID-19.

IMMUNE RESPONSES TO ACUTE UPPER AND LOWER BODY HIGH-INTENSITY INTERVAL EXERCISE.

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INTRODUCTION: A single bout of acute exercise drives a dynamic immune response, which over time may lead to increased immunosurveillance and a lower risk of chronic disease. Prior research indicates that the immune response to moderate-intensity upper-body exercise is diminished in comparison to lower-body exercise. The aim of this randomised crossover study was to compare immune cell responses to acute bouts of upper-body and lower-body high-intensity interval exercise (HIIEUB & HIIELB) and low-to-moderate intensity leg-cycle exercise matched to the absolute upper-body workload (LIIEmatched).

METHODS: Twelve participants (n=9 male and n=3 female, 23±3yrs, 77.1±12.5kg) performed exercise bouts (HIIEUB, HIIELB, LIIEmatched) in a randomised order after performing arm-crank exercise familiarisation sessions and two graded cardiopulmonary exercise tests (CPETs) on each ergometer. For all conditions, participants completed 6x3-minute intervals interspersed with 5x3-minute recovery intervals. Indirect calorimetry was measured throughout each trial. Venous blood was drawn at baseline and immediately post-exercise. Immune cell concentrations were quantified using a haematology analyser and flow cytometry. Data was analysed using a linear-mixed model and are expressed as mean±SD

RESULTS: Peak oxygen uptake (VO2peak) and peak power output (PPO) assessed during the CPETs were significantly higher (P <.001) with leg (40.8±6.5ml/kg/min; 243±54W) compared to arm exercise (32.8±5.7ml/kg/min; 135±28W). The fold change from baseline to post-exercise in lymphocyte concentrations were 0.86±0.50 (HIIEUB), 1.66±0.93 (HIIELB) and 0.20±0.25 (LIIEmatched). Post-hoc comparisons indicated that these fold changes following HIIELB were significantly higher than those following HIIEUB (P=.005) and LIIEmatched (P=.001). Additionally, more detailed phenotypic analysis identified that fold change of CD56dim natural killer cells from baseline to post-exercise was significantly higher in HIIELB (7.38±3.40) compared to HIIEUB (3.96±2.07, P=.002) and LIIEmatched (2.92±1.71, P<.001). HIIEUB was not significantly different to the LIIEmatched trial (P=.576). The fold change in neutrophil numbers were 2.44±1.00 (HIIEUB), 3.61±1.96 (HIIELB) and 0.92±0.56 (LIIEmatched). There were no significant differences between HIIEUB and HIIELB in fold change of neutrophils, however, LIIEmatched was significantly lower compared to both HIIEUB (P=.021) and HIIELB (P<.001).

CONCLUSION: Results indicate greater acute lymphocyte and natural killer cell responses with leg exercise compared to arm exercise at the same modality-specific relative intensity (%Wmax). These findings may have implications for individuals with a lower-body disability who are reliant on performing upper-body exercise to mitigate the risk of chronic diseases. Further research should identify whether there are limb-specific differences in acute and chronic immune cell responses before extrapolating findings from leg-cycle ergometry research to specific clinical populations.

COMPARING THE EFFECTS OF A 12-WEEK MODERATE INTENSITY CONTINUOUS TRAINING AND HIGH-INTENSITY INTERVAL TRAINING PROGRAM ON ANXIETY, DEPRESSION, AND SLEEP QUALITY AMONG PATIENTS WITH ATRIAL FIBRILLATION

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INTRODUCTION: Atrial fibrillation (AF) is the most common sustained cardiac arrythmia and is associated with poor mental health (e.g., anxiety and depression) and sleep quality (i.e., insomnia [persistent difficulties in initiating or maintaining sleep]). Among those with AF, moderate-to-vigorous intensity continuous training (MICT) has been shown to improve mental health; yet, whether these improvements may be related to changes in sleep quality is unknown. High-intensity interval training (HIIT) has shown promise for reducing the frequency and intensity of AF symptoms; however, its effectiveness in improving anxiety, depression, and sleep quality compared to MICT remains unclear.

METHODS: A single-centre RCT was conducted. Patients with persistent and permanent AF were randomized (1:1) to either MICT or HIIT. The Hospital Anxiety and Depression Scale (HADS) and the Insomnia Severity Scale (ISI) were administered in a subset of participants (n=58) at baseline and within one week of completing the 12-week exercise interventions. Exercise protocols were completed twice weekly. MICT included aerobic conditioning for 60 minutes (including a 10-15 min warm-up and 15-min cool-down) at intensities within 67-95% of peak heart rate (HR). HIIT included 2x8 minute interval training blocks of 30-second work periods at 80-100% of peak power output interspersed with 30-second active recovery periods (16-minute conditioning phase), and 4 minutes of recovery between the blocks. A repeated measures ANOVA was performed to determine differences over time between groups in the HADS and ISI. Chi-square analyses were used to compare the proportion of patients meeting the MCID for the HADS (i.e., 1.7 points) between groups. Linear regressions were used to test if baseline ISI scores significantly predicted HADS-A and HADS-D scores at 12-weeks.

RESULTS: Of the 58 participants, 49 (MICT=27; HIIT=22) had complete data. No significant differences over time were observed between the groups for the HADS-A (p=0.558) or HADS-D (p=0.555). A significantly greater proportion of those in the MICT than HIIT group experienced clinically meaningful changes in the HADS-A (33% vs. 27%, $\chi 2$=0.93, p=0.006) and HADS-D (33% vs. 27%, $\chi 2$=0.93, p=0.006). No significant differences over time were observed between the groups for the ISI (p=0.271). The ISI scores were found to significantly predicted HADS-D values (β=0.09, p=0.011).

CONCLUSION: Among patients with AF, 12-weeks of exercise training led to clinically meaningful reductions in anxiety and depression severity scores, with the greatest improvements observed following MICT. Sleep quality was a significant predictor of depression severity among patients with AF. Poor mental health and sleep quality are frequently observed

among patients with AF, thus, future research is implored to more thoroughly understand the role of exercise training on these health outcomes to improve the management of this burgeoning clinical population.

TWELVE WEEKS OF ENDURANCE AND CONCURRENT TRAINING IMPROVE VO2PEAK, HEALTH-RELATED QUALITY OF LIFE, FATIGUE AND SYMPTOMS IN SUBJECTS WITH LONG-COVID – A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Post-Covid-19, commonly known as Long-Covid (LC), is defined as the presence of long lasting (>12 weeks) Covid-19 symptoms, that cannot be attributed to an alternative diagnosis. Current data suggests a prevalence of up to 34% in non-hospitalized Covid-19 survivors. Thus, the disease imposes a burden on healthcare systems around the globe. Exercise, which has been established as an effective rehabilitation measure for similar conditions, might be beneficial to affected individuals. We therefore hypothesized that physical training increases various health-related outcomes and decreases symptom quantity and severity in non-hospitalized subjects with LC.

METHODS: Forty-six individuals, which did not show any contraindications for physical training and presented at least one LC symptom, according to a list of the National Institute of Healthcare and Excellence, were randomized to two training groups, consisting of either twelve weeks of endurance (ET) or concurrent training (CT) or a non-exercising control group (CG). Thirty participants (23 females and 7 males; 41±13 yrs; n=8 for ED, n=10 for CT and n=12 for CG) completed the study. VO2peak, health-related quality of life (HQoL; RAND SF-36), fatigue severity (FSS) and the number of symptoms were assessed at baseline (T0) and after the intervention or control period (T1). A one-way ANOVA and Tukeys multiple comparisons test were performed to detect differences in mean changes of variables. Paired samples t-test (or a non-parametric alternative) was used to detect differences in means (T0 vs. T1) for each group. Statistical significance was accepted at a level of $p<0.05$.

RESULTS: VO2peak (ml/min/kg) increased significantly from 30.1±6.9 to 34.6±8.1 in ET ($p<0.001$) and from 29.6±5.7 to 32.8±5.8 in CT ($p=0.002$), when comparing timepoints via the paired samples t-test. The ANOVA followed by post-hoc analysis revealed significantly greater changes in VO2peak in ET ($p<0.001$) and CT ($p=0.012$), compared to CG. In all groups, significant increases from T0 to T1 in several subscales of the SF-36 were found. However, only in the subscale "Social functioning" significantly greater changes occurred in ET ($p=0.004$) and CT ($p=0.022$). Fatigue severity scores decreased from 5.1±0.7 to 3.8±1.5 ($p=0.005$) and 4.7±0.8 to 3.8±1.2 ($p=0.007$) in ET and CT, respectively. The average number of symptoms observed at T0 decreased significantly in both ED (from 4.6±2.9 to 2.1±2.1; $p=0.01$) and CT (from 4.6±2.2 to 2.6±1.6; $p=0.019$) at T1. No differences in changes were revealed by the ANOVA for both variables. There were no significant improvements in VO2peak, FSS or the number of symptoms in CG.

CONCLUSION: Participants affected by LC showed improvements in VO2peak, HQoL, fatigue severity and the number of symptoms after 12 weeks of ET and CT, compared to a non-exercising control group. Descriptive data suggests slightly greater enhancements for ET. However, further research is required to support these findings.

Oral presentations

OP-MH04 Metabolic Syndrome and Neurological Disease

EFFECT OF DIFFERENT EXERCISE MODALITIES ON SKELETAL MUSCLE ANGIOGENIC MARKERS IN ADOLESCENT MALES WITH TYPE 1 DIABETES MELLITUS

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INTRODUCTION: Type 1 Diabetes Mellitus (T1DM) patients can start developing micro- and macro vascular complications during childhood (1) and are known to have vascular impairments such as endothelial dysfunction, vessel stiffness and reduced capillary density (2). Angiogenesis is the formation of new blood vessels from existing ones and is well documented to occur in healthy individuals in response to various exercise modalities (3). In T1DM however, angiogenesis can be altered and studies on exercise induced angiogenesis in adolescents with T1DM are lacking. The aim of this study was to compare the effects of three different exercise modalities on molecular markers of angiogenesis in skeletal muscle of adolescent males with T1DM.

METHODS: Eight adolescent males (17.5 ± 0.8 years) with T1DM duration >1year attended four sessions, namely a control session followed by exercise tests (VO2max, 1RM) and three randomized exercise sessions (Continuous Exercise (CE), Intermittent Exercise (IE) and Strength Exercise (SE)). One hour after exercise and control a muscle biopsy was taken from the vastus lateralis muscle. RNA was extracted from the sample, followed by one colour microarray-based gene expression analysis as well as enrichment analysis of differentially expressed genes for biological processes and Kyoto Encyclopedia of Genes and Genomes (KEGG) pathways.

RESULTS: Biological Processes related to angiogenesis (blood vessel development, angiogenesis, blood vessel endothelial cell migration, cell migration involved in sprouting angiogenesis) were highlighted following all three exercise modalities, with no exercise specific response being observed. A total 7 KEGG pathways were highlighted across all the conditions,

with AGE-RAGE signaling in diabetic complications as well as Fluid shear stress and atherosclerosis pathways including angiogenesis.

CONCLUSION: In skeletal muscle of adolescent males with T1DM, CE, IE and SE all elicited acute angiogenic response. Analysis of KEGG pathways provide some insight into interplay of other factors in angiogenic signaling in T1DM skeletal muscle.

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NO EFFECT OF 12 WEEKS OF AEROBIC TRAINING ON METABOLIC FLEXIBILITY IN OVERWEIGHT MEN WITH AND WITHOUT TYPE 2 DIABETES

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INTRODUCTION: Metabolic flexibility, reflected by the change in respiratory exchange ratio from fasting to an insulin-stimulated state (deltaRER) (1), is the ability to switch from oxidation of predominantly fat to carbohydrates, which is impaired in patients with type 2 diabetes (T2D) (2,3). Exercise is known to improve deltaRER in T2D patients (4). However, most studies perform a euglycemic clamp ([glucose] at ~5mM), which does not represent a habitual glycemic state of T2D. Therefore, we investigate metabolic flexibility during an isoglycemic clamp ([glucose] at the usual level for the individual) in this ongoing study. We hypothesize 1) T2D are less metabolic flexible than healthy matched controls (CON), 2) aerobic training will increase deltaRER in T2D patients.

METHODS: Five male T2D (age 48±6 yrs, BMI 34.8±3.4 kg/m2, HbA1c 70±28 mmol/mol, T2D duration 3.0±2.5 yrs) and six matched male CON (age 50±6 yrs, BMI 36.9±3.1 kg/m2, HbA1c 36±5 mmol/mol) completed a 12-week aerobic training intervention (3x/wk, 45min at 70% of heart rate reserve). Before and after training (T), metabolic flexibility was measured in the 12hr fasting state, using indirect calorimetry (ventilated hood, Q-NRG, COSMED, Italy) at basal and during insulin infusion at medium (40) and high (400 mU/min/m2) infusion rates during the isoglycemic clamp. Maximal oxygen uptake (VO2max) was measured (Quark CPET, COSMED, Italy) before and after the intervention. Results are mean ± SD. Two-way ANOVA and paired t-test was used for testing

RESULTS: T2D and CON improved their VO2max significantly after the intervention (2.8±0.7 to 3.6±0.9 L/min (p=0.003) and 3.2±0.5 to 3.7±0.4 L/min (p=0.04), respectively). Basal RER did not change with training (0.85±0.10 and 0.83±0.04 (before) to 0.81±0.04 and 0.83±0.05 (after) in T2D and CON, respectively) and was similar in T2D and CON. RER did not increase significantly with medium insulin infusion rate compared to basal state before or after training (p=0.95 and p=0.89, in T2D and CON, respectively (data not shown)). However, in both groups, RER increased significantly with the high insulin infusion rate (T2D: 0.85±0.10 to 0.99±0.12 (before T) 0.81±0.04 to 0.98±0.07 (after T) (p=0.0001); CON: 0.83±0.04 to 0.92 ±0.05 (before T) and 0.83±0.05 to 0.92±0.06 (after T) (p<0.0001)) compared to the basal state. The increase in RER with high insulin was significantly higher in T2D compared with CON (p=0.023). However, training did not change deltaRER in T2D (p=0.62) or CON (p=0.79).

CONCLUSION: Preliminary results showed no effect of training on metabolic flexibility in neither T2D nor CON. However, our results showed that deltaRER in T2D was significantly higher compared to CON, indicating that the T2D patients are metabolic flexible. This is at variance with other studies and is explained by eu- vs. isoglycemic clamping.

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ERGOGENIC EFFECTS OF INVASIVE AND NON-INVASIVE SPINAL CORD STIMULATION STRATEGIES FOLLOWING SPINAL CORD INJURY: A CASE-SERIES

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INTRODUCTION: Individuals with a cervical or upper-thoracic spinal cord injury (SCI ≥T6) typically exhibit impaired exercise responses due to disrupted supraspinal sympathetic control of the cardiovascular (CV) system, which results in reduced peak heart rate (HR), low blood pressure (BP), reduced venous return and thus stroke volume (SV). Epidural spinal cord stimulation (ESCS) has demonstrated an improvement in CV control, with a subsequent increase in aerobic capacity. How-

ever, this surgical procedure is expensive and invasive. This study compared the effects of ESCS and transcutaneous spinal cord stimulation (TSCS) (an affordable, non-invasive alternative strategy) on modulating CV control and submaximal upper-body exercise performance [time to fatigue (TTF)] in individuals with SCI.

METHODS: Participants had a chronic (>1yr), motor-complete SCI. Two had an implanted epidural stimulator [P1 (59 yrs, T4 injury); P2 (24 yrs, C6 injury)], and two without an implant received TSCS [P3 (54 yrs, T4 injury); P4 (40 yrs, T4 injury)]. A mapping session was conducted to manipulate specific stimulation parameters (frequency, intensity, epidural electrode configuration, transcutaneous electrode locations in the lumbosacral region) until an optimal, sustained elevation in BP was elicited (CV-SCS). A sham condition (SHAM-SCS) was included as a comparison. A graded arm-crank ergometry exercise test identified peak oxygen uptake ($\dot{V}O_2$peak) and ventilatory threshold (VT). Following a familiarisation trial, participants exercised to fatigue at a fixed workload corresponding to above their VT on two separate occasions (>3 days recovery), with CV-SCS or SHAM-SCS. HR and gas exchange variables were recorded throughout. BP was monitored before (pre-post applying stimulation) and immediately post-exercise. Rating of perceived exertion (RPE) was determined every 5 min.

RESULTS: CV-SCS increased TTF with both ESCS [P1 (Δ11min 47s); P2 (Δ19min 11s)] and TSCS [P3 (Δ16min 28s); P4 (Δ17min 49s)], relative to SHAM-SCS. Relative to baseline, change in systolic BP at rest was greater with the application of CV-SCS in comparison to SHAM-SCS with ESCS [P1 (Δ11 vs 2 mmHg); P2 (Δ12 vs -1 mmHg)] and TSCS [P3 (Δ17 vs 4 mmHg); P4 (Δ24 vs 13 mmHg)]. Peak oxygen pulse, a reasonable surrogate for SV, was greater with CV-SCS in ESCS [P1 (Δ1.7 mL/beat); P2 (Δ2.4 mL/beat)] and TSCS [P3 (Δ0.8 mL/beat); P4 (Δ2.5 mL/beat)], relative to SHAM-SCS. RPE also tended to be lower with CV-SCS than SHAM-SCS at each corresponding timepoint during the trials.

CONCLUSION: This case-series demonstrates that both ESCS and TSCS improve submaximal upper-body exercise performance, determined via TTF, in individuals with SCI. CV-SCS modulated BP and peak oxygen pulse by seemingly increasing supraspinal sympathetic output to the vasculature to improve exercise performance. While further research is necessary, these data suggest TSCS is as effective as ESCS as an ergogenic aid and could be used to support exercise rehabilitation in this population.

FEASIBILITY OF INTEGRATING AN EXERCISE SPECIALIST SUPPORTED BY MHEALTH TECHNOLOGY TO INCREASE EXERCISE AND PHYSICAL ACTIVITY IN AN ADOLESCENT COMPLICATIONS FROM EXCESS WEIGHT SERVICE: MOTIVATE-CEW

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INTRODUCTION: To address the increasing prevalence of complications associated with severe childhood obesity, NHS England has established 21 Complications of Excess Weight (CEW) services. Despite physical activity (PA) and exercise forming cornerstones of successful weight management programmes, CEW services may not have the capacity to include specialists in their delivery. We propose the inclusion of mHealth (mobile health) technologies could assist specialists with the prescription and long-term monitoring of PA and exercise in CEW services. The aim of the study was to assess the feasibility of embedding an exercise specialist led, mHealth supported, PA and exercise intervention (MOTIVATE-CEW) to a CEW service.

METHODS: A 12-week feasibility, parallel group, randomised control trial was conducted in 23 adolescents with obesity (m/f n=10/13, age 15±1y, SDS BMI 3.54±0.54) receiving care from the Alder Hey Children's Hospital (AHCH) CEW service. Participants were randomised to usual care (UC, n=11) or UC plus MOTIVATE-CEW (n=12). UC involved the development of an individualised care plan with a multidisciplinary team. Participants receiving MOTIVATE-CEW co-designed a personalised and progressive exercise and PA programme alongside an exercise specialist. The intervention was facilitated by mHealth technologies (smart watch, mobile app and coach's platform) which enabled remote exercise sessions and feedback to be guided by biometrics. A mixed method process evaluation assessed reach, dose and fidelity, and preliminary effectiveness was measured (health related quality of life (HRQOL), body composition and cardiovascular disease risk factors).

RESULTS: 45% of eligible participants were recruited and 87% completed post-intervention assessments. Recruited participants shared similar demographics to the AHCH CEW service cohort in terms of age, sex, and deprivation. Large effect sizes favouring MOTIVATE-CEW were observed for the number of exercise sessions completed per week (MOTIVATE-CEW 2±2, UC 0±0; d=1.02) and time spent completing moderate-to-vigorous intensity exercise per week (MOTIVATE-CEW 97±127 mins, UC 5±12 mins; d= 1.01), captured through an optical heart rate monitor. Qualitative perceptions of MOTIVATE-CEW were positive, key facilitators included regular personalised advice from an exercise specialist and the creation of graded action plans with specific behavioural goals. Data availability for in-clinic outcomes was good (≥85%). Preliminary evidence of moderate-to-large effects in favour of MOTIVATE-CEW were observed for HRQOL (EQ-5D-Y visual analogue scale score; d=0.80), HDL cholesterol (d=0.67) and triglycerides (d=0.62).

CONCLUSION: The MOTIVATE-CEW intervention demonstrated positive effects on exercise behaviour, suggesting that the addition of exercise specialists supported by mHealth technologies to CEW services would be an effective strategy to improve engagement in exercise and PA. Good reach and data availability suggests this study design is feasible for future trials.

EVALUATING A SPORT AND EXERCISE INTERVENTION ON METABOLIC SYNDROME, PAIN, COGNITIVE FUNCTION AND CARDIORESPIRATORY FITNESS AMONG FORCIBLY DISPLACED ADULTS. A RANDOMIZED CONTROLLED TRIAL

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UNIVERSITY OF BASEL

INTRODUCTION: Global challenges such as armed conflict or natural disasters have forced many people to leave their homes and led to a doubling of displacements in the past ten years [1]. Those affected face severe physical strain before, during, and after their flight. Unsurprisingly, an increased risk for physical health complaints among forcibly displaced adults has been reported compared to the general population [2]. These challenges can further result in functional restrictions that affect the individuals well-being and pose a barrier for social integration [3]. The present study aimed to examine the effects of a sport and exercise intervention on metabolic syndrome, pain, cognitive function, and cardiorespiratory fitness.

METHODS: One-hundred and forty-two adults (75 women, mean age = 29.2) living in a refugee camp in Greece were randomly assigned by housing units to an intervention (n=74) and a wait-list control group (n=68). Sport and exercise activities (e.g., ball sports, strength training) were implemented five times a week (60 minutes) over ten weeks. The intervention was co-designed with the participants to consider contextual and culturally specific conditions and interests. Metabolic syndrome risk markers (waist circumference, fasting plasma triglycerides, HDL-C, HbA1c, and blood pressure) were assessed and standardized to calculate a continuous metabolic syndrome score. Pain in different body regions (head, back, chest, abdomen, extremities) was measured using a visual analog scale. The Oddball paradigm and the Flanker task were used to assess attention and inhibition. Finally, cardiorespiratory fitness was measured with the (submaximal) Åstrand-Rhyming Test.

RESULTS: A total of ninety-two (64.8%) participants completed the post-assessment. Twenty (40.8%) individuals met the recommendation and attended two or more sessions per week. After performing ANCOVA and controlling for baseline values, we found evidence that VO2max increased more in the intervention group than in the wait-list control group after the 10-week intervention trial (B = 4.05, 95 % CI: 0.74; 7.35, p = 0.017). No statistically significant changes were found for metabolic syndrome, pain, and cognitive functions. However, in hierarchical regression, higher attendance rates predicted lower pain scores and waist circumference at post-intervention.

CONCLUSION: The study points out that regular participation in sports and exercise programs is central to the effectiveness of the intervention. Therefore, research into measures to maintain compliance is needed.

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Oral presentations

OP-SH16 Rating of perceived exertion

AN EXPLORATORY ANALYSIS OF TRIMP, RUNNING SPEED, AND SESSION RPE AS TRAINING LOAD FORMULAS IN A SAMPLE OF 596 DISTANCE RUNNERS.

MORIO, C., PETOT, H.

DECATHLON SPORTSLAB

INTRODUCTION: Training load is a crucial aspect of the training process, as it can significantly impact the runners performance and risk of injury. Notably, the TRaining IMPulse (TRIMP) formula used heart rate (HR) to estimate an athlete's internal load (1). The advent of GPS technology allowed for measuring the external load based on speed or running distance. Finally, the session RPE (sRPE) is supposed to represent the global perceived load (2). This study aims to compare the outputs of these training load formulas in running, as well as the other variables closely related like average HR, distance, and duration.

METHODS: We extracted a sample of specific training sessions from an app where runners provided their RPE after each training log. The HR and GPS data were collected by the runners' own devices. After removing outlier data (speed: [6-30]km/h, age: [18-75]years, maximal aerobic speed (MAS) : [10-25]km/h, elevation: <0.5% of average slope), the different training load formulas were computed. The internal load was estimated using the average HR (in absolute and in %HRreserve) and the TRIMP formula (1). The external load was estimated using the total duration and distance, the average speed (in absolute and in %MAS) and a TRIMP like formula (TRIMPV) with the %MAS replacing the %HRR from the original formula (3). The perceived load was expressed in both absolute RPE and sRPE (2). First, an exploratory principal component analysis (PCA) and a correlation matrix analysis were performed on the 10 training load variables. Then, general linear models were applied between TRIMP, TRIMPV and sRPE, where slope, bias, r^2 and RMSE were calculated.

RESULTS: 5486 running sessions from 440 males and 156 females (age: 40.6±8.9yo; mass: 72.1±11.1kg; Stature: 175.2±9.0cm; BMI: 23.4±2.7; MAS: 14.8±2.2 km.h-1) were analyzed.

The PCA reveals that 90% of the variance of training variables could be explained by 4 principal components which could be closely linked to duration, HR, Speed, and RPE, respectively.

As expected with such a large sample size, 39 out of 45 correlations were significant (p<.001) but only 11 presented very large effect sizes (r>.7), among those TRIMP, TRIMPV, and sRPE were correlated to each other.

The linear model between TRIMP and TRIMPV presented a slope of 0.98 and a bias of 9.4% with r2=.59. The linear model with sRPE presented a slightly higher bias 12.1% and 15.0% and lower r2 .54 and .50 with TRIMP and TRIMPV, respectively. RMSE values ranged between 37.1% and 45.3%.

CONCLUSION: The different training load formulas could be to some extent interchangeable for global usage and general comparison purpose. However, the moderate r2 and high RMSE values, associated with the PCA results confirm that these different formulas actually provide complementary information on different aspects of the running training load.

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2) Foster, Med Sci Sport Exerc, 1998

3) Emig & Peltonen, Nature Com, 2020

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CRITERION VALIDITY OF A NEW RPE SCALE TO ASSESS THE PSYCHOLOGICAL LOAD OF PHYSICAL TRAINING

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INTRODUCTION: Mellalieu et al. have proposed a theoretical framework that identifies 3 main sources of psychological load in athletes: a) training and performance, b) organization, and c) personal (1). Previous studies have proposed the use

of scales such as differential rating of perceived exertion (RPE), or the NASA-TLX questionnaire as instruments to measure the different components of workload with respect to the training session or the task performed. The purpose of this pilot study was to investigate the feasibility and criterion validity of two new RPE scales that separate the psychological load of a training session from the physical one.

METHODS: 53 athletes from a variety of sports were recruited for this study. Participants filled out a questionnaire and 5 unidimensional scales 30 minutes after one of their regular physical training sessions. The questionnaire consisted of some questions about personal details, practiced sport, training experience, and the content of the training just performed. After completing the questionnaire, participants rated how hard the training session was overall using the RPE CR10 scale modified by Foster (2) (O-RPE). Afterwards, participants rated their training according to the following four scales presented in random order: the physical demands and the mental demands subscales of the NASA-TLX questionnaire (criterion measures), and 2 differentiated ratings (physical and mental) of the RPE CR10 scale modified by Foster (2). For the Physical-RPE, participants were asked to rate the muscular and/or respiratory effort required by the training session. For the Mental-RPE, participants rated how demanding the training session was in terms of attention, concentration, learning. memory, emotion and motivation required by the training session. An exploratory analysis was conducted using Spearmans rank correlation test.

RESULTS: The Mental-RPE scores were highly correlated with the NASA mental demand scores (rho=0.80,p<0.001) whilst the Physical-RPE scores were highly correlated with the NASA physical demand scores (rho=0.83,p<0.001). There was also a significant correlation between the Mental-RPE scores and the Physical-RPE scores (rho=0.75,p<0.001). All the NASA and differentiated RPE scores correlated significantly with the O-RPE scores (rho=0.75-0.87,p<0.001).

CONCLUSION: The new differentiated RPE scales were feasible within a field setting. The high correlations with the NASA scales provide preliminary evidence of criterion validity of both the Mental-RPE and the Physical-RPE scales. Because hard physical training can pose significant psychological demands, the high correlation between the Mental-RPE scores and the Physical-RPE scores may be expected. Therefore, further research is required to assess the discriminant validity of these two new scales in the context of training with more varied demands (e.g. physical vs technical/tactical training sessions).

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A META-ANALYSIS OF THE CRITERION-RELATED VALIDITY OF SESSION-RPE SCALES IN ADOLESCENT ATHLETES

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INTRODUCTION: Progressively increasing the training load (TL) is one of the keys to improving athletic performance. Due to the close association between excessively high training volumes and the occurrence of injuries among youth athletes, TL monitoring is particularly pertinent. s-RPE is a more straightforward, non-invasive, and inexpensive method for TL monitoring meanwhile it can monitor the internal load. As this approach has been used and validated in a wide variety of sports and strength and conditioning programs for adults, there may be some limitations when applied to children and adolescents. The objective of this study was to establish the criterion-related validity of the s-RPE method in adolescent athletes.

METHODS: According to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines, a meta-analysis (PROSPERO ID: CRD42022373126) was performed. Eight databases using the following terms: ('s-RPE' OR 'Rating Perceived Exertion session' OR 'RPE session' OR 'RPE' OR 'Rate of Perceived Exertion' OR 'Rated of Perceived Exertion') AND ('Adolescen*' OR 'Youth*' OR 'Teen*') AND ('validity' OR 'correlation' OR 'concurrent validity') were searched up to 2022. Articles meeting the inclusion criteria were screened and adopted the "Methodological Index for Non-Randomized Studies (MINORS)" to evaluate the risk of bias. The certainty of evidence was rated using the GRADE PRO. The relationships between s-RPE and TRIMP were computed using correlation coefficient (r values) and Fishers r-to-z. A 95% confidence interval (95% CI) was reported and the significance level was set at $p<0.05$.

RESULTS: An initial 1798 studies using the s-RPE method were identified and finally, a total of 16 studies were included for further analysis. The exercise modality included 7 team sports and 4 individual sports. The bias scores indicated that all studies were classified as having a low risk of bias. GRADE Pro approach suggested that the authors are highly confident in the association. A total of 15 studies evaluated the correlation between CR-10 and heart rate, involving 170 athletes, while a total of 3 studies evaluated the correlation between CR-100 and HR, involving 108 athletes. A strong to very strong correlation between s-RPE and HR was observed (overall: r=0.74; CR-10: r=0.69; CR-100: r=0.80). CR-100 scale (Fisher's z=1.09) was shown to have a higher criterion validity than that of the CR-10 scale (Fisher's z=0.85).

CONCLUSION: Preliminary findings showed that s-RPE using either CR-10 or CR-100 scales can be valid tools for monitoring internal training load for children and adolescent athletes. Considering the superior benefits of s-RPE and high criterion validity with HR measures, coaches can use it as a "stand-alone" tool for global internal TL monitoring. Future studies should focus on whether CR-100 could better perform than CR-10 for junior and children athletes in different age groups and sports as well as the causes leading to potential scoring biases.

Oral presentations

OP-AP34 Football: Sleep

IS AEROBIC PERFORMANCE AFFECTED BY SLEEP AND CHRONOTYPE IN YOUNG SOCCER PLAYERS?

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INTRODUCTION: The phenotypic expression of circadian rhythms can be defined as Chronotype (CT). People can be classified into three major typologies: Morning-type (M-type), Neither-type (N-type) and Evening-type (E-type). M-types tend to perform better in the morning, while E-types in the evening (Ayala 2017). This difference seems closely correlated to the diverse sleep pattern of the 3 CTs. It has been observed that bad sleep habits tend to worsen physical performance, expecially in endurance and prolonged exercises (Fullagar 2015). Although a substantial body of literature has explored the relationship between sleep, chronotype and physical exercise, it is still unclear the impact that such chronobiological variables have on specific sports, populations and types of performance. Therefore, in this study we wanted to assess the agility, strength and endurance in young soccer players in relation to their sleep quality and chronotype.

METHODS: 58 young male soccer players, aged between 13 and 19 years, were recruited from a non-professional team. They were asked to compile the Morningness - Eveningness Questionnaire (MEQ) and the Mini-Sleep Questionnaire (MSQ), to assess respectively the CT and sleep quality. The physical trial was performed in the morning, at 8:30 AM, and in the evening, at 6:00 PM. Both sessions included three tests to determine agility, carried out by the Illinois Agility Test, strength, assessed by the Sargent Jump Test, and endurance, estimated by the 6 Minutes Run Test (6MRT).

RESULTS: The total sample (n = 58; age = 15.16 ± 1.73; BMI = 20.61 ± 2.24) was classified by CT as M-types (n = 11), N-types (n = 29) and E-types (n = 18). Furthermore, the subjects were categorized as Good Sleepers (GS, n = 28) and Bad Sleepers (BS, n = 30).

The repeated measures ANOVA showed a statistically significant difference in the comparison between the 3 CTs in the 6MRT ($p < 0.001$): M-types performed better in the morning ($p = 0.01$), while E-types in the evening ($p < 0.001$). Paired t-test reported that GS performed better than BS ($p = 0.019$) in the 6MRT in the PM session.

CONCLUSION: As regards the effect of CT on physical performance, the results of the present study underline the difference in aerobic power between M- and E-types during the morning and evening session. Furthermore, BS performed worse than GS in the PM session of the 6MRT. Our findings fit well with the actual literature on soccer player performance and sleep, as our data showed a significant effect of sleep on aerobic power, but not on strength and agility. Aerobic performance in soccer player can be crucial, and the small differences displayed by this study can separate success and defeat.

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SLEEP DURING A TRAINING CAMP IN ELITE ADULT FEMALE SOCCER PLAYERS

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INTRODUCTION: In recent years, the growing interest in understanding how athletes sleep has boosted the number of scientific studies on the topic.1 Elite athletes, including female soccer players, often spend nights in unfamiliar hotel environments, before home and away matches, and during training camps that may affect sleep habits.2 In this scenario, optimizing recovery through sleep is required to reduce the risk of transitioning into a state of excessive fatigue as well as to reduce the risk of injuries.1 Thus, this study aimed to describe sleep characteristics in elite adult female soccer players during a training camp for a National team.

METHODS: Twenty-five elite adult female soccer players (aged 25.4 ± 2.3 years; mean ± SD) participated in the study. Sleep variables were measured using wrist actigraphy and sleep diaries during eight consecutive days (i.e., 6-days with training sessions, and 2-days with matches). Salivary melatonin and cortisol were also measured to access objective sleepiness and alertness on the second and third days of the training camp. Training and match loads were characterized using a global positioning system.

RESULTS: During the eight nights, 8 to 25 players slept less than <8 h, and 10 to 25 players had a sleep efficiency of < 80% in two or more days of the training camp. No significant differences ($p<0.05$) were found between days with training sessions vs. matches for sleep duration (mean [minimum; maximum], 7.9 [5.3;9.2] vs. 7.9 [4.9;10.1] hours, respectively) and sleep efficiency (87 [60;98] vs. 88 [71;98] %, respectively). Self-rate sleep quality (0 "bad" to 10 "excellent") was 7 (1;10) arbitrary units (median [minimum; maximum]). Mid-point of unrestricted sleep was 4.1 (2.3;5.3) hours (i.e., 1 player has characterized as slightly early; 18 players as intermediate, and 6 players as slightly late chronotype). Salivary melatonin measured before sleep was 15 (1.1;332.9) pg/mL, and cortisol measured upon awakening was 15 (6.1;24.9) ng/mL, throughout the second and third days of the training camp. Salivary melatonin and cortisol amplitude were 58.2 (8.3;486.1) pg/mL

and 15 (4.7;23.4) ng/mL, respectively, throughout the second and third days of the training camp. Individually, exposure time, total distance covered, and high-speed running (15.6–23km.h-1) during training sessions were 64 (55;76) min, 3749 (1141;6358) m, and 81 (11;151) m, respectively. During matches, exposure time, total distance, and high-speed running were 59 (20;98) min, 5948 (2008;9887) m, and 512 (72;953) m, respectively.

CONCLUSION: Overall, this study highlights the individual variability of sleep associated parameters, indicating the importance to monitor sleep in elite adult female soccer players during a training camp. Considering this scenario, individualized recovery and monitoring strategies may be required to ensure that all players are in peak condition for training and competition.

1 Walsh, et al., Br J Sports Med, (2020)

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HOW MUCH SLEEP DOES A FOOTBALL PLAYER NEED?

FIGUEIREDO, P.1,2,3, MARQUES, E.A.2,4, CUNHA, L.2, NASSIS, G.1, COSTA, J.A.3, LASTELLA, M.5, BRITO, J.3

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INTRODUCTION: Sleep is recognised as an essential component to athletic performance and recovery. Yet, compared to general recommendations, and their self-reported sleep needs, athletes typically obtain less than the recommended, which can negatively impact performance, recovery, and health. Previous data have examined sleep needs across multiple sports (1); however, little is known about football players sleep requirements.

Therefore, this study compared football players self-assessed sleep needs and habitual sleep duration and the association of sleep insufficiency with their sleep habits.

METHODS: The study included 305 adult football players (53 females, 137 from national leagues, 63 professionals, mean age = 23.6 yrs). The players answered the question, "how many hours of sleep do you need to feel rested?". For each player, a sleep deficit index was calculated by subtracting sleep duration from individual self-assessed sleep needs. A difference of 1h or more indicated insufficient sleep (1). Sleep quality was measured using the Pittsburgh Sleep Quality Index (PSQI) (2), daytime sleepiness with the Epworth Sleepiness Score (ESS) (3), and diurnal type with the Morningness-Eveningness questionnaire (4). Differences between sleep need and habitual sleep duration were analyzed with a linear mixed model. Logistic regression analyses were used to estimate odds ratios (OR) and 95% confidence limits (CL) for insufficient sleep.

RESULTS: Players reported an average subjective sleep need of 8.1 (5-10) hours and an average sleep duration of 7.4 (4.5-10) hours ($p<0.001$). The prevalence of insufficient sleep for the total sample was 47.9%. When stratified by the sleep/wake variables, the prevalence of insufficient sleep was 68.7% for the poor sleepers, 52.3% for players with excessive daytime sleepiness, and 53.4% for the evening type chronotype. When stratified by professional status, the prevalence of insufficient sleep was 52.5% for non-professionals and 30.2% for professionals. The associated factors with the risk of insufficient sleep were sleep quality (poor sleep: OR 4.90, 95% CL 3.29-7.39), daytime sleepiness (excessive: OR 4.85, 95% CL 2.78-9.00), diurnal type (evening type: OR 3.99, 95% CL 2.30-7.05) and the professional status (professional: OR 0.43, 95% CL 0.24-0.74).

CONCLUSION: Adult football players need, on average, 8.1 hours of sleep to feel rested. However, a large proportion of players (47.9%) failed to meet individual sleep needs on most nights. Athletes with low sleep quality, excessive daytime sleepiness, evening type chronotype, and who are non-professional seem to be at a higher risk of insufficient sleep, which may negatively impact performance, recovery, and health.

ACKNOWLEDGEMENTS:

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EVENING WHEY PROTEIN INTAKE, RICH IN TRYPTOPHAN, AND SLEEP IN ELITE MALE AUSTRALIAN RULES FOOTBALL PLAYERS

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INTRODUCTION: Fundamental to athlete recovery and performance is sleep (1). Protein intake has been shown as a potential strategy to influence sleep (2, 3), including in Australian Football League (AFL) players (4). An important factor in the protein-sleep relationship may be the type and timing of ingestion, with evidence indicating that protein high in the amino acid tryptophan consumed 2-4 hours before sleep may improve sleep outcomes (5, 6). However, it remains unclear

whether these practices can improve sleep in athletic populations. The primary aim of this study was to investigate the effect of evening whey protein supplementation, rich in tryptophan on sleep in elite male AFL players.

METHODS: A double-blinded, counterbalanced, randomised, cross-over study examined whether a whey protein supplement, rich in tryptophan, would improve sleep in 15 elite male AFL players on training and non-training days during pre-season. A 5-day pre-intervention period determined habitual dietary intake and baseline sleep measures, used to standardise dietary intake and timing of the supplement or placebo during the intervention. Dietary intake was assessed using a smartphone application (Easy Diet Diary). Sleep/wake behaviour was assessed using a wrist activity monitor (Actical) and sleep diary. Players were provided with either the whey protein supplement or placebo drink on each intervention day and instructed to consume the drink 3h prior to their habitual bedtime. The drinks were isocaloric and matched for taste and colour. All evening meals were provided in accordance with individual habitual intake and remained consistent between the interventions. Separate one-way repeated measures analysis of covariance for training and non-training days were used to analyse any differences between the whey protein supplement and placebo for sleep duration, sleep efficiency (SE), wake after sleep onset (WASO), sleep onset latency (SOL).

RESULTS: The habitual sleep/wake behaviour during the 5-day pre-intervention period for bedtime, SOL, WASO, SE, wake up time and sleep duration on training days was 23:18 ± 1:12 (hh:mm), 18.8 ± 10.0min, 52.6 ± 31min, 90.0 ± 5.6%, 08:36 ± 01:18 (hh:mm), and 7.9 ± 1.1h, respectively and on non-training days was 22:54 ± 1:06 (hh:mm), 20.8 ± 13.1min, 49.5 ± 23.6min, 89.7 ± 4.3%, 07:18 ± 00:30 (hh:mm), and 7.1 ± 0.8h, respectively. No differences were observed for all sleep outcomes between consumption of the whey protein supplement and placebo on training and non-training days ($p>0.05$).

CONCLUSION: The consumption of a whey protein supplement, rich in tryptophan did not improve sleep outcomes in elite male AFL players. However, athletes may be able to ingest a high protein /energy intake close to bedtime without impairing sleep, an important finding for athlete recovery. It is unknown whether this intervention could be valuable for athletes with poor sleep, during periods of restricted sleep or for those athletes with a low habitual protein intake, requiring further investigation.

SLEEP PATTERNS OF ELITE FEMALE FOOTBALL MATCH OFFICIALS DURING WEURO2022: IMPACT OF PROXIMITY TO MATCH DAY, KICK-OFF TIME AND ROLE ON MATCH DAY

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INTRODUCTION: Sleep has numerous important physiological and cognitive restorative functions that are particularly important to elite sports performers and, therefore, also to elite match officials. Athletes are advised to achieve sufficient sleep duration (> 7 hours) and quality (>85%) per night. Elite athletes are reported to have poorer quantity and quality of sleep in comparison to the general population. However, there is currently no research into the sleep habits of elite football match officials who are exposed to similar physical and perceptual-cognitive demands. Therefore, the aim of this study was to examine the impact of proximity to match day (MD), kick-off (KO) time and role on MD on sleep patterns of elite female match officials during the 2022 UEFA European Womens Football Championship (WEURO 2022).

METHODS: Sleep was measured over 18 ± 5 days in nine elite female football match officials (age: 39 ± 4 y) during a 25-day international tournament (WEURO 2022). Wrist-worn actigraphy (Biostrap EVO, USA) was used to measure night-time sleep duration (h:min), sleep onset and wake time (h:min), and sleep efficiency (%; percentage of time in bed spent asleep). Data was analysed by proximity to MD: Training Day (TD; pitch/gym based, at least +/-2 days from MD), MD-1, MD and MD+1; KO time: 17:00 PM or 20:00 PM; and, Role on MD: Referee or Fourth Official. Data are shown as mean ± SD (range), with statistical significance set at $p < 0.05$.

RESULTS: Sleep duration was 7:20 ± 1:20 (6:20 – 8:04), with no difference between type of day (MD: 6:46 ± 1:38, TD: 7:25 ± 1:16, MD-1: 7:37 ± 1:18 and MD+1: 7:12 ± 1:12, $p > 0.05$). Total time in bed was lower on MD (7:22 ± 1:29) compared to MD-1 (8:25 ± 1:19) and TD (8:15 ± 1:07, $p < 0.05$). Sleep onset time was later on MD (00:54 ± 1:22) compared to MD-1, MD+1 and TD (23:39 ± 1:07, 23:58 ± 0:52 and 23:27 ± 0:52, $p < 0.01$) and sleep wake time was later on MD (8:06 ± 0:58) compared to TD (7:42 ± 0:48, $p < 0.05$). An 20:00 PM KO resulted in later sleep onset time (01:29 ± 01:04) compared to 17:00 PM KO (00:00 ± 1:21, $p < 0.01$), with no differences observed in sleep wake time ($p > 0.05$). Accordingly, sleep duration was shorter after 20:00 PM KO compared to 17:00 PM KO (6:00 ± 1:05 vs. 8:06 ± 1:38, $p < 0.01$), as well as total time in bed (6:44 ± 0:59 vs. 8:22 ± 1:38, $p < 0.01$). No differences were observed in any variables between Referee and Fourth Official performance ($p > 0.05$). Sleep efficiency was 89 ± 7% (81-96%) throughout the tournament with no differences observed between type of day, KO time or role on MD ($p > 0.05$).

CONCLUSION: Elite female football match officials, on average, achieved the recommended sleep duration and quality during WEURO 2022, however there was large interindividual variation. Sleep duration was <7 h on MD and after 20:00 PM KO, likely due to a later sleep initiation and non-compensatory wake time. As such, individualized sleep hygiene strategies which consider match scheduling are recommended.

Oral presentations

OP-SH03 Sport Management and law

LEGACIES OF THE 2022 COMMONWEALTH GAMES FOR BIRMINGHAM COMMUNITIES AND INDIVIDUALS FROM DISADVANTAGED BACKGROUNDS: EVIDENCE FROM THE QUALITATIVE DATA

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Introduction

Major and mega sporting events have transformative power to the host city and countries but they are expensive to stage. Politicians and event organisers justify such costs with headline claims that major-event-hosting can generate economic, social, and environmental legacies for the host region. However, event hosting does not always benefit everyone. For cities such as Birmingham (United Kingdom), with 90% of wards being more deprived than the national average, the hosting of the 2022 Commonwealth Games (CWG) attracted substantial media scrutiny, particularly given that a key mission was to deliver 'A Games for Everyone'. As part of a larger study, this cross-disciplinary research explored the legacies of the CWG for communities and individuals from disadvantaged backgrounds (CIDBs) in Birmingham.

Methods

Seven pre-Games (one-month prior to the Games) focus groups were conducted (N = 37) with CIDBs across Birmingham. Guided by event legacy literature and social exchange theory, example questions included: What are individuals attitudes and perceptions of the CWG? What legacies do people anticipate from the Games and how? Data were coded and analysed through reflexive thematic analysis.

Results

There were five themes generated from the pre-Games data: (1) varied attitudes towards the Games, (2) a divided expected legacy, (3) the Commonwealth Games magnifies inequality, (4) barriers resulting in limited engagement, and (5) the importance of community. The findings revealed that individuals, community groups, or community leaders perceived that they were not included in the planning of the events and legacies. Initial communication with the Commonwealth Games organising committee was not sustained or meaningful. Promises of a Games sold for its equality, diversity, and inclusion was perceived as superficial and tokenistic. Participants experienced difficulties taking part in the Games (e.g., volunteering, watching events), felt excluded by the events, had limited awareness of legacy opportunities, and identified a lack of training (i.e., skills development) to ensure equal opportunities in accessing the events. The importance of community was reiterated throughout with a belief that community groups and champions could help to leverage the Games legacy but also act as a bridge between the event and host communities.

Discussion

To our knowledge, this is the first study to explore the views of the legacies of a mega-sporting event of CIDBs. The pre-Games results identified an inclusion problem that CIDBs were not viewed as an integral part of the Games. Moreover, due to the lack of financial and resource support, though there were benefits and opportunities associated with the Games, CIDBs struggled to capitalise on them. Future mega sporting events must ensure CIDBs are better consulted and engaged throughout the event hosting process.

BETTER BASKETBALL ORGANIZATION BETWEEN TWO DIFFERENT CULTURES: THE CHINESE AND THE SPANISH

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Introduction

This research focuses on China and Spain and compares how basketball is managed and developed in these states by focusing on cultural differences between the countries. The aim is to identify notable differences in how basketball growth is approached between two different cultures.

Methods

This study used a mixed-methodologies approach to data collecting, including both qualitative and quantitative methods. Analysis of the responses via Atlas.ti software and a review of scientific literature helped identify a few significant differences regarding training approaches, assessment of coaches, government support, regional development, and talent acquisition. Triangulation was used to combine data from twenty semi-structured interviews, ten representatives from the Chinese Basketball Association (CBA) and ten officials of the Spanish Basketball Federation (FEB), and a study of relevant literature. The literature review was integrated into the methodology to provide a broader understanding of the cultural differences between Spain and China and how they may impact the development and management of basketball. In particular, the study was issued by the Ethics Committee of the Technical University of Madrid, which demonstrates that the study meets the ethical requirements.

Results

The comments of the interviewees indicated that the Spanish Basketball Federation (FEB) and the Chinese Basketball Association (CBA) approach athlete training, coach evaluation, government assistance, regional development, and talent acquisition in different ways. Basketball was discovered to be more professionalized and centralized in Spain, with a major emphasis on player development and conditioning. Basketball in China, on the other hand, was discovered to be more community-based, with a focus on grassroots promotion. The statistics also revealed considerable discrepancies in each countrys amount of investment and resources dedicated to basketball, with China investing more in infrastructure and facilities to promote the sports development. Furthermore, the study indicated disparities in the coaching styles and training methods employed in the two nations, with China emphasizing physical training and conditioning and Spain emphasizing technical and tactical training.

Discussion

The findings demonstrate that the individualistic culture of Spain implies peculiarities that contribute to the better development of basketball. Overall, the findings suggested that cultural differences have a substantial impact on how basketball is handled and developed in these two nations. Thus, while basketball has a strong culture in both Spain and China, the sport is governed and promoted differently in each nation due to cultural differences such as history, customs, and government interests. This result can be a recommendation for other nations to promote basketball growth.

LEVERAGING THE 2023 FIFA WOMEN'S WORLD CUP FOR SUSTAINABLE FAN ENGAGEMENT – A PRELIMINARY ANALYSIS

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The substantial long-term growth experienced by women's football globally has recently resulted in a familiar phase of stagnation, as attendance numbers struggle to remain consistently high and broadcast demands not being met (Meier, 2020). This has also been evident in Australia where the women's national team, the Matildas thrives while the semi-professional A League Women has struggled to grow in regards to game attendance and spectator engagement (Football Federation Australia, 2019). In this presentation, we investigate how the leveraging of a sport mega event – the 2023 FIFA Women's World Cup – can contribute to sustainable fan engagement of women's football in Australia.

The hosting of the FIFA WWC 2023 in Australia and New Zealand in July/August 2023 presents a significant opportunity for Football Australia and its stakeholders to advance women's sport into a position that ensures a prosperous and sustainable future. However, while we know about the leveraging intentions of event organisers to achieve economic and socially driven outcomes (Chalip & Leyns, 2002; Chalip, 2004; Chalip, 2006; D'Hoore et al., 2022) – and how significant fans are to value growth (Kolyperas & Maglaras, 2018; Allison, 2013) – we know very little about sport organisations and how they view leveraging events as a tool to achieve sustainable fan engagement (Smith, 2014; Schulenkorf et al., 2016; Singleton, 2017) – especially in women's sport. Moreover, existing literature has indicated that much of the research conducted within the fan engagement space has primarily focused on men's sporting teams and events, with limited data available on women's sporting leagues (Toffoletti, 2017; Delia, 2020; Clarke et al., 2022). Taken together, there is a lamentable gap in the space of event leverage and sustainable growth in women's sport that deserves to be examined from an organisational perspective (see Sant, 2015; Wasser et al., 2022; Dionisio et al., 2022).

In this presentation, we offer preliminary findings from a larger research study on event leverage for sustainable fan engagement around the WWC 2023. Specifically, we look back at previous sport event leverage attempts and assess key strategies that have been successfully implemented by sporting organisations in their respective leveraging efforts. Moreover, we provide structured social media data that we collected in the lead-up to the event and discuss how social media can be used as a tool to maximise event-related opportunities. In doing so, we make two critical contributions across practice and theory. First, we illicit a number of socio-managerial strategies for event organisers and sport organisations to use in their leveraging efforts; and second, we propose a new event leverage framework that goes beyond current conceptualisations by focusing specifically on (sustainable) fan engagement as a core outcome.

Contributors/Supervisors; Prof. Dr. Nico Schulenkorf, A/Prof. Dr. Katie Schlenker, Dr. Stephen Frawley

THE PERCEPTION OF OLYMPIC AGENDA 2020 RECOMMENDATIONS OF COLLEGE STUDENT ATHLETES IN TAIWAN: A CROSS-SECTIONAL STUDY ON THE IMPLEMENTATION OF THE AGENDA IN 2021

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Introduction

In December 2014, the International Olympic Committee (IOC) has officially approved the Olympic Agenda 2020 at the 127th IOC Session. The strategic roadmap, consisting of 40 recommendations, was built on the three pillars of Credibility, Sustainability and Youth. Since the release of the document, it served as a guide for countries around the globe to commit to reform, promote and implement accordingly. Six years after the adoption of the Agenda at the 137th IOC Session on the 10th of March 2021, the Executive Board agreed the closing report of this Olympic Agenda 2020 unanimously. Hence, it is also of great importance to understand how college student athletes in Taiwan perceive the Agenda after its implementation period.

Methods

The objective of this work is to carry out a survey through purposive sampling to understand how college student athletes in Taiwan who had at least participated in one sports event at a national level think about the Olympic Agenda 2020 after its implementation period. The athletes were surveyed at the competition venues during the game periods of the national intercollegiate sports events. A total of 528 questionnaires were given out with 446 valid ones collected. The data were then analyzed through the methods of descriptive analysis, paired sample t-test, Pearson correlation analysis and importance-performance analysis.

Results

Among all the surveyors, average 20.9 years old, the highest level they had competed in was mostly intercollegiate level. By analyzing the data of how important and satisfactory athletes felt about the execution of the three pillars of the Agenda with paired sample t-test, significant differences were noticed. Based on IPA, none of the 40 recommendations fell under quadrant B (Concentrate Here) with 29 of them in quadrant A (Keep Up the Good Work), ten in C (Low Priority) and one in D (Possible Overkill).

Discussion

Five years after the adoption of the Agenda, it was still noteworthy that athletes put great emphasis on the recommendations, which corresponded to the research outcomes from Chen, B. I., Chen, M. Y. and Yang, Y. J. (2020) in 2018. Hence, government sectors and related associations should take this into account. Furthermore, in terms of the satisfaction level of the respective aspects of the Agenda, the results revealed an approving tendency, which was different from the outcomes in 2018 when students were not satisfied with the performances in all three priorities. Consequently, it proved that the recommendations were developing in an optimistic direction. When applying IPA, none of the recommendations was in the second quadrant. This finding contrasted with the outcome in 2018 when many of the recommendations were located in quadrant B. Overall, comparing with 2018, this study demonstrated that a progress was made in how athletes perceive the reform and that the efforts made by the government sectors and relevant authorities spoke for themselves.

EXPLORING THE RELATIONSHIP BETWEEN THE SWEDISH REGIONAL SPORT STRATEGY, PERCEIVED TRUST, AND NON-PROFIT SPORT ORGANIZATIONS' MANAGEMENT IN SOUTHERN SWEDEN

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Introduction

Sport and trust-based governance is a cornerstone of Swedish sport management. There are more than 20,000 sport associations, and the sport sector receives approximately USD 20 million in public funding yearly. The Swedish Sports Confederation (SSC) is a non-profit umbrella organisation that coordinates the management of Swedish sport. SSC's "what sport wants" is an appropriation document on the vision of the Swedish sport movement wherein SSC advise sport clubs to focus on inclusivity, hard to reach societal groups, and sport for the masses rather than the fostering of elite players. Concurrently, it is problematic that there is no research on what motivates sport clubs to apply what sport wants (Book, Hedenborg & Andersson, 2022). Accordingly, the purpose of this study is to contribute new knowledge on what influences Swedish sports clubs in carrying out what sport wants's national goals for sport participation.

Methods

The data consists of self-rated answers (N = 1,937) from a questionnaire, distributed to all non-profit sport organizations in southern Sweden in 2017, 2018 and 2020. The questionnaire focused on sport organizations' 1) perceived support from SSC, 2) perceived trust in SSC, 3) competence in what sport wants and, 4) how frequently the sports associations worked with equity (including anti-discrimination and inclusion). X2-test and regression analyses were used to analyze differences between the years 2017, 2018 and 2020, and the relationship between perceived support from SSC, perceived trust in SSC, competence in what sport wants, and how frequently the sports association worked with equity. Effect size measurements were calculated and interpreted based on established guidelines.

Results

Preliminary results indicate that sport organizations' perceived support from SSC has decreased significantly and continuously between 2017 (M = 3.0), 2018 (M = 2.9), and 2020 (M = 2.8). It does not seem to be any differences in perceived trust in SSC and equity. The results also show that, competence in what sport wants (β = .225), and perceived support from SSC (β = .278) can predict to which extent sport organizations work with equity (R2 =.278).

Discussion

Preliminary results indicate that more support and trust in SSC lead to increased realization of what sport wants. However, since the results show that perceived support for SSC has decreased between 2017, 2018, and 2020, this study illuminates an urgency of maintaining a strong relationship between Swedish sport clubs and SSC. Moreover, the results confirm the efficiency of the trust-based management model used in Sweden, which seemingly leads to deliverables among the participating associations.

Book, K., Hedenborg, S., & Andersson, K. (2022). New spatial practices in organised sport following COVID-19: the Swedish case. Sport in Society, 25(7), 1343–1357. https://doi.org/10.1080/17430437.2022.2031017

Oral presentations

OP-AP08 Network Analysis in Team Sports

AN EXPLORATORY STUDY OF SPATIAL DIVISION OF FOOTBALL PITCH PASSING NETWORKS

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INTRODUCTION: The integration of network science into the analysis of football passing performance has recently attracted extensive research interest. Compared to player passing networks, pitch passing networks, which describe zonal information and general attacking profile of a team, have received comparatively less attention. Therefore, this exploratory study focused on determining the optimal spatial divisions of the football pitch passing networks and on examining the most prominent network metrics within such networks regarding zone importance.

METHODS: A dataset consisting of spatiotemporal records of 1,665,510 passes of 1,941 matches from the 2017/2018 season of the top five European Leagues, 2018 World Cup and UEFA Euro 2016 was used. The pitch passing networks were constructed by dividing the field into K equal areas (nodes), with K scales ranging from coarsest (1×2) to finest (20×20). Edges were respectively weighted by the numbers of passes between two nodes. Subsequently, two criteria were applied for determining the division scale: i. the extent of how much passing information was retained (L/N, the ratio of the total links (L) to the total successful passes (N) and ii. the heterogeneity of nodes degree (representing whether passes are evenly distributed under a certain network scale). Kendalls Rank Correlation Coefficient (τ) was used to analyze the association between the ranking of zone importance (based on four key passing events: smart pass, forward pass, assist, key pass) and the following network metrics: degree centrality, clustering coefficient, neighbor degree, closeness centrality, betweenness centrality and eigenvector centrality.

RESULTS: It was shown that the division scales of 24, 50, 100 and 400 contained 81.3%, 90.9%, 95.3%, and 98.9% of all pass information. In addition, no obvious difference in the heterogeneity of node degree was shown between different scales. Regarding the relationship of the ranking of the zone importance at four scales with network metrics, degree centrality, betweenness centrality, eigenvector centrality and closeness centrality showed strong correlations (τ_ave(SD)) of 0.77 (0.121), 0.77 (0.108), 0.75 (0.117) and 0.71 (0.116) respectively, while neighbor degree and clustering coefficient showed trivial correlations of 0.36 (0.234) and 0.18 (0.456).

CONCLUSION: The study indicated that scale divisions from K=24 retains largely the passing information, and the heterogeneity may not be a criterion in deciding optimal scales. Also, areas with higher centrality values contained a greater number of key passing events, which proves the prominence of these areas and potentially aids in future assessments of team passing styles. Nonetheless, it should also be acknowledged that the suitable scale for pitch passing networks may differ depending on analysis purposes. While this study focuses on the micro-level of networks, future research could explore improvements at the meso and marco levels with subgroups or entire networks.

THE INFLUENCE OF SCORELINE ON PASSING PERFORMANCE IN ELITE SOCCER

DING, J.1,3, HUANG, Z.2,3, O'DONOGHUE, P.2, STRAFFORD, B.1, STONE, J.1

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INTRODUCTION: Passing value (i.e. number of passes or the percentage of successful passing) is regarded as a performance indicator for quantifying a team's style of football [1] with scoring teams achieving greater passing success in the five minutes leading up to a goal [2]. Furthermore, the losing or drawing team typically prefer holding a long possession period, while the winning team play with shorter possession periods [3]. However, the behaviour of passing (i.e. the location, the aim, the type of the passes) has not been examined. Therefore, the aim of this study is to use a self-organising map (SOM) [4] to detect passing patterns and find the association between scoreline and passing behaviours in elite soccer matches.

METHODS: A SOM neural network was trained to classify 192,538 passes in to 12 passing behaviours from 835 high-performance soccer matches. Wilcoxon signed rank tests were used to investigate the changes in passing behaviour frequencies 5 minutes before a goal and during 8 potential scorelines (ATA: Ahead-to-ahead, ATC: Ahead-to-conceded, ATA: Ahead-to-Level, BTB: Behind-to-Behind, BTL: Behind-to-Level, BTC: Behind-to-Score, LTA: Level-to-ahead, LTB: Level-to-Behind). The different percentage of passing behaviour between paired scoring and conceding scoreline was examined by a Chi square test.

RESULTS: 4 significant changes were found in the frequency of passing behaviours between scorelines (except scoreline ATL and BTS). The frequency of pass type 8, Short- and mid- range passes in the central of the pitch towards to the lateral direction (left or right), was different before (0.88±0.33) and after (0.35±0.43) the ATL scoreline ($P < 0.001$). Significant differences were found in the percentage of passing behaviours among total passes before different paired scorelines (scoring teams and conceding teams). Normally, the conceding team played more defensive passes and sided passes (for example ATL: 39.50% defensive, 33.3% aggressive, 77.2% sided, 22.6% central) while the scoring teams play more aggressive and central passes (for example ATA: 31.3% defensive, 39.4% aggressive, 74.8% sided, 25.2% central).

CONCLUSION: Out of 192,538 passes, the chosen artificial intelligence system created 12 classifications 5 minutes before and after goal scoring. Passing behaviours differed significantly across the pre- and post-scorelines, as well as between relative-paired scorelines. This result means in practice, coaches could give instruction to players on how to maintain or change the scorelines in games by tracking and changing the passing behaviours. The influence of scorelines during different times of the game and a unique series of contests on non-location-based passing behaviour in varying leagues with diverse playing styles should be the subject of future research.

1. Hewitt, Greenham, & Norton (2016), 2. Redwood-Brown (2008), 3. Paixão et al (2015), 4. Kohonen (2001)

CONSTRUCTION OF APPLICATION STRATEGY FOR STATISTICAL ANALYSIS OF BEACH VOLLEYBALL GAME TECHNIQUES AND TACTICS BASED ON THE CONCEPT OF STANDARDIZATION OF RESEARCH METHODS

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INTRODUCTION: To explore the establishment of a standardized statistical analysis strategy for beach volleyball techniques and tactics, and to verify its reliability and validity, to provide theoretical standards and methods for studying the technical and tactical characteristics of beach volleyball games, and to lay the theoretical foundation and practical path for the Chinese Volleyball Association to promote the technical statistical methods of beach volleyball.

METHODS: 1. Expert Interview Method: Interviewing 3 professionals.2. Focus Group Discussion: Focus groups are formed by 3 coaches, 6 players, 2 volleyball technical and tactical statistical analysis professionals and 2 researchers to communicate and discuss statistical technical and tactical indexes and effects as well as analysis methods. 3. Experimental method: Fifteen games (60 players) from the final stage of the 14th National Games in 2021 were selected to allow three technical and tactical statisticians to count the games using the Data Volley 4 strategy and one coach at the game site according to the same statistical criteria.

RESULTS: 1. Sorted out the eight modules of "goal setting, index selection, effect standard, related technology setting, tactics setting, statistical standard, hardware and software configuration and practical analysis" to build a standardized technical and tactical statistics strategy; 2. Using the data of 8 matches of the champion Liaoning mens sand volleyball team No. 1 as the sample, using chi-square test and independent sample t-test to compare the final and preliminaries of receiving and serving ($x2=18.67$, $p=0.001<0.05$), attacking ($x2=3.663$, $p=0.61>0.05$), and average block score per set ($t=2.934$, $p=0.011<0.05$) technical performance effects to provide a basis for the selection of the study matches;

3. The intra-group correlation coefficient test application strategy was used and the degree of rater reliability consistency was excellent (all three ICC coefficients >0.90); the paired t-test and Bland- Altman consistency analysis of the average reception rate and offensive success rate per set of applied strategy statistics and traditional paper-and-pencil statistics showed no significant difference ($p>0.05$) and good consistency ($p>0.05$).

CONCLUSION: 1. The standardized system construction of the application strategy can meet the needs of the sand volleyball team in preparing for matches, and at the same time can provide standards and methods for official match technical statistics. 2.The application strategy has good validity and lays the foundation for different statisticians to divide and cooperate. 3. Among the main opponents in preparing for major matches, the latest matches are preferred when choosing the matches.

NEAREST NEIGHBOR CLUSTERING TO RECOGNIZE TEAM TACTICS

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INTRODUCTION: Team tactics are coordinated moves of team members as for example in team handball or soccer. Several approaches have been published to detect team tactics automatically in streams of spatio-temporal data as they are generated by Kinexon or Catapult equipment in order to take team tactics into account when evaluating the players' performance. Particularly the representative search based on the clustering data mining technique has been identified lately as a means to solve the task. However, the used notion of distance is critical, and first approaches based on the Frechet distance and straight forward clustering techniques based on distance (and density) have shown suboptimal results.

METHODS: A two-step approach is introduced. First, clusters of player trajectories are identified allowing to "encode" whole team moves as combinations of trajectory cluster ids. Then a variation of a co-occurrence grouping is used to find similar team moves. We need a variation because not all groups of trajectories are "significant" for a team move. Thus, we need to assign significance weights to trajectories when searching for co-occurring trajectory groups.

Usual clustering techniques are suboptimal because they need a more or less constant distance (or density) across clusters. Both, distance and density vary a lot in case of trajectories of players, depending on the played position. Thus, it will be shown that a special notion of nearest neighbor similarity outperforms direct distance or density-based approaches. To find the nearest neighbors of trajectories the dynamic time warping (DTW) distance is used instead of the Frechet distance.

RESULTS: Focusing on a single team of the first German team handball league, 32 matches of that team in 2022 have been analyzed. 7,833 raw player trajectories of attack events have been extracted from the spatio-temporal data collect-

ed by Kinexon during the matches. 5.5 seconds of position information before an attack event (the defense trajectories have not been analyzed yet) were used to search for trajectory groups. By excluding team moves of fast breaks and penalties, the search for tactical moves was based on 732 team moves and 6,153 player trajectories.

Using the two-step approach based on the notion of the dynamic time warping distance, 56 groups of team tactical moves have been identified consisting of 35 groups of player trajectories. However, the 56 groups are partially nested meaning that one group is a special case of another group.

CONCLUSION: Using DTW is a much better distance criterion for trajectories than the Frechet distance. Using the nearest neighbor-based similarity based on DTW rather than using the direct distance allows taking into account the differences of moving patterns of different player positions. It will be shown that the typical trajectories of specific player positions are detected and then grouped to complete tactical moves. And this done in a complete automated process without human video classification.

Oral presentations

OP-PN26 Nutrition III

CARBOHYDRATE INGESTION DURING PROLONGED FATIGUING CYCLING IMPROVES NEXT-DAY TIME TRIAL PERFORMANCE AND MAY REDUCE PROTEIN DEGRADATION IN WELL-TRAINED CYCLISTS

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INTRODUCTION: Exercise with low carbohydrate availability increases protein degradation, which can considerably reduce subsequent performance. In parallel, carbohydrate ingestion during exercise has been shown to maintain carbohydrate availability. We aimed to test whether carbohydrate ingestion during exhaustive exercise could reduce protein degradation. In addition, we tested if next-day performance was improved when exhaustion was prevented with carbohydrate ingestion.

METHODS: Seven well-trained male cyclists (VO2max 66.8±1.9 mL·kg-1·min-1; mean±SEM) cycled to exhaustion (~2.5 hours) at a power output eliciting 68% of VO2max (W68%), followed by repeating 1-min work/1-min recovery intervals at 90% of VO2max (W90%) until exhaustion. During W68%, cyclists ingested a placebo water drink (PLA) the first time and a similarly flavored carbohydrate drink (CHO), 1 g carbohydrate·kg-1·h-1, the second time. The participants performed the same amount of work under the two conditions, separated by at least one week. The two conditions were isoenergetic, and diet was provided to the participants. To test the recovery, participants completed a time trial (TT) the next day. TT was designed so that participants completed mechanical work equivalent to 30 min at a workload corresponding to 100% of VO2max. Gross efficiency during TT was calculated as [gross efficiency (%) = work accomplished (kJ)/energy expended (kJ)×100]. Blood and urine were collected throughout the study period. Two-way repeated measures ANOVA was used to determine treatment differences, with treatment and time as factors.

RESULTS: Carbohydrate ingestion maintained carbohydrate availability during W68% and W90%: total carbohydrate oxidation was significantly higher in CHO (CHO, 518±55 g; PLA, 426±31 g; p=0.022), and plasma glucose concentration was maintained in CHO (start, 5.1±0.1 mM; exhaustion, 4.7±0.1 mM; time p=0.523) compared to in PLA (start, 5.2±0.2 mM; exhaustion, 3.7±0.4 mM; time p<0.001; condition p=0.025). Next-day performance during TT was better after CHO ingestion (CHO, 41:49±1:38 min; PLA, 42:50±1:46 min; p=0.020), as well as gross efficiency (CHO, 18.6±0.3 %; PLA, 17.9±0.3 %; p=0.019). Urinary nitrogen excretion did not significantly differ during the study period (p=0.897). Urinary excretion of 3-methylhistidine increased more in PLA than in CHO, but not significantly (p=0.673). Finally, tyrosine and phenylalanine plasma concentrations increased in PLA but not in CHO (p=0.018).

CONCLUSION: Carbohydrate ingestion during exhaustive exercise reduced deterioration in next-day performance through reduced metabolic stress and development of fatigue. Some parameters point toward less protein degradation, which would preserve muscle function, but further investigations are needed. Nevertheless, this study highlights the importance of ingesting carbohydrates during prolonged exercise to maintain subsequent performance, especially when competing over consecutive days.

A DIET RICH IN CARBOHYDRATES WITH LOW GLYCAEMIC INDICES RESULTS IN IMPROVED PERFORMANCE RELATED PARAMETERS IN RECREATIONAL RUNNERS AFTER 10 WEEKS OF ENDURANCE TRAINING

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UNIVERSITY OF VIENNA

INTRODUCTION: Changes in macronutrient intake, such as in a low-carbohydrate high-fat diet (LCHF), are often used to achieve higher fat oxidation rates. LCHF leads to a lower carbohydrate (CHO) oxidation and preserves glycogen stores, because of reduced insulin levels. However, LCHF has shown to decrease metabolic flexibility and performance at higher intensities. Since insulin levels are also lowered in a diet with low glycaemic CHO, we hypothesized that a diet rich in CHO

with low glycaemic indices would combine the fat oxidation-boosting effect of LCHF with the performance-enhancing effects of CHO.

METHODS: 57 male runners (age: 28.3±4.3 yrs, VO2 peak: 55.7±7.8 mL·min-1·kg-1) were randomly assigned to one of three experimental groups (LOW-GI: ≥65% low glycaemic CHO daily, n=19; HIGH-GI: ≥65% high glycaemic CHO daily, n=19; LCHF: ≥65% fat, ≤50g CHO daily, n=19) stratified by their VO2 peak. To determine lactate thresholds, peak power output (PPO), and VO2 peak an incremental test until exhaustion on a treadmill with capillary blood samples taken every 3 min was performed (starting at 6 km·h-1, 1.5 km·h-1 increment, 3 min steps). VO2 peak was measured using breath-by-breath gas analysis. Performance was measured in a 5 km time trial (TT) on a 400m running track. Magnet resonance spectrometry was conducted to measure muscle glycogen content (MG). To test hypotheses one-way ANOVA followed by Tukeys multiple comparisons and paired t-test were used. Significance was accepted at $p<0.05$. Data are reported as mean±SD.

RESULTS: TT improved (LOW-GI: -126±78, HIGH-GI: -78±120, LCHF: -68±92 sec, resp. $p<0.05$) in all three groups, yet, enhancement was 54% higher in LOW-GI compared to LCHF. The increase in relative PPO was greater in LOW-GI (0.26±0.25 W·kg-1) compared to LCHF (0.07±0.16 W·kg-1, $p=0.037$, $\eta^2=0.139$). VO2 peak decreased significantly in LCHF (0.2±0.4 L·min-1, $p<0.05$). A significant increase in performance at 2 and 4 mmol·L-1 thresholds was found in all groups (LOW-GI: 1.5±1.2 and 1.3±0.8 km·h-1, HIGH-GI: 1.2±0.9 and 0.7±1.1 km·h-1, LCHF: 2.1±1.2 and 1.5±0.9 km·h-1, resp. $p<0.05$), changes at 2 mmol·L-1 were most profound in LCHF. Changes in maximum lactate concentration were significantly greater in LCHF (-2.1±1.9 mmol·L-1) compared to other groups ($p=0.008$, $\eta^2=0.198$). Changes in MG were more pronounced in LCHF compared to CHO groups (LOW-GI: 35.4±56.9, HIGH-GI: 31.4±37.2, LCHF: -13.2±35.1 mmol·L wet-tissue-1), but no difference between groups was found ($p>0.05$).

CONCLUSION: These findings demonstrate that a diet rich in low glycaemic CHO appears to increase performance related parameters. Although speculative, these findings could be interpreted as a result of preserved CHO availability, replenished MG and reduced insulin levels. In contrast, LCHF may inhibit training effects at maximal intensities, due to reduced activation of key enzymes in CHO metabolism. Hence, consumption of low glycaemic CHO may be of interest in optimising metabolic flexibility and training adaptions.

THE EFFECT OF DELAYING A CARBOHYDRATE-RICH BREAKFAST ON AFTERNOON INTERMITTENT EXERCISE PERFORMANCE: A RANDOMISED, SINGLE BLIND, PLACEBO-CONTROLLED TRIAL

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1 SWANSEA UNIVERSITY, 2 NATIONAL TAIWAN NORMAL UNIVERSITY

INTRODUCTION: Omission of a carbohydrate (CHO) rich breakfast has been shown to impair afternoon/evening endurance exercise performance, but previous studies have been limited by a lack of a placebo control and an extreme dietary manipulation (i.e., early morning consumption vs. complete omission). In addition, afternoon/evening exercise performance events commonly involve prolonged durations of high-intensity intermittent rather than endurance-based exercise. In this randomised, single-blind, placebo-controlled study, we tested the hypothesis that delaying the consumption of CHO-rich breakfast would impair prolonged high-intensity intermittent exercise performance in the afternoon.

METHODS: Following ethical approval, ten regular intermittent games players (mean±SD: age: 25±6 y; maximal oxygen uptake: 48±7 ml/kg/min) completed two trials (EARLY and DELAY) that were matched for energy and nutrient intake. In EARLY, participants consumed a high-CHO breakfast shake (2 g/kg BM maltodextrin, 1 ml/kg BM orange squash, 0.15 g/kg BM Xantham gum, 0.067 g/kg BM artificial sweetener and 6 ml/kg BM water) at 8am, followed by a taste and texture matched, but energy depleted, placebo shake (1 ml/kg BM orange squash, 0.15 g/kg BM Xantham gum, 0.067 g/kg BM artificial sweetener and 6 ml/kg BM water) two hours later. In DELAY the order of these shakes was reversed. In both trials, following a standardised and individualised high CHO lunch (888±107 Kcal, 145±28 g CHO), participants subsequently completed a 90-min intermittent indoor cycling exercise performance task, starting at 3pm. This consisted of two, 40-min stages with 10-min of rest in between. Each half involved 18 repeated 2-min blocks of steady state cycling (100-s; 35% maximal aerobic power output), followed by 15-s of unloaded pedalling and then a 6-s all-out sprint. Peak, mean, and end power output were measured during each sprint and averaged across each stage of the test for statistical analysis.

RESULTS: The subjective appetite response followed a similar pattern during the morning of both trials, despite differing blood glucose and substrate oxidation responses, which together confirmed the success of the single-blind placebo control. There were no differences in peak power (1st half: mean difference [95% CI]: 0.85 [-12 to 14] W, $p=0.89$, $d=0.01$); 2nd half: 1.6 [-12 to 15] W, $p=0.79$, $d=0.01$), mean power (1st half: mean difference: 2.2 [-12 to 17] W, $p=0.73$, $d=0.01$); 2nd half: mean difference: -2.2 [-16 to 11] W, $p=0.72$, $d=0.02$) or end power (1st half: mean difference: 6.9 [-11 to 25], $p=0.42$, $d=0.05$); 2nd half: mean difference: -1.7 [-16 to 12] W, $p=0.80$, $d=0.01$) during the sprints in the DELAY compared to the EARLY conditions.

CONCLUSION: These data provide no evidence that delaying consumption of a CHO-rich breakfast impairs prolonged afternoon high-intensity intermittent exercise performance.

THE INFLUENCE OF A VEGAN DIET ON BODY COMPOSITION, PERFORMANCE AND THE MENSTRUAL CYCLE IN YOUNG WELL-TRAINED WOMEN

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IST UNIVERSITY OF APPLIED SCIENCES, DUSSELDORF

INTRODUCTION: The number of people who completely renounce animal products and live vegan is continuously increasing. Young women between the ages of 15 and 29 are the most frequently represented population. However, there is hardly any data available for this population. Therefore, this study aimed to examine the influence of a change to a vegan diet and the effects on performance, body composition and menstrual cycle (MC) in young healthy women.

METHODS: Ten well-trained women (>3TE/week) took part in a 12-week controlled study (4 weeks omnivorous control phase, 8 weeks vegan intervention). All participants were informed about the nutritional documentation (FDDB Extender) and a vegan diet one week before the omnivore control phase. In addition, they were supervised by a nutritionist throughout the entire period. Two days before the vegan phase begin, a second information session about the vegan diet was conducted. Every four weeks (T0, T1, T2, T3), performance (squat, countermovement jump (CMJ)) and body composition (body weight, muscle mass (MM), fat mass (FM) were checked and well-being was assessed. In addition, a saliva sample was taken every two days and a menstrual diary was filled out to monitor the MC. A linear mixed model (LMM) was used to test the effects of dietary change on performance, body composition and the MC. Besides, if the change was significant, the influence of the MC phases on body composition and performance was also examined.

RESULTS: No significant changes in squat performance, well-being, and total calories were found (n=9). In CMJ a significant difference in treatment (p:.031) but no time difference (p:.142) was detected. In Body composition a significant decrease over time (p<.001) and treatment effect (p<.001) in MM was observed but not in FM (time: p:.983; treatment: p:.923). In addition, a significant effect of MC phases on MM was observed (p:.023). In macronutrient distribution, the carbohydrate content increased (p<.001), whereas protein content decreased significantly (p<.001). In addition, a negative trend was observed in relative protein intake (p:.050). For fat content, a significant treatment effect was observed (p:002). Hormone concentrations of individual MC showed no significant abnormalities throughout the intervention period.

CONCLUSION: It appears that a change to veganism does not affect squat performance if total calorie requirements are met. In contrast, a significant reduction in CMJ was observed. But, the individual curves show that a considerable reduction in performance was already visible before the vegan phase and cannot be attributed to the vegan diet. The decrease in protein can also be observed in the change in MM. During the vegan phase, the women no longer reach the recommendations for relative protein intake for athletes. Consequently, this could inhibit adaptation or regeneration processes in the long term. However, this can only be speculated at this point. Furthermore, no statement can be made about the long-term effects on MC.

EATING BEHAVIOURS, MENSTRUAL HISTORY, AND THE ATHLETIC CAREER

RAVI, S., VALTONEN, M., IHALAINEN, J.K., HOLOPAINEN, E., KOSOLA, S., HEINONEN, S., WALLER, B., KUJALA, U.M., PARKKARI, J.

UNIVERSITY OF JYVÄSKYLÄ

INTRODUCTION: Sports participation has many health benefits but is also associated with injuries, disordered eating (DE) behaviours, and menstrual dysfunction (MD) in female athletes. This retrospective study aimed to investigate if menstrual history and eating behaviours are associated with sports career-related factors in females who had participated in competitive sports during their adolescence. Moreover, the aim was to evaluate differences in menstrual history and eating behaviours among females with and without a competitive sports background.

METHODS: One hundred females with a competitive endurance sports background and their 98 age-, gender-, and municipality-matched controls participated in the study. Data on demographics, menstrual history, eating behaviours at different age stages, sports careers, and injuries were collected by a questionnaire. Eating behaviours were assessed with the Eating Disorder Examination Questionnaire short form (EDE-QS). EDE-QS scores were calculated for each assessed age period (i.e., ages 13–15, 16–18, 19–21, 22–25, and present) and the scores were used both as a continuous and binary variable. Generalised estimating equations were used to calculate associations of menstrual history and eating behaviours with the outcome variables, i.e., sports career length, participation level, injury-related harms during the career, and career termination due to injury.

RESULTS: Higher EDE-QS scores, indicating unhealthier attitudes toward eating and body image, during the athletic career were associated with a shorter career (B = -0.15, 95% confidence interval (CI) -0.26, -0.05), and secondary amenorrhea was associated with lower participation level (odds ratio (OR) 0.51, 95% CI 0.27, 0.95), injury-related harms during the career (OR 4.00, 95% CI 1.88, 8.48), and career termination due to injury (OR 1.89, 95% CI 1.02, 3.51). Females with a competitive sports background reported higher rates of MD than controls (primary amenorrhea 20% vs 2% in athletes and controls, respectively, p<0.001 and secondary amenorrhea 34.1% vs 20.4%, in athletes and controls, respectively, p=0.035), but no differences between the groups were observed in the EDE-QS scores at any age (p>0.05 for all). However, trends in the EDE-QS scores over time were more stable among controls, while the scores of athletes increased significantly after age 13–15. DE during the sports career among athletes and DE during adolescence or young adulthood among controls was associated with current DE in both groups.

CONCLUSION: The findings of this study indicate that DE behaviours and MD, specifically secondary amenorrhea, are linked with undesirable aspects of a sports career in females competing in endurance sports. DE during the sports career

is associated with DE after the career. Athletes and those working with them should be aware of the negative link of DE and MD to a sports career.

15:15 - 16:30

Invited symposia

IS-BM05 Sex-Based Differences in Fatigability, Sport Performance and Recovery

SEX DIFFERENCES IN FATIGABILITY AND ATHLETIC PERFORMANCE

HUNTER, S.

MARQUETTE UNIVERSITY

Every cell in the human body has a sex. Consequently, males and females differ in anatomy and physiology resulting in marked sex differences in neuromuscular performance, and fatigability of limb muscles. Typically, males outperform females in athletic and neuromuscular performance after puberty across all age groups primarily due to the effects of testosterone which is ~15-20 times greater than females from ~18 years of age. Males on average have larger, stronger, faster and more powerful skeletal muscles. The sex difference in muscle strength and power range from 10-40% depending on the demands of the task and the muscle groups involved. In contrast, there are minimal sex differences in the ability to activate the available skeletal muscle during voluntary contractions prior to fatiguing tasks.

While males are stronger and more powerful than females, the relative decrement in force or power during a fatiguing task of males is usually larger than for females, primarily for isometric and slow-velocity fatiguing contractions. This sex difference in fatigability (relative exercise induced reduction in force or power) is not typically observed during fast-velocity contractions. This presentation will highlight some of the fundamental differences in physiology and anatomy that dictates the sex differences in athletic performance and fatigability. Understanding the sex difference in neuromuscular fatigability has important implications for training and rehabilitation in males and females.

Finally, despite more concerted efforts in the last ~15-20 years to include females in mechanistic studies, there is still inadequate inclusion of females and knowledge on the mechanisms for sex differences of fatigability and athletic performance. The sex bias of studying more males than females in both human and animal experiments in physiology and fatigability has led to the false assumption that males and females respond similarly to interventions including fatiguing exercise. The field is ripe with opportunities to clarify and understand the sex differences in neuromuscular fatigability, athletic performance, and the underlying mechanisms during different tasks.

DO WOMEN SHOW THE SAME STRUCTURAL AND FUNCTIONAL RECOVERY AS MEN AFTER AN ENDURANCE RACE?

NICOL, C.

AIX-MARSEILLE UNIVERSITÉ

The number of participants in endurance running races has increased dramatically in recent years, especially for the half-marathon. Despite the significant health benefits of regular endurance running, it is characterized by thousands of ground impacts and eccentric muscle actions. This can induce focal structural muscle damage leading to muscle regeneration and functional recovery that last a few days after exercise. Oestrogen however, may make women less prone to muscle fatigue, muscle damage and more rapid recovery of muscle structure and function. Only a few studies however, have analysed the sex-specific recovery pattern, and such comparative analyses have been performed for the acute recovery phase only.

In men, the pattern of functional recovery is described as biphasic, and characterized by immediate functional deficits, followed by partial recovery at 2 h, before new deficits 1 to 2 days later that decrease only gradually over several days. The delayed recovery phase is mainly attributed to the structural and functional consequences of the inflammatory/remodelling processes after exercise-induced muscle damage. This phase is accompanied by delayed onset muscle soreness (DOMS). However, because DOMS is only felt around the inflammatory peak, it disappears before full structural and functional recovery is achieved. This constitutes a potential risk of injury when training resumes as runners may overestimate their actual functional capacities. Furthermore, although a causal relationship between muscle damage and force deficit has been reported after eccentric exercise, only a few running studies have assessed structural and functional recovery of the muscle in parallel other than through indirect blood markers of muscle inflammation (e.g. creatine kinase). Furthermore, whether there are sex-related differences in recovery of muscle from running is not known.

We recently compared the structural and functional recovery patterns of recreational female and male runners after a 20-km gradient race. The inflammatory stage was assessed by ultrasound and magnetic resonance imaging. Women had more DOMS and increases in inflammation markers in the hamstring muscles than men, but no differences in the other muscles. Depending on the test, women had similar or less functional deficits and earlier recovery than men. EMG analysis revealed a sex-specific organisation of muscle synergies that could in part explain the sex differences in recovery

times. For example, women recovered faster in drop-jump, a test in which they showed less hamstring contribution, even in the pre-fatigue session.

Finally, irrespective of sex, the lack of a clear relationship between structural alterations in the muscle and functional deficits is attributed to the various neuromuscular compensations that can occur during dynamic multi-joint contractions.

HORMONAL BASIS OF SEX DIFFERENCES IN ATHLETIC PERFORMANCE

SENEFELD, J.

MAYO CLINIC

The world of sport is facing the challenge of creating sport-specific safeguards that promote fair competition and participation for all athletes - including people who are born with differences of sex development and people who identify as transgender or elsewhere on the gender spectrum. Substantial evidence supports that testosterone is strongly associated with sex-based differences in sports performance, more so than any other known factor. The pronounced differences between the sexes in endogenous testosterone levels beginning at puberty correspond to sex-specific divergence in oxygen carrying capacity in the blood (via hematocrit and hemoglobin); muscle strength and endurance; cardiac output; and sports performance. In this framework, this presentation will use elite athletic performance as a model to provide key insights into the timing and magnitude of sex differences in athletic performance during human development and throughout adulthood.

Before puberty, there are limited differences in athletic performance among elite girls and boys. Thus, this presentation will highlight that youth sports should likely focus on inclusivity and equity between girls and boys.

Beginning with the onset of puberty, sex-based differences in anatomical structure (body, limb, airway, and organ size) develop, such that, on average, people who have undergone male puberty are taller; have longer limbs; have larger lungs and wider conducting airways; and have larger hearts compared to people who have not undergone male puberty. In this context, athletic performance during adulthood will highlight sex-based differences in athletic performance and the key contributing physiological factors. Additionally, the impacts of participation by both males and females will be considered, and the potential role of participation in observed differences in athletic performance.

Finally, this presentation will propose that well-coordinated, multidisciplinary research is needed to provide evidence to support sport-specific safeguards that promote fair competition and participation for all athletes - including people who are born with differences of sex development and people who identify as transgender or elsewhere on the gender spectrum.

Invited symposia

IS-PN03 The importance of intramuscular signals on skeletal muscle function in health and disease

ACUTE ADAPTATIONS OF SKELETAL MUSCLE TO EXERCISE: A TRANSLATIONAL APPROACH

PLACE, N.

UNIVERSITY OF LAUSANNE

The transient reduction in muscle force generating capacity after exercise, i.e. muscle fatigue, has been extensively studied for more than a century using different models (from isolated muscle fibre to exercising humans) but there is still no clear consensus about the underlying mechanisms. This lack of consensus might originate from the multifactorial nature of muscle fatigue, potentially involving processes along the whole neuromuscular pathway - from action potential generation at the brain level to the interaction of contractile proteins within the muscle. This presentation will take concrete examples in the literature to illustrate the potential contribution of neural vs. intramuscular factors in the acute adaptations to exercise. Although an arsenal of techniques has been developed to evaluate neuromuscular fatigue in humans, this talk will highlight some of the drawbacks that researchers should keep in mind and provide practical recommendations. We will also show results combining data from various models to emphasize the role of metabolic factors in impaired skeletal muscle Ca2+ handing in response to exercise. As an example, we will discuss the role of the sarcoplasmic reticulum Ca2+ release channel - the ryanodine receptor - as a key regulator of mitochondrial adaptations in response to exercise. This talk is intended to be of broad interest to the sport science community including researchers, sport coaches and clinicians, as it will combine data obtained from non-invasive measurement with more mechanistic investigations for a better understanding of skeletal muscle function.

THE CENTER STAGE OF GLYCOGENOLYTIC DERIVED ENERGY IN SKELETAL MUSCLE FATIGUE

ØRTENBLAD, N.

UNIVERSITY OF SOUTHERN DENMARK

It is well known that glycogen content and turnover is a limiting factor for normal muscle function during both prolonged and high-intensity intermittent exercise. However, the mechanisms explaining why and how glycogen and glycolysis are integrated with muscle function are far from understood. The talk will provide a comprehensive overview of the current understanding of the glycogenolytic regulation of muscle contractile properties. This will bring together recent advance-

ments demonstrating that vital regulations of ions within the cell are controlled locally in micro-domains and that the specific characteristics of glycogen metabolism and glycolysis may provide an essential path for such local control. It is herein remarkable how skeletal muscle fibers to balance energy utilization with production is of vital importance for all cell types, preventing loss of energy and thereby cell integrity, but particularly important in skeletal muscle with a high and fluctuating energy-turnover. Still, the scientific community has mere explanations on how this remarkable precise balance between energy conversion and work is accomplished. We and colleagues in the field have now established research methods to pin-point the mechanisms linking glycogen and glycolytic flux to muscle cell key functions. This has demonstrated that the specific metabolic pathway of glycolysis, which is rate depending on muscle glycogen, is essential for both membrane excitability and calcium regulation. The talk will in line with the overall proposed symposia demonstrate and discuss recent advancements in our understanding of the role of glycogenolytic derived energy, based on experiments from the isolated muscle fibre through to human whole-body exercise, including high level athletes.

INSIGHT INTO HOW INTRAMUSCULAR STRESSORS INTERFERE WITH THE MUSCULAR MACHINERY

LANNER, J.

KAROLINSKA INSTITUTET

Skeletal muscle has an impressive ability to adjust to physiological challenges with enhanced muscle strength and aerobic capacity as examples of beneficial adaptations. However, in disease conditions, and even during normal aging, skeletal muscle may become dysfunctional and weak., i.e., entering a maladaptive state. Both the adaptive and maladaptive alterations to skeletal muscle may occur even without changes in muscle mass, highlighting the importance of the intramuscular machinery for muscle performance, including mitochondria and the contractile apparatus. This presentation will focus on how exercise- and disease-induced intramuscular signals/stressors (including Ca2+, reactive oxygen species, TNFa) contributes to skeletal muscle adaptation and maladaptation. With data from human subjects and preclinical models, emphasis will be put on how intramuscular signals/stressors contribute to reduced mitochondrial health and muscle weakness in subjects with non-communicable disease, for example rheumatoid arthritis and breast cancer. We will also discuss in what manner molecular tools that empower the mitochondrial health can be used to counteract disease-induced muscle maladaptations.

Oral presentations

OP-AP22 Cycling: Training and Testing

CAN WE ACCURATELY PREDICT CRITICAL POWER AND W FROM A SINGLE RAMP INCREMENTAL EXERCISE TEST?

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DEPARTMENT OF MOVEMENT AND SPORTS SCIENCES, GHENT UNIVERSITY, GHENT, BELGIUM

INTRODUCTION: The critical power model defines the hyperbolic relationship between power output (PO) and its sustainable endurance time by two parameters: critical power (CP) and the work capacity above CP (W'). Theoretically, CP represents the maximal metabolic steady state intensity while W defines a fixed amount of energy available during efforts above CP (1). The practical use of the CP model remains heavily constrained by the necessity to perform multiple exhaustive constant work rate (CWR) tests. Therefore, alternative test protocols have been explored, including a simple ramp incremental test (2), which seems feasible as it can be easily tailored to the individual by adjusting the ramp slope and because these tests are already widely utilized in both sports and clinical practice (3). The purpose of this study was to examine the suitability of a single ramp incremental test to predict critical power (CP) and W. We hypothesized that CP would correspond to the corrected power output (PO) at the respiratory compensation point (RCP) and W would be calcutable from the work done above RCP.

METHODS: 153 healthy young people (26±4 yr, 51.4±7.6 mL·min-1·kg-1) performed a maximal ramp test (20, 25 or 30 W·min-1), followed by a series of constant load trials to determine CP and W. CP (243±46 W) and W (18.7±4.7 kJ) were estimated using a 'best individual fit' approach, selecting the mathematical model with the smallest total error. RCP was identified by means of gas exchange analysis and then translated into its appropriate PO by applying a correction strategy. We evaluated the agreement between CP and the PO at RCP, and between W and the total work done above CP (WRAMP>CP) and above RCP (WRAMP>RCP), as derived from the ramp test.

RESULTS: CP was significantly higher than the PO at RCP (Δ = 8±16 W, $p<0.001$). WRAMP>CP was significantly lower than W (Δ = 1.9±3.3 kJ, $p<0.001$), whereas WRAMP>RCP and W did not differ from each other (Δ = -0.6±5.8 kJ, $p=0.21$).

CONCLUSION: Despite the fact that CP and RCP occurred in very close vicinity, the estimation of W from ramp exercise may be problematic given the likelihood of underestimation and considering the large variability. Therefore, we do not recommend the interchangeable use of CP and W values derived from constant load vs. ramp exercise, in particular when the goal is to obtain accurate estimates or to predict performance capacity.

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FORCE-VELOCITY-ENDURANCE RELATIONSHIP: DEVELOPMENT OF A MATHEMATICAL MODEL AND VALIDATION OF THE IFLET TEST

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INTRODUCTION: Force production capacities during brief maximal efforts are constrained by a force-velocity relationship, a negative linear function characterized by theoretical maximum force (F0) and velocity (V0) [1]. For longer efforts, the intensity-duration relationship is mathematically described by an asymptotic decay function, the asymptote being the critical intensity [2]. Changing the force and velocity produced during an exercise e.g. by manipulating cadences in cycling, modifies the intensity-duration relation [3]. When the effort is prolonged, alterations in force and velocity capacities may also be different. Unfortunately, a unified force-velocity-time relationship as a representation of biomechanical and bioenergetical capacities of exercise performance has never been modeled. The aims of this study were to develop a mathematical model of a force-velocity-time relationship and to validate a test to determine the model parameters.

METHODS: Based on the assumptions that i) the force-velocity relationship is linear and remains so when fatigued and that ii) both the force and velocity capacities decrease over time following an exponential decay function, a mathematical model has been developed. It is defined by 6 parameters being initial force (F0i) and velocity (V0i) capacities, the critical force (F0c) and velocity (V0c) capacities and the time constants for force (TauF) and velocity (TauV) decay. 16 participants realized the IFLET test on two separate days to test the reliability. It consists in a modified cycling 3-min all-out exercise during which the flywheel was instantaneously braked every 30 s so that the participant had to re-accelerate, thus allowing regular evaluation of the force-velocity capacities. The mean force and velocity of each pedal stroke was computed and used to fit the model's parameters.

RESULTS: The goodness of the fit of the model from experimental data was excellent (all $r^2 > 0.93$). F0i and V0i presented no systematic bias, excellent ICC (> 0.9) and very low SEM (< 5%). F0c and V0c demonstrated very good reliability (ICC > 0.8) and low SEM (5.4 and 7.6 %, respectively). TauF and TauV showed good reliability (ICC > 0.75) but higher SEM (~20%). Overall, when looking at the F(v,t) surface, independently of the parameters mentioned above, the relative and absolute reproducibility was very good to excellent.

CONCLUSION: This is the first time that a model describes the force capacity considering both velocity and time simultaneously. This model fitted very well with experimental data obtained during the IFLET test, a 3-min all-out sprint interspersed exercise which also showed very good test-retest reliability. Applications of this approach could be numerous in the evaluation of physical capacities as well as for performance application through training or the optimization of human-material interactions.

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MUSCLE TYPOLOGY UNDERPINS SPRINT CYCLING CHARACTERISTICS IN ELITE TRACK CYCLISTS

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INTRODUCTION: Maximal power output (i.e., Pmax) and the ability to maintain Pmax (i.e., fatigue rate) are key determinants of track sprint cycling events. Track sprint cyclists have been categorized as possessing fast-typology (i.e., a greater proportion of type II fibres)1,2. Nonetheless, it is unknown whether muscle typology underpins the key characteristics (i.e., Pmax and fatigue rate) of track sprint cycling. The aim of this study was to determine whether muscle typology is associated with the key mechanical characteristics of track sprint cycling in elite track cyclists.

METHODS: Ten male (84.3 ± 8.3 kg) and eight female (66.5 ± 9.4 kg) elite track cyclists volunteered for this study. Five cyclists were classified as world-class athletes, with the remaining thirteen cyclists classified as elite3. Within this cohort, 13 were track sprint and 5 were track endurance specialists. Subjects attended a laboratory testing session where they performed a sprint cycling protocol on either a Lode or custom motor driven SRM ergometer, both with a standard crank length of 170 mm. The laboratory session was comprised of three 5-s maximal sprints completed in isokinetic mode at fixed cadences (80, 120, 160 rev·min-1). Data from the ergometers and power meters were stroked averaged and fatigue free torque- and power-cadence profiles were constructed. Pmax and the corresponding optimal cadence (Fopt) were identified following best practice methodology4. Cyclists then completed two optimised sprints; a 5 s and 15 s maximal effort which were completed at the athletes Fopt, whereby stroke averaged data was used to quantify fatigue per pedal stroke. Carnosine content was quantified by proton magnetic resonance spectroscopy in the gastrocnemius and soleus and expressed as an aggregate Z-score to estimate muscle typology. The association between muscle typology and the

mechanical parameters of the torque- and power-cadence profiles and fatigue rate per pedal stroke in the optimized sprint were analysed using linear regression.

RESULTS: Muscle typology explained 50% and 55% of the variation in Pmax in males and females, respectively (P<0.05), whereby a higher carnosine Z-score (i.e., greater estimated proportion of type II fibres) was associated with a greater Pmax. In contrast, while muscle typology explained 41% of the variation in the fatigue rate of male track cyclists (i.e., a higher carnosine Z-score was associated with a greater fatigue rate), there was a trivial association in female track cyclists.

CONCLUSION: These findings indicate that for male track cyclists there is a trade-off between Pmax and the decrement in power output per pedal stroke with variation in muscle typology, while Pmax is also underpinned by muscle typology in elite female track cyclists.

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METABOLIC SIGNATURES OF PERFORMANCE IN ELITE WORLD TOUR PROFESSIONAL CYCLISTS DURING COMPETITION

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INTRODUCTION: Investigations in elite professional athletes offer a unique opportunity to determine the ceiling of human performance, providing a benchmark to compare human physiology of healthy occasional, recreational, semi-professional and professional athletes. While omics characterizations of recreational and professional athletes under controlled acute training regimens have provided information regarding substrate utilization as a function of exertion, studies are scarce on these processes in elite professional athletes during testing in the field and, more importantly, World Tour competitions.

METHODS: Using dried blood spot collection to circumvent logistical hurdles associated with field sampling, whole blood samples were isolated from 28 international-level professional male cyclists before and after a graded exercise test (GXT) to volitional exhaustion and before and after a long aerobic field training (FT) session (180 km). Additional samples were taken from 5 of these cyclists before and after three stages of a multi-stage World Tour race. Samples were analyzed using high-throughput mass spectrometry-based metabolomics and lipidomics.

RESULTS: Blood profiles of lactate, carboxylic acids, fatty acids and acylcarnitines differed between different exercise modes (GXT and FT). The GXT elicited significant accumulations in lactate and succinate, in addition to significant elevations in free fatty acids and acylcarnitines. Conversely, FT elicited a larger magnitude of increase in fatty acids and acylcarnitines without appreciable increases in lactate or succinate. Comparable signatures were revealed after sprinting and climbing stages, respectively. In addition, signatures of fatty acid oxidation capacity correlated with competitive performance.

CONCLUSION: Collectively, these studies provide a unique view of alterations in the blood metabolome of elite athletes during competition and at the peak of their performance capabilities. Furthermore, they demonstrate the utility of dried blood sampling for omics analysis, thereby enabling molecular monitoring of athletic performance in the field during training and competition.

MIXED-METHOD PRE-COOLING AND SELF-PACED CYCLING PERFORMANCE IN THE HEAT: EFFECTS OF APPARENT TEMPERATURE

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INTRODUCTION: It is often believed that pre-cooling (PreC) may only be of benefit to performance when the thermal strain experienced by an individual is sufficiently high, even though this claim is largely unsubstantiated. Thus, the aim of this study was to explore the effects of mixed-method PreC on 20-km cycling time-trial (CTT) performance in various apparent temperatures (AT).

METHODS: Twelve male cyclists or triathletes (mean ± SD: Weekly training distance and frequency = 289 ± 176 km and 5 ± 1, respectively) completed six 20-km CTT separated by 7 days in a randomised order in three different apparent temperatures: hot-dry (31°C, 49% RH; 35°C AT [35AT]), moderately hot-humid (34°C, 55% RH; 40°C AT [40AT]), and hot-humid (36°C, 71% RH; 46°C AT [46AT]) . All trials were preceded by 30 min of mixed-method PreC (crushed ice ingestion 7g·kg-1 body mass + cooling vest) or no cooling (control; CON) in a thermoneutral environment.

RESULTS: During the PreC period, rectal temperature (Tre) was not significantly lower when PreC was applied. However, Tre decreased by 0.01 – 0.02°C/min, which was significantly greater than the rate of decrease in CON ($p < .01$). Mean skin temperature (Tsk) was also 0.70 – 0.87°C lower when PreC was applied compared to CON during the PreC period ($p < .01$). During the CTT, PreC reduced the rate of split time increase in 46AT by 1.14 s/km compared to CON (βdist x temp x int = 1.72, $p < .01$). Further, Tre did not differ between CON and PreC (37.22 vs. 37.03°C, $p > .05$). However, an interaction

effect between condition and distance cycled (βtemp x dist = 0.03, p < .01) indicated that Tre increased over the course of the CTT faster at 46AT (βPreC = 0.11°C/km; βCON = 0.10°C/km) than 35AT (βPreC = 0.07°C/km; βCON = 0.08°C/km). The rate of change in Tsk across the CTT was 0.04°C/km higher when PreC was applied than CON in 46AT only (βtemp x dist x int = 0.04, p < .01). Pre-cooling decreased average rating of perceived exertion compared to CON in 46AT (βint x cond = -1.03, p < .01). Average thermal comfort and sensation during the CTT were significantly lower for PreC compared to CON in 40AT (p < .01) and 46AT (p < .01). Furthermore, the rate of increase in thermal comfort and sensation across the CTT was also higher when PreC was applied (p < .01) compared to CON (p < .01).

CONCLUSION: Although not detrimental to performance, PreC provided the greatest benefit to 20-km CTT performed in hot-humid environmental conditions compared to hot-dry and moderately hot-humid conditions. This may be due to lower mean Tsk and improved exercise-related sensation when PreC is utilised compared to no cooling. Therefore, mixed-method PreC may be of greater benefit to endurance performance when applied in hot-humid environments (>46AT) compared to hot-dry and moderately hot-humid conditions (<46°C AT).

Oral presentations

OP-BM03 Biomechanics: [Muscle and/or tendon function]

IN-VIVO ESTIMATION OF DYNAMIC POSTERIOR TIBIAL TENDON EXCURSION AND TORSION USING ULTRASOUND SPECKLE TRACKING: PRELIMINARY RESULTS

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INTRODUCTION: Abnormal torsion of the posterior tibial tendon (PTT) is suggested to be associated with the avascular injury mechanism of tendon degeneration [1]. As dynamic tendon torsion is theorized to present along with tendon excursion during joint motions [2], assessments of both tendon motions are essential in understanding the injury mechanism and prognosis of PTT dysfunction. Ultrasound speckle tracking (UST) is a non-invasive method that can quantify in-vivo tendon motions [3]. The present study utilized UST to investigate tendon excursion and torsion during passive joint motion or isometric muscle contraction and compare outcomes between individuals with neutral and pronated feet.

METHODS: Eight individuals with neutral feet (NE group, age: 25.8±2.28 years) and five individuals with pronated feet (PR group, age: 22.8±2.9 years) were enrolled. All participants were asked to perform passive ankle eversion and isometric ankle inversion tasks on an isokinetic dynamometer. During both tasks, a series of long-axis and short-axis PTT ultrasound images (USIs) was taken sequentially at 2 cm above the medial malleolus using a 4–15 MHz ultrasound probe. UST was then applied to the recorded USIs to calculate speckle displacements within the self-defined region of interest to quantify in-vivo tendon excursion (millimeter) from long-axis images and tendon torsion (degree) from short-axis images. The Mann–Whitney U test was used to evaluate between-group differences.

RESULTS: A significant difference was found in PTT torsion during passive ankle eversion (median [interquartile range]; NE: 3.77° [4.10°], PR: 7.48° [5.14°]; p=0.048; d=1.07) but not during isometric ankle inversion (NE: 3.69° [2.17°], PR: 5.93° [2.04°]; p=0.177; d=0.49) between the groups. No significant between-group differences were noted in PTT excursion during passive ankle eversion (NE: 0.53 [1.10] mm, PR: 1.36 [1.28] mm; p=0.222; d=1.27) and isometric ankle inversion (NE: 1.21 [0.77] mm, PR: 1.75 [3.31] mm; p=0.622; d=0.37).

CONCLUSION: To our knowledge, the present study is the first to report dynamic PTT torsion in vivo. From our preliminary results, as tendon excursion and torsion are suggested to co-occur, more tendon excursion and torsion during passive ankle eversion might imply excessive tendon movement associated with the altered foot posture. However, more participants should be included to further increase the statistical power. Future work should also incorporate measurements of the tendon's mechanical properties to support the hypothesis.

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A FORCE-ENDURANCE MODEL ABLE TO DESCRIBE THE MUSCLE FATIGABILITY IN THE SEVERE DOMAIN: VALIDATION ON ELECTRICALLY STIMULATED ADDUCTOR POLLICIS.

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INTRODUCTION: Muscle fatigue refers to the decay in muscles' ability to generate force. The Critical Power (Pc) concept (1) predicts the point at which fatigue develops in such a way that the required constant intensity will no longer be sustainable, i.e., time to exhaustion (TTE). However, this model only distinguishes two states: when it is possible to continue the exercise or not depending on whether W' (fixed amount of work that can be performed above Pc) is emptied or not. Recently, Bowen et al. (2) extended the Morton's 3-parameters model (3) to describe maximal force decrease over time in

the severe domain, whatever the intensity being constant or variable: Fmax(t) = (-1/Tau) integral(F(t)-Fc)dt + Fi. This study aimed at testing the predictive capacity of this model for constant, ramp, and oscillatory intensities on electrically stimulated Adductor Pollicis in isometric condition

METHODS: A custom ergometer coupled with an electrical nerve stimulation system was developed to study the Adductor Pollicis isometric force production capacities, independently of participants' voluntary activation. While participants remained passive, a PID control regulated ulnar nerve stimulation discharge frequency between 6 and 30 Hz to follow a force target. Maximal capacities (Fmax) were assessed every 15 s with 100 Hz tetanus of 500 ms duration. Eight participants realized 3 experimental sessions. The individual parameters Fi, Fc and Tau were determined by adjusting the model to Fmax and time data from constant intensity tests. Model's validity was tested through the accuracy of the model's prediction of i) exhaustion times during increasing ramp tests and ii) Fmax(t) during an oscillatory force exercise (sinus function between Fc and Fc + 0.1 Fi with a 120 s period).

RESULTS: The model's goodness of the fit on constant exercise experimental data was excellent (median adjusted R2 = 0.96; interquartile range = 0.15; RMSE = 4.4 ± 2.7 %Fi). Mean ± SD Fi, Fc and Tau were respectively 95.9 ± 1.2 %Fi, 22.4 ± 4.1 %Fi and 39.9 ± 15.5 s. Mean difference between predicted and observed TTE was 8.9 ± 18.2 s (RMSE = 9.7 ± 5.2 %Fi). The RMSE between predicted and observed Fmax during the oscillatory test was 6.1 ± 3.1 %Fi.

CONCLUSION: The present results evidenced that it is possible to determine individual model's parameter Fi, Fc and Tau from experimental data obtained during electrically induced isometric contractions of the Adductor Pollicis. Moreover, once individually fitted, the model showed very good predictions of the time to exhaustion in an increasing ramp test. Finally, the proposed model allowed for the accurate prediction of fatigue, i.e., decrease in maximal force, over an oscillatory fatiguing exercise. To conclude, the force-endurance capacities mathematical model seems valid to characterize muscle-level isometric fatigability in the severe domain, independently from central mechanisms.

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EVIDENCE OF DIFFERENT SENSITIVITY OF MUSCLE AND TENDON TO MECHANO-METABOLIC STRESS

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INTRODUCTION: Inability of tendons to match muscle strength gains in response to exercise could lead to an imbalance between these structures and place the tendon under a higher mechanical demand (i.e. higher strain; 1). The current investigation aimed to examine the effects of mechano-metabolic stress on the temporal dynamics of triceps surae (TS) muscle and Achilles tendon (AT) mechanical and morphological adaptive changes by conducting fatiguing cyclic mechanical loading exercise at low and high muscle force generation capacity.

METHODS: Twelve young adults (27±5 yrs) completed a 12-week training intervention of 3 weekly sessions of 3 sets of cyclic unilateral isometric plantarflexion contractions at 80% of maximal voluntary contraction until failure to induce high muscle metabolic stress. As TS muscle operates on the ascending limb of the force-length-relationship (2), a short (PF; 115º) or a long (DF; 85º) muscle-tendon unit (MTU) length was used for each leg during exercise to achieve low and high levels of mechanical stress, respectively. TS MTU mechanical and morphological properties were assessed biweekly via simultaneous ultrasonography and dynamometry. All three compartments of the TS muscle and the AT were 3D reconstructed using magnetic resonance imaging.

RESULTS: Similar temporal adaptive increments in TS muscle strength, pennation angle and cross-sectional area were found between DF and PF legs over the 12 weeks of cyclic fatiguing loading exercise ($p<0.05$). DF leg demonstrated a significantly higher AT stiffness post 12 weeks of training (pre 473 ± 106 vs. post 12wk 523 ± 107 N/mm; $p<0.05$) along with greater AT CSA, with no observable changes in AT force-length relationship for the PF leg. In both legs, maximal AT strain followed a similar temporal increase within the first 8 weeks (on average relative tendon strain increase ≈15%), after which a continuous reduction towards baseline levels was observed only in the DF leg. The PF leg demonstrated a further increase until the end of the 12-week intervention (on average from 5.4 to 6.6%).

CONCLUSION: The current findings provide evidence that muscle and tendon responsiveness to mechano-metabolic stress over time differs in rate and magnitude, and that muscle is more sensitive to metabolic stress and muscle activation, whereas tendon adaptation depends primarily on the magnitude of experienced stress and strain. We propose that such differences between muscle and tendon sensitivity to mechano-metabolic stimuli can temporarily lead to higher functional demand on the tendon and need to be considered to reduce the risk of unbalanced adaptive changes within the MTU during exercise.

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TORQUE-ANGLE AND TORQUE-VELOCITY RELATIONSHIPS DURING UNILATERAL LEG EXTENSIONS: TOWARDS AN INDIVIDUAL TORQUE-VELOCITY-ANGLE PROFILE

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INTRODUCTION: Torque production for single- or multi-joint movements depends on joint angle and angular velocity due to the muscle force-length and force-velocity relationships[1]. Therefore, to characterise individual strength variations with joint angle and angular velocity can be useful to better understand and enhance human performance.

A three-dimensional model constructed from Hill's hyperbolic Torque-angular Velocity (T-V) and Torque-Angle (T-A) relationships modelised by a second order polynomial can be used to describe the Torque-Velocity-Angle (T-V-A) relationship[1]. However, this model is based on some assumptions, such as: 1) the optimal joint angle (A0) at which the maximal torque is produced for a given angular velocity is independent on the angular velocity, and 2) the T-V relationship can be modelised by the Hill's function over the entire angle spectrum. So, in order to validate these assumptions, the purpose of this study was to test 1) the A0 independence from velocity, 2) the degree of fitting (r^2) of Hill's hyperbolic T-V model for different joint angles, and 3) the consistency of the T-V relationships parameters (theoretical maximal torque, T0, and angular velocity, V0; curvature of the T-V relationship, C).

METHODS: Seven active participants randomly completed maximal intensity isokinetic knee extensions at 21 angular velocities (30 to 450°/s). Range of motion was set from 0 (full extension) to 110° knee flexion.

A0 was calculated for each angular velocity from the second order polynomial T-A relationships. A0 coefficients of variation were calculated to determine the deviation of A0 across velocities.

T-V relationships from Hill's hyperbolic function at different knee angles were modelised from experimental torque, angle and angular velocity data. T0, V0 and C were then extrapolated. Repeated measures ANOVAs were used to test differences in T-V relationship parameters (T0, V0, C and r^2) at three knee angles: A0-30°, A0-15°, A0.

RESULTS: Maximal torque occurred between 64 to 80°, resulting in a mean A0 of 72±8° knee flexion. The mean coefficient of variation was 6.72±4.08% illustrating that A0 remains stable across velocities.

T0 was significantly lower at A0-30° (156±17 N.m) than at A0-15° (194±23 N.m), and lower at A0-15° than at A0 (223±27 N.m).

Despite a high-level fitting (r^2>.85), V0 and C did not significantly change according to the knee angle, probably because of the high variability of the modelised values illustrated by a small effect size (η^2=0.005).

CONCLUSION: The optimal knee angle does not depend on the contraction velocity. Maximal torques obtained by Hill's hyperbolic extrapolation varied according to the second order polynomial torque-angle relationships. This result confirms the independent effect of angle and angular velocity in torque production. Further studies should include experimental data closer to the maximal knee angular velocity to improve model parameter adjustments, mainly V0 and C.

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TRICEPS SURAE MUSCLE-TENDON UNIT MECHANOBIOLOGICAL RESPONSES TO FREQUENT HIGH MAGNITUDE OF MECHANICAL LOADING

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INTRODUCTION: Muscle strength gains in response to long-term exercise are commonly accompanied by increased tendon stiffness (1), which is reported to increase tendons tensional load resistance. Over shorter timeframes muscles however react to mechanical loading at faster tissue renewal rates than tendons (2). Accordingly, frequent exercise with limited resting periods may lead to a net degradation of tendon matrix (3), potentially causing a higher mechanical demand for the tendon (i.e. increased strain). The current study examined the effects of consecutive repetitive high strain cyclic loading with different resting periods on triceps surae (TS) muscle-tendon unit (MTU) mechanical properties and extracellular matrix turnover-related biomarkers.

METHODS: Eleven young healthy male adults (26±6 yrs) underwent 12 consecutive days of isometric resistance exercise for ankle plantarflexors using high AT strain cyclic loading (90% MVC). Participants exercised one leg once a day (~24h rest; low dose) and the contralateral leg three times a day (~2h rest between sessions within day; high dose). TS MTU mechanical properties (maximal AT force, maximal AT strain and AT stiffness) were assessed at baseline, every second day of exercise intervention and 48h after last day (i.e. retention effects) using synchronized dynamometry, ultrasonography and motion capture. Further, extracellular matrix turnover-related biomarkers concentrations were determined from serum along the exercise period.

RESULTS: Similar increase in maximal AT force (~10%) was observed along the 12-day exercise period in both legs. While low dose exercise did not alter the AT mechanical properties, high dose leg showed ~20% increase in maximal AT strain along with a corresponding decrease in AT stiffness already after 8 consecutive days of high AT strain cyclic loading, an effect which remained even after 48h of rest ($P<0.05$). However, when adjusting for total training volume no significant leg-differences in tendons force-length-relationship were observed. Extracellular matrix biomarker analysis revealed no

inflammatory responses, but an altered collagen turnover and delayed increase in collagen type I synthesis rate. Further, biomechanical and biochemical measurements were supported by gradually higher perceived AT pain in the high dose trained leg.

CONCLUSION: This study indicates that frequent high strain cyclic loading exercise can lead to a persistent elevated tendon strain, potentially due to an accumulation of molecular damage within the tendon. One decisive factor to exercise-related increase in tendon strain seems to be the total experienced volume of mechanical loading. Hence, high cyclic mechanical loading over short timeframes may overweigh tendon's recovery leading to an increased demand and decrease tendons' tensional load resistance.

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Oral presentations

IS-EX02 FEPSAC invited symposium - Psychological perspectives on sport injuries

IMPLEMENTATION OF PSYCHOLOGICAL BASED STRATEGIES FOR INJURY PREVENTION

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There are high injury rates associated with sport participation, both on grassroot as well as lite level. Taking this into consideration-together with the negatively consequences at the individual, team/club, and community levels-the development of preventive programs and strategies for sport injuries are important. In the process of developing effective preventive programs and strategies, the first step is to identify risk factors that will increase the likelihood of sport injuries. In the history of research focusing on risk factor and prevention of sport injuries, the dominant perspectives have been physiological and/or biomechanical During the last three decades, the role of psychological factors in sport injury prevention has, however, gained more attention. The aims of this presentation are to: (a) present psychosocial risk factors for injuries, (b) describe potential mechanisms for the relationship between the presented risk factors and sport injuries, and (c) discuss the development and implementation of psychological based injury prevention programs. In relation to the first aim (a) the focus will be to present psychosocial risk factors for sport injuries. Following the presentation of risk factors, I will also explain how these risk factors might influence injury risk (aim b). Related to the last aim (c) I will present the designs and effects of injury prevention programs implemented in different sports. Despite most studies having shown that psychological based training programs can reduce the number of injuries within several different sports, there are few teams, clubs, or organisations that have included this type of training into their general injury prevention programs. There might be several reasons for the rather unsuccessful implementation of this type of content into general prevention practice. I will, therefore, also discuss aspects that can improve the implementation of psychological strategies within the injury preventive work for sport clubs. This talk is relevant to researchers and clinicians wishing to understand the how psychological techniques and strategies can be implemented to prevent sport injuries within various sporting contexts.

PSYCHOLOGICAL INTERVENTIONS TO OPTIMISE POST-INJURY RECOVERY

VAN DE WOUW, A.

PRIVATE PRACTICE

For competitive athletes the chance of sustaining an injury during a regular season is fairly high. One could argue that injury is an inevitable part of engaging in sport.

In prevention and rehabilitation of sport injuries, the primary focus of sports medicine professionals is on the physical aspects. However, psychosocial variables also influence both injury risk and injury rehabilitation outcomes (1). A variety of psychosocial interventions both pre-and post-injury have been developed and scientifically evaluated, but these are often overlooked (2).

In adopting a holistic perspective on injuries, the aim of this presentation is to: (a) examine psychological interventions that have been shown to optimise post-injury recovery, (b) articulate benefits of these interventions and (c) discuss ways of implementing them in rehabilitation programmes.

In regards to aim (a), research indicates that psychosocial interventions can facilitate post-injury recovery by managing fear and anxiety, increase motivation, positively influence therapy compliance and speed up the rehabilitation process (3). Psychosocial interventions shown to be effective are: relaxation, imagery, goal setting, self-talk, self-confidence, social support and effective physician-patient communication (3). The focus of this talk will be on relaxation and imagery. In relation to aim (b), the use of deep breathing or voluntary muscle relaxation techniques during physical rehabilitation has shown to decrease anxiety and pain, and to speed physical recovery (3). Using imagery results in a faster recovery time from injury (3). Finally, for aim (c), various ways of integrating relaxation and imagery exercises in rehabilitation pro-

grammes will be discussed. Examples will be given from my experience working with injured athletes and sport medicine professionals. Key is integrating the interventions into the daily rehabilitation schedules, providing information, communication, co-operation and education.

This talk is relevant to clinicians, injured athletes, coaches and researchers wishing to know more about psychological interventions optimising post-injury recovery, the benefits of these interventions and how they can be implemented.

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A RELATIONAL PERSPECTIVE ON THE RETURN TO SPORT FOLLOWING INJURY

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Over the past 20 years, research has shed light on a variety of psychological factors influencing athlete's return to sport following injury. The return-to-sport (RTS) refers to the time frame when athletes are transitioning from the completion of rehabilitation (or recommended rest period) to sport-specific training and competitive performances. While much of the research to date has focused on variables impacting athletes' RTS, an exclusive focus on the athlete neglects the fact that returning athletes can impact and be impacted by relevant others in the rehabilitation environment. The latter focus has been referred to as a relational perspective on sport injury. In adopting a relational perspective on the RTS, the aim of this presentation is to: (a) examine returning athlete's impact on key injury stakeholders, (b) articulate benefits of a relational perspective and (c) discuss future relational research on the RTS. In regards to aim (a), initial research suggests that a returning athlete can have a range of positive and negative effects on coaches, teammates, family/friends, and sport psychologists. For example, coaches may experience benefits of a returning athlete such as: more options in team-selection, bolstering and reinvigorating the team atmosphere, and increasing the likelihood of achieving key performance objectives (e.g., winning a game or league). A returning athlete may also have negative impacts on others. In one study, parents reported their fears of their children getting re-injured, while in another report, a sport psychologist described feelings of guilt, professional incompetence and sleeplessness after informing a returning athlete that re-injury was highly unlikely, only for the athlete to experience an ACL re-tear in her first competition back. In relation to aim (b), adopting a relational perspective can broaden the scope of inquiry to include key injury stakeholders, can provide important information for helping injury stakeholders better cope with the injury experience, and can influence the development of sport injury models and frameworks for investigating key interactions and dynamics surrounding injury management. Finally, for aim (c), I will discuss various future research directions, such as the need to further explore the impact of athletes' RTS on sport medicine providers (e.g., physiotherapists) and to examine RTS interactions between injury stakeholders (e.g., discussions between coaches and physiotherapists regarding RTS decisions). This talk is relevant to researchers and clinicians wishing to understand the impact of injury on others and injured athletes interested in understanding their impact on various injury stakeholders.

Oral presentations

OP-PN04 Nutrition

EXOGENOUS KETOSIS IMPROVES HYPOXIC TOLERANCE AND MAINTAINS BLOOD OXYGEN SATURATION IN HYPOXIC CONDITIONS.

STALMANS, M., HESPEL, P., DEBEVEC, T., POFFÉ, C.

KU LEUVEN

INTRODUCTION: High-altitude exposure, especially when the altitude exceeds ~2000m, poses individuals at risk to develop acute altitude sickness which becomes more and more prevalent with further altitude increases (1). This is primarily due to a drop in partial oxygen pressure resulting in hypoxemia (2). Intriguingly, we have recently shown that elevating blood ketone bodies via ketone ester (KE) ingestion increases blood oxygen saturation during exercise (3). Therefore, we investigated whether KE intake could counteract the drop in blood oxygen saturation and the development of acute altitude sickness during an intermittent exercise protocol at high-altitude.

METHODS: In a randomised crossover design, thirteen subjects participated in two experimental sessions in a normobaric hypoxic facility set at a simulated altitude of 4000m (FiO2: 12.7 %O2). During the 28 hour protocol, subjects performed five 30-min submaximal exercise bouts (1.5 W.kg-1), to simulate the workload associated with normal ascend rates to alpine huts and summits, interspersed by passive recovery. Throughout the protocol subjects received either placebo (CON) or ketone ester (KE), with the specific aim to induce a stable physiological ketosis at ~3 mM throughout the day. Immediately

after entering the hypoxic room (0h) and after 4h of hypoxic exposure, blood oxygen saturation (SpO2), oxygen uptake (V02) and minute ventilation (VE) were assessed in a resting state. Subjects were asked to comply to the 28 hour protocol until voluntary resignation. A paired t-test and two-way repeated-measures ANOVAs were performed to evaluate differences between the experimental conditions.

RESULTS: In KE, blood D-β-hydroxybutyrate concentrations were stable at ~3-4 mM during the diurnal phase of the hypoxic residence, while they remained low (~0.3 mM) in CON ($p < 0.05$ for KE vs. CON). KE increased duration of compliance to the protocol by 29% (CON: 16.0 ± 10.1h vs. KE: 20.7 ± 9.5h, $p = 0.028$). Blood SpO2 dropped by 6.3% in CON throughout the first 4h in hypoxia ($p < 0.001$), but remained stable in KE ($p > 0.999$). As such, blood SpO2 values were higher in KE vs. CON after 4h ($p = 0.007$). V02 concomitantly increased by 10% in CON ($p < 0.001$), yet remained stable in KE ($p = 0.982$), while VE increased by 17% in both conditions ($p < 0.001$).

CONCLUSION: These data indicate that KE ingestion delays the development of high altitude sickness. We provide preliminary evidence that this is related to an inhibition of the drop in blood oxygen saturation level and the increase in oxygen consumption during hypoxic residence.

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EXOGENOUS KETOSIS IMPROVES SLEEP EFFICIENCY AND COUNTERACTS THE DECLINE IN REM SLEEP FOLLOWING STRENUOUS EXERCISE

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KU LEUVEN

INTRODUCTION: Available evidence indicates that strenuous exercise impairs sleep quality and quantity (1). Interestingly, a study in rodents suggests that ketone bodies may improve sleep quality (2). Therefore, we determined whether increasing blood ketone bodies, by ketone ester (KE) ingestion, could counteract sleep disruptions induced by strenuous exercise.

METHODS: In a randomised crossover design, ten well-trained cyclists participated in two experimental sessions each involving a morning endurance training and an evening high-intensity interval training ending one hour before sleep. Following exercise, sleep architecture was assessed during the night using polysomnography. Post-exercise and 30min before sleeping time, subjects received either 25g KE (EXKE) or a placebo drink (EXCON). A third session without exercise, but with placebo supplements (RCON) was added to evaluate the effect of exercise per se on sleep. A one-way and two-way repeated-measures ANOVA or a linear mixed model was performed to evaluate differences between the experimental conditions.

RESULTS: Blood D-β-hydroxybutyrate concentrations transiently increased to ~3mM post-exercise and during the first part of the night in EXKE but not in EXCON or RCON. Exercise significantly reduced REM sleep by 26% ($p = 0.001$ vs. RCON) and increased wakefulness after sleep onset (WASO) by 95% ($p = 0.004$ vs. RCON). Interestingly, KE improved sleep efficiency by 3% ($p = 0.040$ vs. EXCON) and counteracted the exercise-induced decrease in REM sleep ($p = 0.011$ vs. EXCON) and the increase in WASO ($p = 0.009$ vs. EXCON). This was accompanied by a KE-induced increase in urinary dopamine excretion ($p = 0.033$ vs. EXCON). In addition, exercise increased sleep spindle density by 36% ($p = 0.005$ vs. RCON) suggesting an effect on neural plasticity processes during sleep.

CONCLUSION: These data indicate for the first time that KE ingestion improves sleep efficiency and quality following high-intensity exercise. We provide preliminary evidence that this might result from KE-induced increases in dopamine signalling.

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THE EFFECT OF EIGHT-DAYS ORAL TAURINE SUPPLEMENTATION ON THERMOREGULATION AT FIXED HEAT PRODUCTION IN HOT CONDITIONS OF INCREMENTAL HUMIDITY: A DOUBLE-BLIND, PLACEBO-CONTROLLED TRIAL

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INTRODUCTION: Exercise in hot and/or humid environmental conditions can cause positive heat storage, if thermal equilibrium is not maintained through sufficient dry or latent heat dissipation (Eskin) [1]. This may lead to uncompensable heat stress, denoted by inexorable increases in core temperature (Tcore) [2]. To delay the upward inflection of Tcore, thermal sweating and the efficiency of evaporative heat transfer can be enhanced through interventions, such as heat acclimation [2]. Similarly, taurine supplementation has been shown to increase sweat rate and hasten the onset of sweating during exhaustive exercise in the heat [3], but its potential role in thermoregulation has not been thoroughly evaluated. The aim of the current study was to determine the effect of an eight-day taurine supplementation period on Tcore and sweating responses, calorimetric heat transfer components (Eskin, heat storage), plasma volume and plasma taurine concentrations during prolonged exercise of a fixed heat production (Hprod) in hot conditions at both fixed, and incremental vapour pressures.

METHODS: Fifteen healthy, non-heat acclimated females (n = 3) and males (n = 12; 27 ± 5 years) completed a treadmill walking protocol in the heat (37.5 ± 0.1°C) at fixed- and ramped-humidity, following one-week of oral taurine supplementation (50 mg/kg/bm) or placebo in a double-blind, randomised, placebo-controlled, cross-over design. Participants were assessed for whole-body sweat loss (WBSL), local sweat rate (LSR), sweat gland activation (SGA), core temperature (Tcore), point of uncompensability (Pcrit) and calorimetric heat transfer components (Eskin and heat storage). Plasma volume and plasma taurine concentrations were established through pre- and post-trial blood samples.

RESULTS: Taurine supplementation increased WBSL by 26.6% and 5.1% (p = 0.035), LSR by 15.5% and 7.8% (p = 0.013), SGA (1 x 1 cm) by 32.2% and 29.9% (p < 0.001) and SGA (3 x 3 cm) by 22.1% and 17.1% (p = 0.015) during the fixed- and ramped-humidity exercise periods, respectively. Evaporative heat loss (Eskin) was enhanced by 27% (p = 0.010) and heat storage was reduced by 72% (p = 0.024). Pcrit was greater in taurine vs. placebo (p = 0.002), as was plasma taurine concentration (p = 0.001).

CONCLUSION: Taurine supplementation increased sweating responses during fixed Hprod in hot conditions, prior to substantial heat strain and before the point of uncompensability. The enhanced evaporative cooling and reduced heat storage delayed the subsequent upward inflection in Tcore – represented by a greater Pcrit. The apparent taurine-induced augmentation of the sweating response offers preliminary evidence for the use of this dietary supplementation strategy to support thermoregulation in humans during exercising heat stress.

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ALGAE INGESTION INCREASES RESTING AND EXERCISED MYOFIBRILLAR PROTEIN SYNTHESIS RATES TO A SIMILAR EXTENT AS MYCOPROTEIN IN YOUNG ADULTS.

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INTRODUCTION: Algae are protein and essential amino acid rich, sustainably produced food sources. As such, several species are potential non-animal-derived dietary protein sources to stimulate myofibrillar protein synthesis (MyoPS); however, in vivo human data are lacking. We assessed the impact of ingesting isonitrogenous boluses of spirulina ('blue-green algae' or cyanobacterium; Arthrospira platensis) or chlorella (microalgae; Chlorella vulgaris) compared with an established high quality non-animal-derived dietary protein source (fungal-derived mycoprotein) on plasma amino acid concentrations, and resting and post-exercise MyoPS in young adults.

METHODS: Thirty-six healthy young adults (age: 22±1 y; BMI: 23±0 kg/m2; male [m]/female [f], 18/18) participated in a randomised, double-blind, parallel-group trial. Participants received a primed, continuous infusion of L-[ring-2H5]-phenylalanine and completed a bout of unilateral resistance leg exercise before ingesting a drink containing 25 g protein from either mycoprotein (MYCO; n=12; m/f, 6/6), spirulina (SPIR; n=12; m/f, 6/6), or chlorella (CHLO; n=12; m/f, 6/6). Blood and bilateral muscle samples were collected at baseline, and during a 4-h postprandial and post-exercise period to assess plasma amino acid concentrations and MyoPS rates in rested and exercised tissue. Two- and three-way ANOVAs were used to detect differences in plasma amino acid concentrations (time × group) and MyoPS rates (time × group × leg), respectively (with Bonferroni post-hoc tests applied to detect individual differences).

RESULTS: Protein ingestion increased plasma total (TAA) and essential (EAA) amino acid (and leucine) concentrations (time effects; all P<0.001), but most rapidly and with higher peak responses following ingestion of SPIR vs MYCO and CHLO (P<0.05), and MYCO vs CHLO (P<0.05). Protein ingestion increased MyoPS rates (time effect; P<0.001) in both rested (MYCO, from 0.041±0.01 to 0.060±0.004%·h-1; SPIR, from 0.043±0.009 to 0.067±0.007%·h-1; and CHLO, from 0.037±0.002 to 0.055±0.005%·h-1, respectively) and exercised (MYCO, from 0.046±0.004 to 0.092±0.007%·h-1; SPIR, from 0.036±0.003 to 0.087±0.009%·h-1; and CHLO, from 0.048±0.005 to 0.090±0.007%·h-1, respectively) tissue, with no differences between groups (interaction effect; P>0.05), but with higher rates in exercised compared with resting muscle (time × leg effect; P<0.001).

CONCLUSION: Ingestion of protein-rich boluses of algae robustly increases resting and post-exercise MyoPS rates, and to a comparable extent as a high-quality non-animal-derived protein source, despite divergent postprandial plasma amino acid responses. These mechanistic data are the first to indicate microalgae and cyanobacteria as viable alternative protein sources to acutely support (post-exercise) skeletal muscle reconditioning.

EFFECTS OF REDUCING DIETARY PROTEIN ON PERFORMANCE AND BODY COMPOSITION IN WELL-TRAINED ENDURANCE ATHLETES

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INTRODUCTION: Dietary protein intake is high among athletes, but the actual requirement for protein in endurance athletes has not been directly assessed in a controlled longitudinal dietary intervention study with performance outcomes.

Reducing protein intake in endurance athletes allows for higher carbohydrate intake, ensuring glycogen replenishment between daily exercise sessions, which may be beneficial for performance and training adaptations.

METHODS: Here, we investigated performance in well-trained cyclists and triathletes (maximal oxygen uptake; VO2max, mean±SD: 61±5 ml·min-1·kg-1) before and after a 6-week controlled, eucaloric, dietary intervention. After a 3-week run-in period with diet- and activity registration, participants were randomized into a control group continuing their habitual, normal diet (NP, n=7; 2.4±0.4 g protein·kg-1·d-1, 53±1E% carbohydrate) and a reduced protein group with carbohydrate replacement (RP, n=7, 1.07±0.07 g protein·kg-1·d-1, 64±1 E% carbohydrate). Dietary fat intake was matched (30±1 E%) and in accordance with their habitual diet. All foods were weighed to 1 gram of accuracy and delivered to the participants. Daily activities and body composition were carefully monitored before and throughout the intervention, and habitual training volume was maintained throughout the intervention (~15±4 h·wk-1). Cycling performance was evaluated during a 100-min cycling protocol including a 10-sec all-out sprint, an incremental test to exhaustion to determine VO2max, a 1-min maximal aerobic power (Wmax), and was finalized with a 15-min maximal test in the fatigued state.

RESULTS: Preliminary data show that both groups maintained lean body mass (RP: 63.5±5.7 kg vs. 63.2±5.0 kg, NP: 59.0±3.8 vs. 59.6±3.4 kg pre and post 6 weeks, respectively). Performance in a fresh state was unaltered in both groups from pre-, to post-intervention (relative changes in VO2max: RP: 1±4%, NP: 0±2%; Wmax: RP: 1±2%, NP: 0±2%; 10-sec mean power output: RP: 2±5%, NP: 1±3%, interactions p>0.05). The dietary interventions did not affect 15-min performance in the fatigued state differently between groups (time x group p=0.26). However, relative mean power output during the 15-min fatigue test was improved by 6±4% in RP (Pre: 4.29±0.35 vs. Post: 4.54±0.32 W·kg-1, p=0.003), while a non-significant change of 4±5% was observed for NP (Pre: 4.26±0.44 vs. Post: 4.42±0.43 W·kg-1, p=0.06).

CONCLUSION: These preliminary data suggest that endurance athletes can reduce dietary protein to as low as ~1 g protein·kg-1·d-1 for 6 weeks without compromising lean body mass and overall performance, and potentially may induce improvements in performance in the fatigued state.

Oral presentations

OP-AP04 Training and Testing

DATA PROCESSING STRATEGIES TO DETERMINE MAXIMUM OXYGEN UPTAKE: A SYSTEMATIC SCOPING REVIEW AND EXPERIMENTAL COMPARISON WITH GUIDELINES FOR REPORTING

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INTRODUCTION: Gas exchange data from maximum oxygen uptake (VO2max) testing typically requires post-processing. Different processing strategies can lead to varying VO2max values [1]. This affects their interpretation particularly in situations where small differences in VO2max matter (e.g. training monitoring or clinical classification) [2]. However, the exact processing strategies used in the literature have not been systematically investigated yet [3]. Previous research investigated differences across methods at the group level only [1].

METHODS: Based on preregistered methods and code, we conducted a scoping review and an analysis of experimental data. Out of a random sample, we investigated 242 recently published articles which measured VO2max during ramp(-like) tests. Reported data processing methods and their rationale were extracted. We compared the most common processing strategies on a data set of 72 standardized running exercise tests in trained athletes.

RESULTS: Almost all of the included studies (94.2%) failed to provide a rationale for the particular strategy chosen and 44.2% did not report their data processing strategy at all. In those which reported their strategy, most studies (79.5%) used binned time averages to determine VO2max, with a minority using moving time (6.8%), moving breath (5.7%) or other averaging methods (8.0%). Despite previous recommendations [3], no study reported the use of digital filters. The processing strategies found in the literature can lead to median differences in VO2max of more than 5% (range 0-7%) with considerable variation at the individual level.

CONCLUSION: Data processing strategies have a meaningful impact on determining VO2max. Hence, we recommend to report the following seven relevant items: (1) metabolic cart model, (2) measurement mode, (3) analysis software, (4) preprocessing routine, (5) processing strategy type, (6) processing strategy parameters, (7) rationale for the processing. To improve reproducibility, we encourage authors to use available software solutions [5] and share their analysis code.

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MODE MATTERS - ENDURANCE EXERCISE MODES INFLUENCE CHANGES IN EEG RESTING STATE BRAIN NETWORKS

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INTRODUCTION: Acute bouts of exercise affect the organization of human brain networks transiently and can either improve or deteriorate neural processes underlying sports performance. Exercise intensity is regarded as a key variable in this interaction, since moderate to high intensities facilitate neural processing, while exhaustive exercise seems to impair these processes. Besides intensity, the sensorimotor demands of different exercise modes may further affect modulations of brain networks due to differences in sports-specific techniques or muscles involved. However, exercise mode is barely considered an additional moderator of acute exercise brain interactions. Therefore, this study aimed to explore the effect of exercise mode on transient changes in electroencephalography (EEG) resting state networks (RSNs) comparing running and cross-country (XC) skiing.

METHODS: Fifteen male and highly trained XC skiers (20.1+.6 years, 74.4+5.6 kg, 178.9+5.5 cm) participated in the study. All athletes performed an incremental treadmill test to obtain peak oxygen uptake (VO2peak) in running (65.3 ml/min/kg) and XC skiing (63.5 ml/min/kg). Based on the incremental test, each athlete performed another incremental treadmill protocol with continuous stages at 50, 70, and 90% of speed VO2peak in both modes. EEG resting state data was recorded once before and intermittently throughout the protocols after each stage. The reconstruction of brain graphs allowed for the computation of the small world index (SWI, network efficiency), clustering coefficient (CC, network segregation), and path length (PL, network integration) in the theta, alpha-1, and alpha-2 frequency bands. To compare physiological demands between modes, blood lactate concentration, heart rate, and Borg scale were assessed. Repeated measures ANOVA was applied to explore the modulatory effects of exercise intensity (protocol stages) and mode (running vs XC skiing) on RSN outcomes and physiological markers.

RESULTS: ANOVA revealed main effects of exercise intensity in the theta network which indicated modulations of SWI ($p < .001$), CC ($p < .001$), and PL ($p = .003$) following exercise at 90% of speed VO2peak for both modes. Further, main effects of mode on SWI ($p = .047$), CC ($p < .001$), and PL ($p = .031$) were observed in the alpha-2 network and indicated stronger modulations in network organization following XC skiing. Physiological outcomes were modulated by intensity solely and peaked after exhaustive exercise in both modes ($p < .001$).

CONCLUSION: The present study demonstrated that both exercise intensity and mode may affect transient modulations of brain networks after exercise. Exercise intensity seems to induce modulations in brain networks associated with attentional control. Additionally, exercise mode seems to induce modulations in brain networks related to task-related information processing. Further research is required to understand the modulatory role of exercise mode in the acute interaction between exercise and brain function.

CYCLING PERFORMANCE AFTER ACCUMULATED LOAD: DOES DURABILITY CHANGE DURING A CYCLING SEASON?

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INTRODUCTION: Durability is the ability to produce high power outputs after accumulated load (at the end of a race), which has been shown to be an important success factor in professional road cycling [1-4]. Gross efficiency (GE), fat oxidation (FATox) and carbohydrate oxidation (CHOox) have been proposed as underlying physiological factors for durability, as changes have been shown to be related to a decrease in performance after accumulated load [5-7], although there is much debate about them. Therefore, the aim of this study is to investigate durability and the underlying physiological factors in semi-professional cyclists. Secondly, this study investigates how durability and certain physiological factors changed during a cycling season.

METHODS: In total, 16 semi-professional cyclists (10min PO: 379±22 W) visited the lab on 3 occasions: Start of pre-season (PRE), start of race season (START), and halfway into the race season (IN). Testing days included: a warm-up at 55% of VO2peak power at which GE, FATox and CHOox were determined, followed by a 1min and 10min time trial to measure power output (P1min, P10min). After 3hours of endurance training (31±5 KJ/kg) the same protocol was repeated to investigate the influence of accumulated load on performance (P1min and P10min) and physiological parameters (GE, FATox and CHOox). Differences between PRE vs START vs IN and fresh vs fatigued were investigated using a mixed-effects multilevel model. When significant ($p<0.05$) main effects occurred, Bonferroni post-hoc was executed for pairwise comparisons.

RESULTS: P1minfresh was significantly higher than P1minfatigued at PRE, START and IN, however, no differences between PRE, START and IN were found. P10minfresh did not differ from P10minfatigued on all occasions, however, both P10minfresh and P10minfatigued were lower at PRE compared to START and IN. CHOox (PRE and START) and GE (START) were lower in fatigued compared to fresh state, while FATox was higher in fatigued compared to fresh (PRE and START). In addition, GEfresh was higher at START and IN compared to PRE, while there was a decrease in FATOxfatigued from PRE and START to IN. Lastly, an increase from PRE to START in CHOoxfatigued and PRE to IN in GEfatigued and CHOoxfatigued was noted.

CONCLUSION: This is the first study investigating (the change in) power output, GE and substrate oxidation in fresh and fatigued state after accumulated load during a cycling season. Performance over short efforts (P1min) is affected by fatigue but doesn't improve from PRE to IN. Endurance capacity (P10min and GE) is not significantly affected by accumulated load, however, improves throughout the season (from PRE to IN). Also, substrate oxidation after accumulated load changes as FATox decreases while CHOox increases from PRE to IN.

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PERFORMANCE UNDER PRESSURE: PHYSIOLOGICAL AND COGNITIVE RESPONSES TO HYPEROXIC EXERCISE IN SCUBA-DIVING

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INTRODUCTION: Hyperoxia reduces minute ventilation (VE), heart rate (HR), and blood lactate ([Lac-]) during exercise in normobaric settings1,2. In addition, hyperoxia and exercise are known to positively affect executive functions (EF) of cognition3,4. However, little is known about applied sports activities underwater, like SCUBA-diving, where the practical relevance is emphasized by elevated inspiratory oxygen pressures (PIO2) from water depth and used gas mixtures. Here, environmental factors, the sport-specific exercise modality of underwater fin-swimming (UFS), and breathing resistance from diving equipment might alter previous results. We hypothesized that the combined increase in exercise intensity and PIO2 would (I) reduce VE and (II) amplify a positive interaction between exercise intensity and EF performance.

METHODS: Based on a priori power analysis (f=0.5; Power 1-β=0.9), 15 experienced SCUBA-divers (age: 28±6.2; 5 female) performed 3×8min of UFS at individual exercise intensities of 25% (LOW), 45% (MOD), and 75% (vIG) heart rate reserve. This scenario was repeated on three separate days with altered oxygen fractions in the breathing gas, resulting in 29, 56, and 140kPa PIO2 at 4m water depth (double-blind). HR and VE were measured continuously. Post-exercise, an EF task on inhibitory control was conducted (100 stimuli), capillary blood taken, and breathing gas analysis performed. Two-way ANOVAs with repeated measures on the factor INTENSITY and GAS investigated differences in VE, [Lac-], end-tidal pressure of carbon dioxide PetCO2, and incompatible reaction times (RT) and accuracy (ACC) for EF.

RESULTS: VE was significantly lower during 140kPa PIO2 compared to 29kPa at MOD ($p=0.006$, $d=0.437$) and VIG ($p=0.006$, $d=0.405$), and during 56kPa compared to 29kPa at VIG ($p=0.002$, $d=0.525$) compared to air (GAS: $p=0.004$, $\eta2P=0.356$). [Lac-] and PetCO2 showed no effects. RTs, not ACC, were significantly faster after VIG compared to REST, LOW, and MOD (all $p\leq0.022$), without effects for GAS.

CONCLUSION: VE was reduced by 8-10 % during MOD to VIG exercise only, while a ceiling can be assumed between 56 and 140kPa PIO2. Based on similar post-exercise [Lac-] and PetCO2 values (all $p>0.669$), but in contrast to studies with submerged bicycle exercise (-15% VE5), dampened chemoreceptor control rather than metabolic changes was suspected as a possible cause. Superior EF performance corresponds to elevated [Lac-]- levels6 and maintained cerebral oxygenation during severe exercise7. Findings emphasize sport-specific influence from exercise modality and capacity, affecting safety, planning, and training for underwater activities like SCUBA diving.

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INFLUENCE OF USING INDIVIDUALIZED ERGONOMIC HANDLES ON UPPER LIMB KINEMATICS, NEUROMUSCULAR ACTIVITY AND PERCEIVED COMFORT, DURING SCULL ROWING.

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INTRODUCTION: All the power generated by the rower is transmitted to the oars and water by the handles, resulting in significant mechanical stress on wrist, elbow and shoulder joints. This might explain the large injury rate of the upper limb, representing more than 60% of injuries in paddle sports. This could be linked to joint overuse (e.g. repetition of 1800 propulsive cycles per training session in rowing (1)). In addition, the use of the standard circular handle could increase the injury risk, since a circular handle with a generalized size is not optimal for a strong and simple gripping pattern (2). Also, discomfort could lead to a higher risk of injuries (3). The purpose of this study was to measure the impact of using individualized ergonomic handles on upper limb kinematics and neuromuscular activity and perceived comfort during rowing.

METHODS: Twelve elite rowers performed 250 meters runs in single scull at their own race stroke rate with three handle types: (a) standard circular handles, (b) ratio handles following a 1:1.25 diameter ratio with an irregular hexagon shape fitted to the hand length of the athlete (CareMoSim, Nancy, France) and (c) comfort handles with ratio handles optimized based on adequacy of the rowers (CareMoSim, Nancy, France). Rowers were equipped with surface EMG electrodes (Flexor carpi Ulnaris, Brachioradialis, Biceps brachii, Triceps brachii longus, posterior and anterior Deltoid), and inertial movement units on the left upper limb. Joint range of motion and EMG were calculated from the recorded data. A comfort scale was used after the test for each handle (3). Repeated measures ANOVAs and Statistical parametrical mapping (SPM) were performed.

RESULTS: SPM showed a significantly smaller amplitude pattern of wrist flexion-extension during the first and last third of the drive phase ($p<0.001$), and during the last half of the recovery phase ($p<0.001$) with both ratio and comfort handles compared to the standard handle. There was significantly less EMG activity of posterior Deltoid ($p=0.01$) and Triceps brachii longus ($p=0.03$) with the ratio handle. There was significantly more comfort with the ratio ($p=0.04$) and comfort ($p<0.001$) handles compared to regular handle.

CONCLUSION: Individualized handles increased comfort and decreased wrist flexion/extension amplitude suggesting less articular stress on the wrist. It also induces lesser neuromuscular stress on the shoulder with less recruitment of Deltoideus posterior and Triceps Brachii Longus. Greater comfort, and lesser stress may decrease injury risks. The ergonomic design of the handle allows the rower to precisely control his wrist due to a constant wrist position feedback provided by the hand-fitted shape, thus decreasing stress over the upper limb. Hand-casted handle may be the next step.

1. Thornton et al., Sports Med, 2017

2. Rossi et al., Journal of Applied Biomechanics, 2015

3. Revilla et al., Journal of Occupational and Environmental Hygiene, 2022

Invited symposia

IS-MH03 Physical exercise as a therapeutic strategy

THE EFFECT OF EXERCISE TRAINING ON PERIPHERAL VASCULAR RESISTANCE AND BLOOD PRESSURE IN MEN AND WOMEN

HELLSTEN, Y.

UNIVERSITY OF COPENHAGEN

Essential hypertension is a major cause of cardiovascular events and premature death in the world. The condition is closely associated with arterial stiffness and a reduced ability to adequately regulate peripheral vascular tone. Skeletal muscle contributes importantly to systemic vascular resistance due to its proportionally large mass and relatively extensive vascular network. Vascular resistance in skeletal muscle is regulated by a balance between, on one hand, sympathetic constriction and circulating vasoconstrictors and, on the other hand locally formed vasodilators and mechanisms which inhibit the constrictive effect of sympathetic activity, so called functional sympatholysis.

It is well known that regular aerobic exercise training has multiple beneficial effects on the vasculature in skeletal muscle with profound effects on arterial blood pressure, in particular in individuals with hypertension. Vascular effects include enhanced arterial compliance, an increased balance between vasodilators and vasoconstrictors, a lowering of sympathetic activity and improved functional sympatholysis. The enhanced capacity for vasodilation with training involves several compounds of which nitric oxide and prostacyclin are known to be central. Their increased bioavailability is the result of an upregulation and activation of related proteins but occurs also through a reduction in oxidative stress.

Although both men and women present vascular adaptions to regular physical exercise, evidence suggest that there is a reduced and/or slower adaptive progress in postmenopausal women compared to age matched men and that this progress is particularly evident in women many years after menopause. The mechanisms underlying this effect remain to be unraveled but some possibilities will be addressed in this talk.

METABOLIC FLEXIBILITY WITH AGING: IMPACT OF PHYSICAL ACTIVITY

BROOKS, G.

UNIVERSITY OF CALIFORNIA

Metabolic Flexibility can be defined as the ability to switch among energy substrates depending on metabolic need and substrate availability. The key hypothesis is that fragmentation of the mitochondrial reticulum results in loss of muscle respiratory capacity, one result being loss of metabolic flexibility in aging. For this, a mixed model has been employed with results of studies on young and old, male and female NIA mice informing the course of human experimentation. The human experiment is to compare metabolic responses in physically active (trained) and inactive (sedentary) young men and women (21-35 yr.). Results are to be compared with those on older, trained and sedentary men and women (60-80 yr.). Before, during and after a 75 g Oral Glucose Tolerance Test (OGTT) volunteers receive primed continuous infusions of [13C]Bicarbonate, D2-Glucose, [3-13C]Lactate and D5-Glycerol. On mouse, heart and muscle 3-D microscopy will reveal presence of mitochondrial reticulum fragmentation and disruption of the mitochondrial lactate oxidation (mLOC) complex. On human subjects, muscle biopsies genomic analyses will be by RNAseq and single cell whole genome sequencing. Dr. Brooks will deliver first report on the role of mitochondrial fragmentation on loss of metabolic flexibility in aging.

MUSCLE AND FUNCTIONAL REPERCUSSIONS OF SICKLE CELL DISEASE: BENEFICIAL EFFECTS OF ENDURANCE TRAINING

MESSONNIER, L.

UNIVERSITÉ SAVOIE MONT BLANC

The fundamental challenge of physical exercise for sickle cell disease patients remained prevention of exercise-induced complications like vaso-occlusive crises, favoured by lactate accumulation-associated risks. Indeed, lactate accumulation i) is accompanied by acidosis, which, in turn, may promote hemoglobin S polymerization and red blood cell (RBC) sickling, ii) is related to exercise-related adrenaline secretion which activates muscle glycogenolysis but also cell adhesion, and iii) is primarily driven by sympathetic nervous system activation with also induces vasoconstriction. Sickling, cell adhesion and vasoconstriction are all major triggering factors of VOCs. Because moderate-intensity exercise avoids blood-lactate ac-

cumulation, a safe and potentially beneficial moderate endurance-exercise training program appeared conceivable for SCD patients. Therefore, a randomized-controlled trial including an 8-week personalized moderate-intensity endurance training programme on a cycle ergometer in adult patients without severe chronic complications has been implemented. No significant peripheral oxygen desaturation, blood lactate accumulation, or complications occurred, so that the proposed programme appeared safe. This programme also induced muscle microvascular, structural, energetic, and functional improvements. More specifically, muscle histological analysis highlighted microvascular benefits in the trained compared to the untrained patients, including increases in capillary density and functional exchange surface between muscle fibre and the adjacent capillaries. Endurance training also increased type I muscle fibre surface area and oxidative enzymes activity (citrate synthase; cytochrome c oxidase of type I fibres; complex IV of the respiratory chain). Concerning more integrative physiological parameters, respiratory exchange ratio, blood lactate concentration and rating of perceived exertion were all significantly lower at a given submaximal power output after training. Finally, trained patients improved their workload at the first lactate threshold and their metabolic flexibility compared to controls. In conclusion, an individually-tailored endurance exercise training can be considered as a possible strategy to counteract the skeletal muscle defects, and to improve muscle function and quality of life of patients with SCD. In addition, we recently observed that the muscle microvascular and structural remodeling observed in (male and female) patients with sickle cell disease included sex specificities. These specificities will be exposed. Finally, age-related disease progression on muscle energetics and function have been recently highlighted on the Townes model of sickle cell disease. This age-effect will be addressed during this symposium.

Oral presentations

OP-AP10 Winter Sports

SPEED AND POWER IMPROVEMENTS DERIVED FROM HYPOXIC REPEATED-SPRINT TRAINING IN WORLD-CLASS SHORT-TRACK SPEED SKATERS ARE INFLUENCED BY THE ANAEROBIC SPEED RESERVE

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INTRODUCTION: Short-track speed skaters with different physiological traits can be successful on the international stage. We aimed to investigate the ergogenic potential and transferability of cycling repeated-sprint training in hypoxia (RSH) on key performance indicators in world-class speed skaters with different physiological and race profiles.

METHODS: Fourteen national team short-track speed skaters (women, n=6; men, n=8), including World and Olympic champions and world cup performers, added RSH (FIO2 13.5%) to their training regime 3 times per week for 3 consecutive weeks. RSH was implemented immediately after specific ice training sessions to prolong metabolic stimulation. Testing included on- and off-ice evaluations, pre and 2- and 4-weeks post RSH. Skaters were classified based on their race profile (endurance, hybrid, sprinter) estimated from fuzzy cluster analysis of the anaerobic speed reserve (top speed – maximal aerobic speed). Due to the team heterogeneity in sexes and race profiles, control participants could not be used, and all athletes undertook RSH.

RESULTS: On-ice top speed measured during a 3-lap test improved in both males (0.8%, Cohen's effect size ES 0.63, p=0.03) and females (1.3%, ES 1.04, p=0.06) 2-weeks post. Concomitantly, males improved their peak power during a 7-s cycling sprint (5.1%, ES 0.39, p=0.04). These changes were not meaningful 4-weeks post. In males only, Wingate average power also improved 4-weeks post RSH (3.3%, ES 0.23, p=0.08). Training did not enhance indices of endurance capacity (maximal aerobic power and 27-lap time-trial time). Sub-analysis of race profiles suggested that endurance-type athletes benefited the most from RSH to improve on-ice top speed (ES 0.45 vs hybrid ES 0.32 vs sprinter ES 0.17).

CONCLUSION: Results demonstrate that cycling RSH can transfer into meaningful improvements on the ice that are associated with neuromuscular function and anaerobic capacity in world-class skaters. This RSH modality tended to benefit athletes with the smallest anaerobic speed reserve, which could be used to target athletes with the greatest chances of improvements.

COMPARATIVE ANALYSIS OF THE DIAGONAL STRIDE TECHNIQUE DURING ON-SNOW AND ROLLER-SKIING IN JUNIOR CROSS-COUNTRY SKIERS

MA, M., LIU, H., LONG, T.

BEIJING SPORT UNIVERSITY

INTRODUCTION: To investigate the similarities and differences of the Diagonal Stride (DS) technique during on-snow and roller-skiing in junior cross-country skiers by three-dimensional video analysis. The results of this study provide a theoretical basis for the design of DS technique training and supplementary training for junior athletes on land.

METHODS: Six junior cross-country skiers participated in the experiment. The kinematic data of the DS technique on snow and land were obtained by three-dimensional video analysis. Two cameras were placed on the left and right sides of the test ramp. The Angle between the main optical axis is about 80°, the shooting frequency is 60fps, and the shutter speed is 1/500s. Athletes techniques were obtained using automatic recognition techniques and Direct Linear Transfor▪mation(DLT)

methods. The coefficient of multiple correlations (CMCs) and one-dimensional statistical parametric mapping (SPM1d) were used to evaluate the similarity and difference in angle-time curves for each stage of the DS technique for on-snow and roller-skiing. Paired sample T-test was used to compare the cycle characteristics, range of motion at each stage, and the angle at each moment of DS technique between on-snow and roller-skiing.

RESULTS: No significant difference in roller-skiing cycle characteristics compared to on-snow in DS technique. The hip flexion and extension angles are highly similar and the body anteversion angle, trunk anteversion angle, calf anteversion angle, and the vertical movement range of the center of the mass showed moderate similarity in the landing stage and the swing stage; The adduction and abduction angle of the hip joint showed low similarity in the swing stage, the body anteversion angle and calf anteversion angle are smaller on roller-skiing and the anteversion angle is smaller on roller taking off. The flexion and extension angle of the shoulder joint, the adduction angle of the shoulder joint, the flexion and extension angle of the elbow joint, the angle of pole-ground, and the vertical movement range of the center of mass show high similarity in the poles-support stage and the back-swing stage; The body anteversion angle in the poles-support stage and the trunk anteversion angle in the back-swinging stage are moderately similar; The range of flexion and extension of the shoulder joint is small in the back-swinging stage, and the body anteversion angle and trunk anteversion angle are small at poles landing and taking off.

CONCLUSION: Higher similarity of upper limb movements, the moderate similarity of lower limb movements between on-snow and roller-skiing with DS technique, and the movement range of the DS technique on land are small. Junior athletes should imitate fast kick in the kick zone of the ski when training DS technique on the roller, and increase the explosive power of the lower extremity, especially the explosive power of plantarflexion, as well as upper extremity extensor strength.

EFFECTS OF POSTURE ON THE AERODYNAMIC CHARACTERISTICS DURING TAKE-OFF IN SKI JUMPING

HU, Q.

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INTRODUCTION: From an aerodynamic perspective, take-off phase is very critical because athletes always need to find a balance between maximizing vertical acceleration and minimizing aerodynamic drag. Rapid full exposure to the air during take-off leads to a rapid increase in the aerodynamic drag, while the aerodynamic lift helps the athlete during the take-off process. The research on the aerodynamic characteristics of take-off phase mainly focuses on the experimental test and training in the wind tunnel, or the analysis from the perspective of kinematics, but the aerodynamic force during take-off is still unclear, and few related computational fluid dynamics (CFD) studies are reported.

METHODS: From an aerodynamic perspective, take-off phase is very critical because athletes always need to find a balance between maximizing vertical acceleration and minimizing aerodynamic drag. Rapid full exposure to the air during take-off leads to a rapid increase in the aerodynamic drag, while the aerodynamic lift helps the athlete during the take-off process. The research on the aerodynamic characteristics of take-off phase mainly focuses on the experimental test and training in the wind tunnel, or the analysis from the perspective of kinematics, but the aerodynamic force during take-off is still unclear, and few related computational fluid dynamics (CFD) studies are reported.

RESULTS: 1) For take-off mode A, the initial total drag is 40.20N and the final total drag is 99.05N; the initial total lift is 31.31N and the final total lift is 53.58N; the initial moment is 19.69N·m and the final moment is 69.05N·m; the lift-to-drag ratio drops from 0.779 to 0.541.For take-off mode B, the initial total drag is 50.66N and the final total drag is 140.01N; the initial total lift is 35.56N and the total lift peak is 55.54N; the initial moment is 28.06N·m and the final moment is 98.82N·m; the lift-to-drag ratio drops from 0.702 to 0.365. 2) The total drag and moment of take-off mode B are significantly higher than that of take-off mode A, and the lift-to-drag ratio of take-off mode B is significantly lower than that of take-off mode A. 3) At first the total lift of take-off mode B is higher than that of take-off mode A, but in the last attitude the total lift of take-off mode B does not rise but fall, and finally the total lift of the take-off mode B is lower than the take-off mode A .

CONCLUSION: 1) The aerodynamic characteristics change dynamically in a short time, and the two take-off modes differ greatly, which are difficult to be observed in real training and competition site. 2) Take-off mode A has obvious aerodynamic advantage compared with take-off mode B. During take-off, the angle between trunk and thigh should not be too large, or the extension angle of the hip joint should not be too fast and too large, which can bring obvious aerodynamic advantage. 3) Although the aerodynamic force of arms themselves is not obvious, they have a huge impact on the overall aerodynamic characteristics of the athlete, so the posture of arms cannot be ignored. 4) The influence mechanism of different take-off postures on the aerodynamic characteristics in ski jumping can provide scientific guidance for the training and improvement of jumping and flight technology, and also provide effective auxiliary support for on-the-spot prediction and decision-making.

DOES TRUNK RANGE OF MOTION DURING SITTING PARA CROSS-COUNTRY SKIING DIFFER BETWEEN CLASSES?

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NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

INTRODUCTION: In sitting Para cross-country (XC) skiing, athletes compete in a seated position and thus rely predominantly on their arms and trunk for propulsion [1]. Double poling at higher work rates requires increased trunk motions [2], and it is likely that the trunk function of Para sit-skiers will influence their ability to produce high power output [3] and speeds. The classification of sitting XC-skiers is based on clinical trunk function tests, and athletes with higher trunk func-

tion are often allocated to higher classes. However, it is difficult to accurately estimate the functional trunk range of motion (ROM) of an athlete during sit-skiing based on these assessments. Modern inertial measurement unit (IMU) technology allows the estimation of the trunk ROM during on-snow competitions. This study therefore aimed at comparing the trunk ROM between classes of sitting para-XC skiers during competition.

METHODS: A single IMU sensor (AdMos, ASI, Lausanne, Switzerland) was attached to the back of the race bib of 22 sitting para XC-skiers during a sprint race at a World Championship competition (9F, 13M, LW10=1, LW10.5=4, LW11=3, LW11.5=9, LW12=9). The IMU was placed between the scapulae and recorded gyroscope and accelerometer data at 200Hz, which was processed in Matlab (R2022b, MathWorks, Natick, MA, USA) to calculate joint angles. Data from the final 70-meter stretch of the race was extracted for analysis. Due to the low number of athletes in each class, the data was solely assessed descriptively. The differences in trunk ROM between classes were assessed by comparing the 95% Confidence Intervals (CI) around the mean. When these showed no overlap, it indicated 95% confidence of a difference between means.

RESULTS: Since the dataset only had one LW10, this data point was excluded from the comparison (ROM: 6.3°). The 95%CI did not overlap for the comparison between the LW10.5 and LW12 classes (mean ROM ±95%CI: LW10.5 12.4°±6.4°, LW12: 28.7°±5.9°). The other comparisons had overlapping CI and quite a large variability in ROM (mean ROM ±95%CI: LW11: 25.6°±31.1°, LW11.5: 19.8°±14.0°).

CONCLUSION: While we see a tendency towards larger functional trunk ROM in the higher classes, the 95%CI overlapped for all comparisons except for LW10.5 vs LW12. This overlap between adjacent classes, and in some cases also classes further apart suggests that the clinical assessment used in classification may sometimes fail to adequately identify the amount of trunk function a sit-skier uses during competition. The extent to which the functional trunk ROM differs between the classes remains unknown and should be subject to further research. This study suggests that assessing the functional trunk ROM alone may not provide sufficient information to differentiate between the classes during para sit-skiing.

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V2 CROSS-COUNTRY SKIING TECHNIQUE VARIATIONS ASSESSED THROUGH PRINCIPAL MOVEMENT DISCRIMINANTS EXTRACTED FROM WEARABLE SENSOR DATA

DEBERTIN, D.

UNIVERSITY OF INNSBRUCK

INTRODUCTION: Cross-country (XC) skiing experts (instructors, coaches) describe precise technique forms, e.g. V2 technique, and distinct variation/deviation patterns from the technique ideal. These qualitative decriptions have high practical value, e.g. for the communication between coach and athlete, however, they are difficult to quantify, limiting their applicability for research or technology development. The current study utilizes and expands technique analysis approaches based on principal component analysis of kinematic data [1,2] and applies them to analyse V2 technique variations in XC skiing. The aim of this proof-of-concept study was to determine sensitivity for 14 distinct V2 technique variations.

METHODS: Ten experienced XC skiers (5 females, age 30±8y, national or FIS licenced as instructor or athlete) performed the V2 technique according to curriculum guidelines [3] and according to 14 technique variations, each represented through two opposite extremes: weight shift (forth/back, up/down, lateral/centered), inward/outward upper body rotation, closed/opened legs, flat/canted ski strike, flat/canted ski off, long/short gliding phase, raised/lowered head, lowered/lifted heel, highly extended/flexed elbows, lowered/lifted elbows, maximal/minimal arm swing, closed/opened hands. The skiers' body segment movements were recorded using a full-body wearable sensor system (Xsens, Enschede, NL; 240Hz). For each technique variation, a principal component analysis (PCA) was calculated on centered and normalized kinematic data yielding principal movements (PMs) [2] that were dominanted by the variance produced by the two opposite variation extremes. Three left-right step cycle sequences were extracted and then averaged for each subject. These averaged PM scores were normal distributed (Shapiro-Wilk) and effects of the technique variation (3 levels: extreme(-); guideline V2 technique; extreme(+)) could therefore be tested using rmANOVAS (a=.05). Sensitivity was quantified through effect sizes (np2).

RESULTS: Eleven out of the 14 technique variations showed significant differences in their waveform means, with the largest effects found for horizontal weight shift (np2= .906), arm swing (np2 = .803) and elbow flexion/extension (np2 = .785).

CONCLUSION: The current study proved sensitivity for 11 of 14 distinct technique variation/deviation patterns. The three variations for which our approach was not sensitive included variations for which a more sofisticated analysis might be promising, but also variations poorly represented in the current sensory signals (e.g. raised/lowered head) for which hardware adaptations might be needed. In conclusion, our approach utilizes the knowledge and skills of skiing experts and makes them accessible for research and technology development.

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Oral presentations

OP-MH05 Sports Medicine/Mixed Session

INVESTIGATION OF FALSE POSITIVE RESULTS IN ANTI-DOPING TEST CAUSED BY PRESERVATIVES IN COSMETICS

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INTRODUCTION: Chlorphenesin is a legitimate preservative used in cosmetics. Chlorphenesin shares the same urinary metabolite of 4-chlorophenoxy acetic acid (4-CPA) with a stimulant meclofenoxate which is prohibited in sports. In recent years, there have been several cases involving athletes who used chlorphenesin-containing products were misjudged as using meclofenoxate. To distinguish the origins of 4-CPA from using chlorphenesin or meclofenoxate, we investigate the content of personal care products on the market and perform an administration study to confirm whether using chlorphenesin-containing products can lead to an adverse analytical finding (AAF) or not.

METHODS: We selected personal care products with different functions (e.g. facial care, body cleansing, sun protection, make-up, hairstyling, perfume and oral cleaning) on the market. These cosmetics were detected for chlorphenesin by using the developed liquid chromatography with diode-array detection (LC-DAD) method. To further investigate the metabolic pattern after applying chlorphenesin-containing cosmetics, we established a liquid chromatography-tandem mass spectrometry (LC-MS/MS) method for the quantification of 4-CPA and related metabolites in urine.

RESULTS: A total of 61 personal care products were tested. Among all, there were 29 labeled as containing chlorphenesin, and their concentrations ranged from not detected (ND) to 2.67 μg/mg (0.267 %). Chlorphenesin was not detected in the 32 items unlabeled with chlorphenesin. The LC-MS/MS method successfully achieved mass transitions of the target analyte by optimizing the parameters for ionization, fragmentation, and MRM detection. The accurate mass of the precursor ion (m/z 184.85) and product ions (m/z 140.85 and 126.86) was confirmed for 4-CPA analysis. In the proof-of-concept study, participants applied chlorphenesin-containing products and the concentrations of 4-CPA in their urine were measured.

CONCLUSION: The detection of chlorphenesin in cosmetics did not exceed the limit of 0.3 % (3 μg/mg), which was in accordance with Taiwanese regulations. According to the World Anti-Doping Agency (WADA) Technical Document, the urinary concentration of 4-CPA exceeding 5 μg/mL may be considered as an AAF. Therefore, it is inferred that single or multiple doses of chlorphenesin-containing products may result in 4-CPA higher than the threshold. The present study can support sports drug testing to identify the sources of 4-CPA and assist in the results management process.

NON-INVASIVELY MEASURED CENTRAL AND PERIPHERAL FACTORS OF OXYGEN UPTAKE ARE AFFECTED BY AGE, SEX, ENDURANCE CAPACITY, AND CHRONIC HEART FAILURE

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INTRODUCTION: Maximum oxygen uptake is influenced by age, sex, endurance capacity, and chronic heart failure. However, underlying central and peripheral factors are essential to take into account for optimizing diagnostics and interventions in athletes and patients [1, 2], but are less studied due to the in part invasive approaches. This study aimed to investigate the effects of age, sex, endurance capacity, and chronic heart failure on non-invasively measured central and peripheral factors of oxygen uptake.

METHODS: 15 male children (11±0 years), 15 male recreationally active adults (24±1 years), 14 female recreationally active adults (23±1 years), 12 male highly trained endurance athletes (24±2 years), 10 male elders (59±3 years), and 10 male chronic heart failure patients (62±4 years) were tested during a cardiopulmonary exercise test until exhaustion on a cycling ergometer for: oxygen uptake, systolic blood pressure, diastolic blood pressure, mean arterial pressure, heart rate, stroke volume, cardiac output, cardiac power output, vastus lateralis muscle oxygen saturation, and (calculated) arterio-venous oxygen difference. Stroke volume and muscle oxygen saturation were measured non-invasively using bioreactance analysis and near-infrared spectroscopy, respectively. A two-factor repeated measure ANOVA was applied for statistical analyses at rest, 80, and 100% of maximum oxygen uptake.

RESULTS: For the age effect, there were statistically significant group differences for all factors ($p \leq .033$; ES:≥.169). Concerning sex, there were group differences for all factors ($p \leq .010$; ES:≥.223), except diastolic blood pressure and heart rate ($p \geq .698$; ES:≤.006). For the effect of endurance capacity, there were no group differences for any of the factors ($p \geq .065$), albeit up to medium effect sizes (ES:≤.129). Regarding chronic heart failure, there were group differences for the heart rate and arterio-venous oxygen difference ($p \leq .037$; ES:≥.220).

CONCLUSION: Non-invasively measured central and peripheral factors of oxygen uptake are affected by age, sex, endurance capacity, and chronic heart failure. The detected differences may be due to various morphological or physiologi-

cal reasons, particularly heart volume or myoglobin functions [3, 4], which however remain unknown. Our outcomes should serve as a basis for further studies in sport science and medicine.

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EFFECTS OF CONCURRENT, WITHIN-SESSION, AEROBIC AND RESISTANCE EXERCISE TRAINING ON FUNCTIONAL CAPACITY AND MUSCLE PERFORMANCE IN PATIENTS WITH CHRONIC HEART FAILURE

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INTRODUCTION: The best format of exercise training (ET) in the setting of cardiac rehabilitation in patients with chronic heart failure (CHF) is still to be defined. Current guidelines recommend aerobic exercises, such as running and cycling including some sessions per week of resistance exercise. The aim of this study was to address the effectiveness of a concurrent exercise training program utilizing a circuit of sequential endurance and resistance exercises on functional capacity and muscular strength in patients with CHF.

METHODS: Ninety-five consecutive male patients with CHF (EF<40%) in NYHA functional class II /III, with were randomly assigned on 1:1 basis to a 12-week aerobic continuous training (AT) or concurrent CT), aerobic + resistance, training (CT), three times a week, with each session lasting 80 minutes. We used high quality, specifically designed, ergometers, connected one each other and governed by a central consol, managed by a single physiotherapist. Before and after training all patients performed a symptoms-limited exercise test on a treadmill and a 6-min walking test (6MWT). Patients in the CT group also performed resistance exercises of the upper and lower body.

RESULTS: 6MWT and exercise duration at ergometric test increased significantly in both AT and CT groups, with the increase being greater in CT group (P<0.001; ES = 0.13; P<0.01; ES = 0.07). Muscular strength increased significantly in the CT group, particularly in the-lower body muscular districts (P<0.001). Quality of life improved in both groups, with a significantly greater improvement in the CT group (P< 0.05). No side effects leading to discontinuation of training were observed.

CONCLUSION: These findings indicate that concurrent, within-session. training results in larger improvements in functional capacity, in addition to muscle performance, in patients with CHF in comparison to single-mode aerobic training.

RETINAL LAYERS PARAMETERS ASSESSMENT AS BIOMARKERS AFTER RUGBYMEN'S HEAD TRAUMA

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ROTHSCHILD FOUNDATION HOSPITAL

INTRODUCTION: The consequences of mild traumatic brain injures and sports-related concussions are a challenge for clinicians, players, coaches and parents involved in contact sports. Retinal layers' changes have been reported in numerous neurodegenerative diseases. The aim of this study was to investigate longitudinally the retinal thickness changes and their association with concussion during one rugby season in professional rugbymen, using spectral domain (SD) - optical coherence tomography (OCT).

METHODS: This is a longitudinal prospective cohort study. All patients were members of the Racing 92 rugby team (Paris, France). The first ophthalmological visit was performed before the beginning of the season, then a second visit was planned the following year just before the beginning of the next season. During the season, participants were closely followed by the teams' medical staff and the number of concussions was reported. At each ophthalmological examination, all participants had SD-OCT and OCT-angiography, which allowed the measurement of peripapillary and macular thicknesses.

RESULTS: Among the 59 rugbymen included at baseline, 36 were followed during one year and had one final visit after the season. Mean Retinal Nerve Fiber Layer (RNFL) thickness decreased significantly between the initial and the final visit (102.65 ± 7.01 µm vs. 101.46 ± 7.14 µm, p=0.0001). There was also a significant decrease of the mean ganglion cell layer (GCL) volume (1.16 ± 0.08 mm3 vs. 1.14 ± 0.09 mm3, p<0.0001) and of the mean macular vascular density (19.71 ± 3.01 % vs. 19.36 ± 3.03 %, p = 0.0002).

Among those 36 patients, 5 (13.9%) suffered from at least one concussion during the follow up. Mean RNFL loss was significantly higher in rugbymen who had at least one concussion during the follow up (n=5, -3.9 □ 1 µm) in comparison with those who had no concussion (n=31, -0.8 □ 1.2 µm) (p = 0.0008). No correlation was found between the number of concussions and the position of the rugbyman in the team.

CONCLUSION: RNFL loss was significant in professional rugbymen, after only one season time, and was significantly higher in concussion group, showing the interest of SD-OCT in the assessment of head traumas' consequences in rugby-

men. OCT RNFL monitoring could be helpful for the management of concussions in rugbymen. Further longitudinal studies are still needed to determine which level of RNFL loss should be a recommendation of sport cessation.

PHYSICAL ACTIVITY AND VENTRICULAR TACHYCARDIA IN PATIENTS WITH ARRHYTHMOGENIC CARDIOMYOPATHY

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INTRODUCTION: The aim of this study was to investigate the association of accelerometer-measured lifestyle physical activity with rapid-rate non-sustained ventricular tachycardias (RR-NSVTs) in patients with arrhythmogenic cardiomyopathy (AC).

METHODS: This multicenter, observational study enrolled 72 patients with AC (recruited from two Spanish hospitals), including right, left-, and biventricular forms of the disease, with underlying desmosomal and non-desmosomal mutations. Lifestyle physical activity was objectively and continuously monitored for 30 consecutive days with accelerometers (Axivity AX3, OmGui, Newcastle University). To evaluate the occurrence of RR-NSVTs, the participants were required to wear a textile Holter electrocardiogram (Holter Nuubo ECG PLATFORM®) for 30 consecutive days. A RR-NSVTs was identified as having a heart rate >188 bpm for >18 beats and were confirmed by an independent electrophysiologist blinded to the patients' medical history and the level of physical activity.

RESULTS: Sixty-three AC patients (38±17.6 years, 57% men) had valid data for both devices and were included in the analyses. A total of 17 patients experienced ≥1 RR-NSVTs, and a total of 35 events were recorded. The odds of occurrence of ≥1 RR-NSVT during the recording did not increase as a function of either total physical activity (OR=0.95, 95% confidence interval [CI 95%]=0.68-1.30 for 60-min increase) or moderate-to-vigorous activities (OR=0.89, CI 95%=0.71-1.08 for 5-min increase). Participants presenting RR-NSVTs during the recording (n=17) did not present greater odds of RR-NSVT in the days with more time either in total physical activity (OR=1.05, CI 95%=0.84-1.29 for 60-min increase) or moderate-to-vigorous activities (OR=1.05, CI95%=0.97-1.12 for 5-min increase). Physical activity levels were neither different between the patients with and without RR-NSVTs during the recording period nor on the days of the occurrence of RR-NSVT compared with the rest of the days. Finally, 4 of the 35 RR-NSVTs recorded in the 30 days occurred during physical activity (3 during moderate-to-vigorous intensity and 1 during light-intensity activities).

CONCLUSION: The main findings of this study suggest that lifestyle physical activity is not associated with RR-NSVTs in AC patients. Therefore, this study supports the notion that lifestyle physical activity of light and moderate intensity could be promoted among AC patients to ensure they obtain the multiple benefits associated with physical activity.

Oral presentations

OP-AP12 Timings in Team Sports

PERFORMANCE PROFILE IN INTERNATIONAL MALE 3X3 BASKETBALL, REGARDING LIVE-STOPPAGE TIME RATIO AND GAME TIME

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INTRODUCTION: 3x3 basketball is a novel sports discipline and merely a paucity of evidence on the physical demands is available. Only few studies deal with live- (LT) & stoppage-time (ST) and the ratio of these parameters, which could be useful for coaches to design appropriate and close-game training sessions [1]. Therefore, the aim of this study was to analyze LT and ST in relation to the dynamics of the game.

METHODS: Fifteen international male 3x3 basketball games were analyzed using a video analyze system. For each game LT and ST were tagged and categorized into five phase (ph) durations: ph-I: 1-10s; ph-II: 11-20s; ph-III: 21-30s; ph-IV: 31-40s; ph-V: >40s. Time intervals (TI) were defined to subdivide the game: first 5min (t1), 5-10min (t2), last 3min (t3).

A repeated measures ANOVA was used to detect differences between the number and duration of LT and ST as well as effect size expressed as partial eta-squared (ηp^2). Significant main effects were followed-up by Bonferroni post-hoc procedures. Significance was set at $P<0.05$.

RESULTS: Mean±SD of all actions and rest periods per game were 28±5 each. The total time ratio between LT and ST was 0.92±0.22.

Actions in ph-I accounted 42% of all actions (ph-II: 23%, ph-III: 15%, ph-IV: 9%, ph-V: 11%). Significant differences were found in the number of all actions between TI ($P\leq0.001$; ηp^2=0.748). Observed number of actions in t1 were 9±1, t2: 6±1 and t3: 3±1. Post-hoc test revealed differences between all TI with a significance of $P\leq0.004$.

Rest periods lasting for 11-20s accounted 53% of all breaks (ph-I: 11%, ph-III: 11%, ph-IV:10%, ph-V: 14%). The distribution of LT and ST for the entire game is also reflected in all TI (t1-t3). Significant differences were found regarding the number of rest periods in relation to the TI ($P\leq0.001$; ηp^2=0.690). The number of rest periods in t1 were 8±1, t2: 7±1 and t3: 4±1. Post-hoc test revealed differences between all TI with a significance of $P\leq0.038$.

Mean duration of LT was 20.0±3.7s and of ST 22.0±1.9s. Significant differences were only found in ST regarding to the TI (P=0.023; ηp^2=0.280). The duration of ST in t1 were 18.3±4.1s, t2: 30.9±15.0s, and t3: 24.8±7.3s. Post-hoc test revealed differences between t1&t2 (P=0.018) and t1&t3 (P=0.042) with no differences between t2&t3. No significant differences were found regarding the duration of LT.

CONCLUSION: T1 showed significantly higher numbers of actions and breaks compared to t2 and t3. Furthermore, rest duration was highest in t2, which could be caused by external influenced breaks (e.g.: TV time-out). Even if the total LT duration is 20.0s, almost half of the actions last for ≤10s only. In summary, results of this study suggest that game dynamic seems to change over the course of time. This should be considered for technical and tactical competition preparation by the coaching staff.

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THE MOMENTARY EFFECT OF TIMEOUTS IN NATIONAL BASKETBALL ASSOCIATION GAMES

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INTRODUCTION: During competitive basketball matches, coaches are expected to optimize the collective performance throughout effective decision-making, including calling timeouts, devising player rotation and rearranging tactics. Previous studies have demonstrated that teams usually presented better scoring performance after coaches' substitutions and their decisions were influenced by multifactorial competition constraints. In this vein, this study aimed to quantify the temporal effects of the timeouts during professional basketball matches, so as to evaluate the performance of coaches' decision-making and to provide insights into player management and match status anticipation.

METHODS: Play-by-play and spatio-temporal data from 100 NBA games during the 2015-2016 season provided by STATS LLC were used, with 1155 timeouts being identified and extracted. The temporal effects that timeout may have on scoring performance were analysed using the points scored and received within the previous and post 5 ball possessions. The analysis included the following performance indicators: rebounds, fouls, turnovers, free throws, 2-point and 3-point field goals; contextual indicators: point difference, location, timeout type, and period; and spatio-temporal indicators: team run distance and average speed. For each category, the indicators were calculated as the difference between two teams. After normalizing the data, a stepwise multiple linear regression model was established to explore the relationship between the timeout effect and indicator variables, with the teams points difference as the dependent variable.

RESULTS: After considering a total of 10 independent variables above, the model was obtained after 5 steps of modeling, 4 variables were excluded. The model obtained is y= -0.075+0.167*period+0.324*rebounds-0.316*turnovers+0.181*free throws+0.112*fouls-0.055*team run distance (adjusted R-squared: 0.200, p<0.05). During 5 ball possessions, team run distance showed significant negative effect for the timeout (p=0.04). For the dummy variable of period, the coefficient of the 4th period is 0.167 (p=0.023), while the other periods had no statistically significant effect for the timeout (p>0.05).

CONCLUSION: The results showed that calling a timeout in the 4th period positively affects rebounds, free-throws, and fouls, possibly due to increased pressure and fatigue in this crucial period of the game. Also, it is important for teams to focus on minimizing turnovers in order to improve overall performance. Nevertheless, team run distance had a negative relationship of timeout effect in this model, which was probably due to the fact that coaches tend to call timeouts to modify team tactics. This could lead to a decrease in overall team run distance as players move deliberately to execute specific plays. In conclusion, the study provides novel insights for assessing timeout effectiveness and emphasizes the need to consider multiple factors when evaluating coaches decision-making performance.

EXPLORING SUCCESS OF FOUR LIQUI-MOLY HANDBALL BUNDESLIGA TEAMS FROM 2019 TO 2022

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INTRODUCTION: Handball is a contact team-sport with the objective to score more goals than the opponent. Knowledge about the match demands and their relation to playing success are crucial to optimizing training procedures. Previous studies show that running related demands do not differ with respect to the match outcome [1], while other studies found differences between winning and losing teams [2]. Thus, the aim of this study was to explore match demands in relation to the team and match outcome in top-level handball players.

METHODS: Four handball teams competing over three seasons (2019-2022) in the LIQUI-MOLY Handball-Bundesliga (HBL) were compared and analyzed according the match outcome using a range of common match demand metrics (n = 28) collected by a local positioning system (Kinexon Perform LPS). Match summary statistic files (n = 371, n=228 with ball tracking) were exported using the Kinexon software and merged with the match outcome data. Mean differences were investigated by one-way ANOVAs on trimmed means. Pairwise comparisons were conducted and p-values were adjusted for multiple testing by Bonferroni corrections.

RESULTS: The lower ranked teams spent less time at high-speed (-89.9 [-140.0, -48.9]; -132.5 [171.5, -93.4]) and high metabolic power (-86.4 [-123.9, -48.9]; -73 [-220.0, -139.4];-179.8 [-220.1, -139.5]), whereas they executed a higher number of jumps (16.7 [9.8, 23.6]; 8.0 [2.0, 13.9]) and passes (168.6 [123.3, 213.9]; 97.2 [47.7, 146.7]; 105.3 [53.4, 157.2]). Winning teams perform slightly less passes (-51.2 [-101.2, -1.14]; -28.4 [-67.6, 10.7]) than drawing teams and show no differences in

time at high-speed (29.1 [-25.3, 83.5]; 10.7 [-18.3, 39.8]) and time at high metabolic power (21.0 [-42.3, 84.5]; -24.6 [-55.4, 6.1]) than drawing or losing teams.

CONCLUSION: The lower ranked teams spent less time in high-intensity running and perform more passes. In this context, winning teams tend to perform less passes, but do not differ between drawing and losing teams in terms of high-intensity running. These findings provide a new perspective of the influence of match demands on success in top-level handball. It underlines that the players are all "physically well developed" [2] and therefore we hypotheses that technical-tactical actions are more important to win a game at this level. However, more studies that include the technical-tactical context to explain success in top-level handball are needed.

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Oral presentations

OP-AP44 AI for Sports Analytics

OPTIMISING THE USE OF MACHINE LEARNING AND COMPUTER VISION IN SPORT: AN ECOLOGICAL DYNAMICS PERSPECTIVE

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INTRODUCTION: Machine learning and computer vision technology is a growing area of research aimed at improving athlete development and performance, but the use of machine learning and computer vision in athlete development programs does not guarantee an improvement in athletic performance (5). Computer scientists typically design and implement machine learning and computer vision technology into athlete development programs because of the high level of technical knowledge required. This approach can lead to siloed working and sporadic approaches to athlete development which can negatively impact skill development [1, 2]. The integration of machine learning and computer vision in athlete development programs need to be rationalised to allow practitioners to collaborate effectively and avoid siloed working to maximise its potential within athlete development programs. Currently there has been no attempt to contextualise the applications of these technologies.

METHODS: In this study, pervious literatures were reviewed to show that the development of an ecological dynamics and Department of Methodology pillared framework is necessary to support the application of machine learning and computer vision into athlete development programs. A pillared ecological framework including the Department of Methodology was then developed.

RESULTS: This study suggests that the transdisciplinary approach of the Department of Methodology can allow practitioners to collaborate effectively through shared principles and language under the rubric of ecological dynamics to create information rich practice environments enriched with machine learning and computer vision. Machine learning and computer vision techniques can improve the quality of athlete development programs by improving perceptual information within virtual environments (6), predict overuse injuries (4) and provide coaches highly detailed data to increase the quality of coaching feedback. To fully utilise machine learning and computer vision technology within athlete development programs collaboration between sub-disciplines of sport and computer science is essential. The ecological pillared framework developed can also support the need for a more embodied and embedded application of machine learning and computer vision in sport [1].

CONCLUSION: This study provides practitioners with an ecological dynamics and Department of Methodology pillared framework to enhance athlete development programs through the implementation of collaboratively designed machine learning and computer vision technology. This study also demonstrates how an ecological pillared framework can improve the representative learning design, promote an individualised approach and enhance but not replace the quality of coaching feedback through the application of machine learning and computer vision technology.

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SMART BOXING GLOVE: TECHNIQUE AND TARGET RECOGNITION USING MACHINE LEARNING

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INTRODUCTION: Novel technologies, such as the smart boxing gloves establish new ways for training and documentation. This technology comprises of a specifically developed and validated force sensor and an IMU, which combined, enables the possibility to provide more exact estimations of the used boxing technique using machine learning (ML) algorithms (anderes boxing paper zitieren). The aim of the study is to include and evaluate different ML algorithms, to establish the best procedure for (kick-) boxing technique recognition (punch, hook, upper cut, backfist, and ridge hand) and target

object recognition (wall, punching bag, and hand pads) in a broad spectrum of fighters with different anthropometrics and experience levels.

METHODS: Two experiments (model development n=13; system evaluation n=8) were conducted to implement models for the striking technique and target object classification. The data samples (n=3453) from the first experiment were used to identify necessary data pre-processing steps, derive a suitable feature extraction method as well as perform model selection by evaluating and optimizing the following classifiers: Decision Tree, Random Forest (RF), Naive Bayes, k-Nearest-Neighbour (kNN), Perceptron, Multi-Layer Perceptron (MLP), Support Vector Machine (SVM) and Logistic Regression. For the evaluation, the three-way holdout method and k-fold cross-validation were used. As performance metrics, the accuracy and f1-score were used. Subsequently, the second experiment was used to evaluate the final models based on new and unseen data from additional participants which were chosen so that they represent a broad sample regarding height, experience level and sex.

RESULTS: The model implementation and selection phase showed that similarly good accuracy results can be achieved with the RF, kNN, MLP and SVM classifiers for the striking technique as well as for the target object classification. The best result for both classification tasks was achieved with the optimized SVM model which was 93.03% for the striking technique and 93.49% for the target object classification based on model development dataset. Regarding the system evaluation dataset (n=1951), the final accuracy for the striking technique classification was 89.55% and 75.97% for the target object classification.

CONCLUSION: The research demonstrated which process steps and components are necessary to be implemented in order to develop a striking technique and target object classification based on data collected using IMU and force measurement sensors of the smart boxing gloves. Furthermore, the implemented models provide a good generalization performance based on the high accuracy results regardless of the broad range of athlete characteristics. This paves the way for further research in this area, as e.g. the automatic assessment of the quality of an executed striking technique which could suppport athletes during their learnining process.

DEEP REINFORCEMENT LEARNING FOR SIMULATING VIRTUAL BOXERS THAT IMITATE THE FIGHTING INTERACTIONS GIVEN IN MOTION CAPTURE DEMONSTRATIONS

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INTRODUCTION: VR enables to immerse users in a simulated environment, with simulated opponents in fighting sports, to minimize the impacts and the risk of injuries, while increasing the number of repetitions. However, designing a virtual opponent that behaves and moves as a real opponent would, is still an open problem. Recent approaches include Generative Adversarial Imitation Learning, which enables a virtual character to have realistic behavior learned from large datasets of multiple motion clips [1, 2]. We propose to extend this idea to imitate realistic boxing fights with a little set of examples, i.e. motion capture clips with two opponents. As a result, a real-time controller is designed to compute the relevant joint torques to apply to each physics-based character.

METHODS: We propose to associate an adversarial motion prior (similar to [1]) with a new concept, the adversarial interaction prior. Both priors are based on the same approach, composed of a policy that computes the relevant actions to transit from the current state to the next one. The motion prior uses a single boxer motion clip to compute a reward quantifying to which extent a transition from the current pose to a next one is similar to those viewed in the examples. The interaction prior aims at computing a similar reward but for interaction between two fighters instead of the motion of a single boxer, using a second motion clip with two fighters. A controller (namely a policy) is trained using reinforcement learning to compute the joint torques required to simulate the next pose while maximizing both rewards.

RESULTS: This method has been successfully applied to simulate two virtual boxers fighting each other while imitating the motions of a 6-minute single boxer motion clip, and another 70-second motion clip with two boxers. The results demonstrate the ability of the approach to simulate realistic fighting behaviors.

CONCLUSION: We have proposed a new deep reinforcement learning approach to simulate two-boxers fighting each other while imitating the style of fight given in a 70s example. Future works will tend to control a virtual opponent thanks to this controller, while fighting against a real user, and evaluate the ability to actually reproduce realistic interactions for serious training game in VR.

ACKNOWLEDGEMENT:

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MACHINE LEARNING FOR AUTOMATED CATCH RECOGNITION IN AMERICAN FOOTBALL TRAINING.

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INTRODUCTION: Mastering a sport requires hours of practice. To practice and train efficiently an athlete's abilities have to be monitored precisely. So it is with catching passes in American Football. However, evaluating each pass manually and keeping track of the statistics by hand is a tedious job. State of the art systems for catch recognition, e.g. [1], are accurate

but require IMUs worn by every athlete. To remove this restriction, we propose an audio-visual recording system combined with a machine learning approach to automatically classify catch attempts during training.

METHODS: A camera and a microphone with a directional pattern were mounted on the ball-throwing machine from [2]. After triggering, an audio sequence and an independent video sequence were recorded for each catch attempt. Experiments were conducted both indoor and outdoor with different background types. The recorded dataset, consisting of 2,276 passes, formed the basis for training the neural networks. The dataset was then labelled using two main classes: catch or drop and four sub classes: jump, one-handed, run and stand. In addition, the dataset was augmented using various methods for the video and audio signal and divided in train, validation and test parts.

The machine learning approach was based on a Convolutional Neural Network (CNN) used for feature extraction. To this end, the pre-trained VGG16 [3] network was embedded and combined with a Long Short-Term Memory (LSTM) layer to classify the video data. In addition, classification of the audio data was performed using a one-dimensional CNN.

RESULTS: The network described above was only used to predict the two main classes: catch and drop. Achieved accuracies when using only the audio network range from 76%-81%. Using only the video network 83%-87% accuracy was obtained. When combining both networks, catch attempts were classified with an accuracy of up to 92%.

CONCLUSION: It was shown that the classification of catch attempts using audio and video data is possible. The achieved accuracies are comparable to that of state of the art methods using wearable sensors. Further research should focus on identifying the sub classes and improvement of audio and video only classification.

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Oral presentations

OP-SH04 Psychology and Motivation

A QUALITATIVE INVESTIGATION OF CHILDRENS PERCEPTIONS OF SCHOOL-BASED PHYSICAL ACTIVITY AND ITS IMPACT ON THEIR COGNITION AND ACADEMIC ACHIEVEMENT.

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A Qualitative Investigation of Children's Perceptions of School-Based Physical Activity and its Impact on their Cognition and Academic Achievement.

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Introduction

Physical activity (PA) provides a wealth of benefits to children. Over recent decades, academic research has shown that it might also positively impact their cognition and academic achievement (AA). However, findings are inconsistent, and common conclusions simply state that PA is of no detriment to children's cognition or AA. Further, in this field, qualitative research involving key stakeholders, including children themselves, is sparse. This research aimed to investigate children's perceptions on their school-based PA, and the perceived influence this PA has on their cognition and AA.

Methods

Twenty-one semi-structured focus groups were conducted across two different schools, totalling 77 participants aged between 5 – 12 years old.

Reflexive Thematic Analysis with an inductive and semantic perspective was conducted. Study quality was promoted through several methods, such as peer debriefing, prolonged engagement with schools, and reflexivity.

Results

A notable finding was that most children enjoyed their school-based PA and believed it was beneficial to them. Further, children readily identified aspects they felt either hindered or assisted in the delivery of, or their engagement with, school-based PA, such as lack of time, the impact of schoolwork, and social factors pertaining to peers, teachers and class behaviour. However, whether such aspects were perceived as barriers or facilitators varied between children.

Additionally, children were able to identify the influences they believed school-based PA had on their cognition and AA, discussing aspects such as focus, attention, listening, handwriting and mistakes. However, perceptions again differed between children regarding the extent of the influences and whether these were identified as beneficial or adverse. Additionally, children commonly discussed their requirement for an appropriate 'wind-down' period following their in-school PA, allowing them time to adjust both physically and mentally before continuing with academic content.

Discussion

The inter-relatedness of factors discussed by the children highlights the complexity of the relationships between children's PA and their cognition and AA. The majority of children enjoying PA is a notable finding and remains an under-explored factor in this area. Further, this aligns with Self-Determination Theory, which states that enjoyment leads to prolonged PA participation.

This study provides an important insight into how children perceive their school-based PA, and how they perceive its influence on their cognition and AA. Addressing the barriers and promoting the facilitators identified by children, as well as focusing on their enjoyment, may increase engagement and improve the benefits of school-based PA.

THE EFFECTS OF COACH-CREATED MOTIVATIONAL CLIMATE IN RHYTHMIC GYMNASTICS

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Introduction

Rhythmic gymnastics is an aesthetic sport involving complex and particular training processes with high physical and psychological demands. As in other gymnastics disciplines, the coach plays a crucial role in the development and training of athletes. It is essential that coaches strive to create a positive and supportive motivational climate and nurture an optimal environment for their athletes. This study aimed to investigate the athletes' perception of the coach-created motivational climate in rhythmic gymnastics and its relation to the athletes' motivational and social outcomes.

Methods

Ninety-one rhythmic gymnasts (aged 12 to 18) completed an online survey consisting of several standardised questionnaires, including the Empowering and Disempowering Motivational Climate Questionnaire-Coach, Athlete Engagement Questionnaire, and Youth Sport Environment Questionnaire. The participants were all experienced contestants who competed at the national level (57.1 %) or had international experience at a non-elite level (42.9 %). Using the concept of empowering and disempowering coaching climate, we hypothesised that the empowering climate (represented by greater autonomy, task orientation, social support, and lower ego orientation and controlling coaching) would be positively related to motivational (i.e., athletes' engagement) and social (i.e., team cohesion) outcomes.

Results

The observed patterns of correlations between engagement, team cohesion, and dimensions of motivational climate corroborated our predictions. In regression models, autonomy-supportive climate and task involving motivational climate were the main predictors of athletes' engagement and team cohesion, explaining 43.5 % of the variance in athletes' engagement and 33.1 % in task cohesion. In the k-means cluster analysis, we identified two types of participants, which we labelled as "empowered" and "disempowered". Overall, the disempowering climate was more prevalent, as 57 % of participants belonged to the "disempowered" type. The participants of the "empowered" type reported high levels of task-involving, autonomy-supportive and socially supportive climates and low levels of ego-involving and controlling climates, whereas the "disempowered" gymnasts reported opposite values in all dimensions of motivational climate. Furthermore, the "empowered" gymnasts showed significantly higher engagement and team cohesion.

Discussion

These results suggest that the coach-created empowering motivational climate may be an important predictor of motivational and social outcomes in competitive athletes. Coaches providing higher emphasis on athletes' autonomy and task orientation and lower emphasis on social comparisons and control of athletes might enhance their positive experience of their sport. This environment may be especially important in rhythmic gymnastics, as only a minority of our participants experienced the empowering coach-created motivational climate.

COACH/PEERS/PARENTS NEED SUPPORTIVE QUESTIONNAIRE (CPP-NSQ-FR): PRELIMINARY VALIDATION, AND RELATIONSHIPS WITH ADOLESCENT ATHLETES WELL-BEING.

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UNIVERSITY GRENOBLE ALPES

Introduction: In the competitive sports context, coaches, parents, and peers constitute the close social network of adolescent athletes [1]. To date, no measurement scale simultaneously captures adolescent athletes perceptions of the behaviors and attitudes of these three agents. However, this is necessary when it is known that they can foster ill-being in athletes.

Based on self-determination theory [2], the present study aimed to (a) examine the psychometric properties of a french questionnaire (based on the Interpersonal Behavior Questionnaire [3]) adapted to the three actors, designed to measure the need-supportive style of coach, parents, and peers (the CPP-NSQ-Fr), and (b) examine the links between the need supportive style of the three agents on athlete well-being (i.e., vitality, need satisfaction, and burnout).

Method: French athletes in competitive team sports (N = 290; F = 131; Mage = 15.19; SD = 1.56) completed the CPP-NSQ-Fr and questionnaires measuring well-being. Using the R studio software, several evidences of validity were tested: factorial (with CFA), convergent (with factor loadings), discriminant (with inter-factor correlation), internal consistency (with Cronbachs alpha) and criterion validity (correlations with well-being variables).

Results: A hierarchical model with a latent variable for need satisfaction by each actor in the first order, and a latent variable by actor in the second order showed the best fit to the data (χ^2 (546) = 877.02, p < .001, CFI = .93, TLI = .92, RMSEA = .05 (90% CI [045-.057]), SRMR = .06), acceptable standardized factor loadings (<.05) and good estimates of internal consistency (α between .76 to .85). The CPP-NSQ-Fr subscales correlated with well-being outcomes in the expected direction. Indeed, CPP-NSQ-Fr subscales were positively correlated with need satisfaction (autonomy, competence, and relatedness) and subjective vitality, and negatively correlated with the dimensions of athlete burnout (reduced accomplishment, negative feelings toward sport, and physical exhaustion).

Discussion: The present study results outlined preliminary validity evidence for the CPP-NSQ-Fr. Further research is needed to confirm these results and to demonstrate the validity of the CPP-NSQ-Fr in different populations (e.g., high performance athletes). In the future, this tool may be used to simultaneously compare athletes perceptions of coach, peers, and parents' need-supportive style. Further studies may also explore the potential interactions between athletes perceptions of their social environment and links with well-being.

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EXPLORING THE ROLE OF INTENSITY PREFERENCE AGREEMENT ON BASIC PSYCHOLOGICAL NEEDS, ENJOYMENT, INTENTION TO CONTINUE EXERCISING, AND EXERCISE FREQUENCY: A MODERATED MEDIATION ANALYSIS

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Introduction

Several theoretical frameworks have been used to understand and promote exercise adherence. Basic psychological needs, grounded on self-determination theory, have received large attention for this purpose. More recently, the hedonic theory and the assumptions related to the exercise characteristics that can bolster positive affective responses have been revitalized. One of those characteristics pertains to the way exercise intensity is being experienced by the individual. Given the need to further explore theoretically integrated models and their interaction mechanisms, this study aimed to explore the associations between the agreement of current exercise intensity and the one individually preferred (as a trait characteristic), basic psychological needs satisfaction/frustration, enjoyment, the intention to continue exercise, and exercise frequency. Additionally, an exploration of the direct and indirect effects, while also testing for sex as a moderator, was also intended.

Methods

A sample of 369 health club exercisers (Mage = 43.6, SD = 12.96; 214 females) enrolled in 26 health clubs representing all districts in Portugal participated in this study voluntarily. Data received in a first approach descriptive and correlational analyses. Next, a moderated mediation was performed using model 15 (PROCESS v.4.2 macro for SPSS v.26.0). This model assumes an independent variable (preference agreement), parallel mediators (six; autonomy, competence, and relatedness satisfaction; autonomy, competence, and relatedness frustration), a dependent variable (separately: enjoyment, intention, frequency), and a moderator (sex; tested in the independent > dependent variable path, and mediators > dependent variable paths).

Results

Agreement in preference for exercise intensity was positively associated with enjoyment, intention, and all needs satisfaction, and negatively associated with all needs frustration. In the moderated mediation analysis, the same pattern of results emerged in the direct effects. Indirect effects were significant for autonomy in most of the models. Regarding sex as a moderator, the most relevant interactions were detected with preference and with autonomy satisfaction in the enjoyment and intention models.

Discussion

Findings suggest that promoting an individually adjusted training intensity may foster basic psychological needs satisfaction. It appears to be present an independent (of needs) but positive association with exercise enjoyment and intention to continue exercising, two well-known predictors of exercise behavior. Also, sex appears to differentiate how preference agreement and some psychological needs relate to these outcomes. In general, partial mediation results were detected, highlighting the need to consider individual characteristics in exercise prescription/supervision when aiming to promote the conditions for the development of self-determined and sustainable behavior.

THE 'WHAT' OF ATHLETES' GOAL PURSUIT: RELATIONSHIPS TO THE PERCEIVED MOTIVATIONAL CLIMATE, GOAL-RELATED PROCESSES, AND WELL-BEING

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Introduction

Goal Contents Theory (GCT) [1] postulates that the goals people pursue not only direct their perceptions of and behaviours relevant to goal pursuit, but also hold implications for their well-being. According to GCT, intrinsic goals (e.g., mastery, personal growth, self-expression) should link to more adaptive goal processes and optimal functioning while extrinsic goals (e.g., social recognition, popularity, superiority) are expected to correspond to maladaptive goal processes and compromised well-being. Past research [2] has found the perceived motivational climate on a team to predict the 'why' (motives) of goal pursuit but little is known whether this social environmental factor relates to 'what' (goal content) is being pursued in sport.

Extending past sport work grounded in GCT, this study examined whether athletes' self-generated goals were differentially aligned with empowering and disempowering coach climates, goal-related processes (self-efficacy for goal attainment, perceived goal difficulty, goal-directed effort), and well-being (vitality, burnout).

Methods

414 University team sport athletes (M = 20.61; SD = 2.58 years of age; male (n=206), female (n=208)) provided their goal for the season via an idiographic methodology and responded to validated scales tapping the targeted goal-related processes, perceptions of the motivational climate and positive and negative indicators of well-being. Three expert judges deductively coded the goal content.

Results

Fleiss' Kappa revealed substantial agreement amongst coders; 60.8% of the goal content was classified as intrinsic, 31.1% extrinsic and 8% ambiguous. Women reported more intrinsic goals compared to men. MANCOVA (with gender as a covariate) revealed that athletes who pursued extrinsic goals reported significantly lower self-efficacy ($\eta 2$ =.02), greater goal difficulty ($\eta 2$=.10) and perceived the motivational climate to be more disempowering ($\eta 2$ =.03) than athletes with intrinsic goals. No differences in well-being indicators emerged.

Discussion

Findings were largely congruent with GCT and indicate that: (a) features of the motivational climate hold implications for the type of goals athletes pursue, and (b) the quality of athletes' goal-related processes vary as a function of whether they are pursuing intrinsic or extrinsic goals. Future work may address whether an interplay between goal content and athlete well-being emerges when examined as the season progresses.

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Oral presentations

OP-SH25 Qualitative and quantitative methods

ASSESSMENT OF VARIABILITY IN PREFERENCE AND TOLERANCE TO EFFORT INTENSITY AND AFFECTIVE RESPONSES

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Introduction

Understanding psychological variables along with the individual characteristics and motivations of subjects are interesting tools to associate with quality and adherence to physical activity. Recent studies have focused on hedonist theories to relate physical activity enjoyment and the biopsychosocial factors involved in the prescription of physical training. This study aimed to assess the effects of exercise intensity preference and tolerance over time, their link to affective responses, and subjective perception of effort in a 3-month self-paced training program.

Methods

Twenty-one adults of both sexes were randomly allocated to two groups based on their baseline scores on the Exercise Intensity Preference and Tolerance Questionnaire (Smirnaul et al. 2015). A personalized follow-up program was applied remotely for 3 months, with three weekly training sessions lasting 60 minutes, two supervised by a professional and one unsupervised. Participants reported their preferences and tolerances for exercise intensity, perceived exertion, and enjoyment each month. The effects of preference, tolerance, perceived exertion, and enjoyment (Alves et al. 2019) over time and between groups were observed using Anova two-way with a significance level of $p < 0.05$ and Power 1-ß >0.8.

Results

There was no significant effect on exercise intensity preference over time. The group with lower scores showed approximately 27-31% less tolerance over time with differences at the start and at the 3rd month ($p<0.05$). The group with lower scores showed increased tolerance until the 2nd month with a decline in the 3rd month, inversely proportional to the group with higher scores. Enjoyment presented a significant difference between groups at the start ($p<0.05$), with the

group with lower scores having less enjoyment, without differences over time. The perceived effort was lower in asynchronous training than in synchronous training sessions, with significant effects of time on perceived effort in both types of sessions (p <0,001). In the group with the lowest preference and tolerance score, it was observed that despite an increase in perceived effort, tolerance decreased.

Discussion

The findings suggest that individuals who initially had lower exercise preference and tolerance showed a significant improvement in both tolerance and enjoyment in the first two months of the study. However, there was no significant change in exercise intensity preference over the three-month period. Its important to note that these individuals did not show an increase in tolerance similar to those with higher scores, and also they reported a higher subjective perception of effort.

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COGNITIVE ABILITIES EVALUATION OF EXPERT ATHLETES : SCIENTIFIC VALIDATION OF TESTS BATTERY

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To be an expert in sport result of fine adaptations on the physical, technical, psychological and cognitive levels. For a long time, Sports sciences have examined the methods of physiological and technical development and they thus become essential in the preparation of athletes. While tests to measure the physiological and physical abilities of an athlete (e.g. Vameval test, force test) are widely standardized and referenced in the literature, the investigation of cognitive abilities still remains unclear and equivocal.

The present study was based on the postulates of the cognitive skills approach, which studies the differences between athletes by testing their basic cognitive abilities through standardized laboratory tests, dissociated from the sport context. Using a battery of cognitive tests to investigate different cognitive skills, the objective of the current study was to determine how expertise in a sport shaped the athletes cognitive identity card. The hypothesis that there is a specific development of certain skills according to the sport practiced was tested (as well as the link between this development and the level of expertise of the athletes).

A battery of cognitive tests was proposed to measure (i) executive functions (motor inhibition (Go/No Go task), cognitive flexibility (switching task), working memory (N back Task)), (ii) selective attention (Flanker task) and (iii) information processing (perceptual visual task).

98 athletes of national level (61 males & 27 females, average age : 16.3 ±1.5) classified according to 3 categories of sport were involved in the experimental protocol (N = 40 for interception sports, N = 23 for static sports and N = 35 for strategic sports).

The results confirmed the law of information processing. Indeed, complexity of the processing process manipulated through the experimental conditions for each test resulted in increased processing time and lower success rates regardless of the sport. This main result allow us to validate our cognitive test battery. Secondly, differences obtained in dominant cognitive functions across sport types showed that athletes practicing interception and strategic sports performed better on the selective attention task, while athlete in interception sports showed better performance on motor inhibition and working memory test. Thus, the results of this study validate an operational test battery for the sports domain that reliably measures executive functions.

The prospects for the integration of this test protocol to the already well known physiological and physical test battery is of particular interest and really promising to complete the identity card of the athlete at different levels. Furthermore, later on, the choices and orientations of cognitive training protocols will be all the more relevant as they will be based on reliable and complete scientific data.

THE SPORT IMAGERY INTERVENTION QUESTIONNAIRE: DEVELOPMENT AND PSYCHOMETRIC EVALUATION

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The Sport Imagery Intervention Questionnaire: Development and Psychometric Evaluation

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Introduction

The Sport Imagery Intervention Questionnaire (SIIQ) was developed to assess athletes use of imagery intervention. SIIQ was developed based on PETTLEP model of imagery (Holmes & Collins, 2001). This model provides a framework for the effective execution of seven imagery interventions (i.e., Physical, environment, task, timing, learning, emotion, and perspective). Because imagery is related to performance, it is important to understand whether such imagery interventions can be evaluated.

Methods

In this three-part study, the psychometric properties of the SIIQ were addressed. After items were developed based on constitutive definitions representing each of the seven elements of the PEPPLEP model to measure athletes use of imagery intervention, SIIQ's factor structure was verified using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). Multivariate analysis of variance (MANOVA) was used to evaluate the group differences in SIIQ (such as gender and subjective performance level). Finally, correlation and regression with imagery ability were investigated.

Results

In study 1 (N = 366) EFA revealed a 10-factor model assessing imagery intervention of physical, environment, task, timing-real, timing-slow, timing-fast, learning, emotion, perspective-third-person, perspective-first-person and these were confirmed through the CFA conducted in study 2 (N = 442) and study 3 (N = 378).

Result demonstrated good fit with the data of the 10-factor model. Additional validation of the SIIQ demonstrated good temporal reliability and concurrent validity. SIIQ scores distinguish between athletes with varying subjective performance levels. However, there was no significant gender difference in SIIQ mean scores. Several SIIQ subscales positively predicted imagery ability.

Discussion

The SIIQ provides a comprehensive assessment of athletes use of imagery intervention through ten subscales.

The results highlight the importance of separately evaluating imagery interventions for timing as timing-real, timing-slow, timing-fast, and perspective as perspective-third-person, perspective-first-person. These were confirmed through series of CFAs. A 7-factor model in which timing-real, timing-slow, and timing-fast items were forced onto a timing subscale and perspective-third-person and perspective-first-person items were forced onto a perspective subscale revealed a poorer fit than 10-factor model.

SIIQ discriminated among athletes of different subjective performance levels. Athletes with a higher subjective performance level significantly used imagery intervention more in their sport compared with those with a lower level. SIIQ subscales predicted imagery ability positively, which suggests how the SIIQ can be practically applied in the sporting field. Overall, SIIQ has excellent psychometric properties.

APPLYING THINK ALOUD TO APPLIED SPORT PSYCHOLOGY PRACTICE

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Introduction

The Think aloud (TA) method involves an athlete or participant verbalizing his or her thoughts whilst performing a task and has been used in sport research to generate understanding of athlete cognition (e.g., Whitehead et al., 2016;2018). This research often suggests the benefits of TA as a useful tool for applied sport psychologists (ASP) in service-delivery with clients. However, no study has yet explore how practitioners could use TA within their practice. To address this gap, we explored trainee and registered ASP's use of TA in practice, when working with clients.

Methods

A workshop was delivered to ASP's (n = 25, registered and trainees) on how TA could be used with clients. At approximately 4 and 12 months' post workshop, 11 participants (5 females and 6 males) with 1-15 years of professional experience were interviewed to share the story of their use of TA in their practice. Data analysis began with an examination of the narrative structure of the practitioners' stories, followed by an investigation of the narrative themes related to factors influencing its effectiveness. A composite vignette was developed to fuse the account of multiple participants to represent our findings.

Results

A story of Steve the ASP and Barney the darts player provides an account of how TA can be used within sport psychology practice. We found that TA influenced client self-awareness, particularly in the needs analysis and intervention phases. Practitioner confidence in applying TA was shaped by the practitioner-client relationship.

Discussion

This study extends literature on TA by demonstrating how ASP's can use the method as a collaborative applied practice tool at multiple stages of the consultancy process. We encourage ASP's to use the method in creative and meaningful ways to support their clients.

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PSYCHOMETRIC VALIDATION OF THE FRENCH VERSION OF THE COACH-ATHLETE RELATIONSHIP QUESTIONNAIRE

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Introduction.

For the past twenty years, the Coach-Athlete Relationship Questionnaire (CART-Q; Jowett & Ntoumanis, 2004) has been considered as an effective measurement tool to explore the coach-athlete relationship (CAR) quality (in terms of closeness, commitment, complementarity, and co-orientation). However, although few studies used a French translation of the CART-Q, these did not focus on evaluating the psychometric properties of this scale. The two present studies aim to contribute to the psychometric validation (i.e., factor structure, discriminant, convergent, criterion validity, and temporal invariance) of a French athlete version of the CART-Q among two different samples.

Method.

In the first study, 442 athletes (Mage = 21.66, SD = 4.82; 34.2% of women) from both individual and team sports competing at different levels completed a French translation of the 11-item CART-Q. For study two, 282 young handball players (Mage = 15.39, SD = 1.01; 41.6% of women) involved in intensive training centers completed at two measurement times (early and mid of the season) a revised 12-item French version of the CART-Q. Confirmatory factor analysis and structural equation modelling were conducted to explore the psychometric properties of the CART-Q.

Results.

Results of the first study indicate a satisfactory fit of the second-order model (χ2/df = 4.97; CFI = .90; SRMR = .05), a satisfying convergent validity (factor loadings above 0.63), and a good criterion validity with athletes' perceptions of self-competence (b = .30, p <.001). In the second study, results also reveal a satisfactory fit of the second-order model (χ2/df = 3.96; CFI = .90; SRMR = .07), a satisfying convergent validity (factor loadings above 0.55), and a good criterion validity (b = .34, p <.001). In addition, results provide evidence for the temporal invariance (scalar invariance: χ2 >.05; delta CFI <.01) of the CART-Q over time.

Discussion.

These two studies provide evidence for the psychometric validity of the 12-item French revised version of the CART-Q. In addition, the second study is the first – to our knowledge – to highlight the temporal invariance of the CART-Q. This result suggests that despite the dynamic nature of the CAR (Roux et al., 2022), the factorial structure of the CART-Q remains stable over time. Thus this 12-item French version of the CART-Q can be considered as adapted to measure the CAR quality among French-speaking athletes.

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Oral presentations

OP-MH34 Health and Fitness: Ageing

THE INFLUENCE OF RESISTANCE TRAINING AND PROBIOTICS SUPPLEMENT ON INSULIN SENSITIVITY AND COGNITIVE FUNCTION IN ELDERLY

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INTRODUCTION: Aging associated with sarcopenia, gut microbiota dysbiosis, cognitive function decline, and insulin resistance. Maintaining muscle mass and gut microbiota abundance may be beneficial for insulin sensitivity and cognitive function during aging process. However, limited studies examined the the impact of exercise and probiotics in the elderly. The current study was to investigate the effect of resistance training and probiotic supplementation on gut microbiota, insulin sensitivity, and cognitive function in healthy elderly.

METHODS: A total of 36 volunteers over the age of 65 were recruited for this study(71.3±6.1yrs). The participants were randomly assigned into three groups : resistance training + placebo (R), resistance training + probiotics (RP), and probiotics supplement (P). The R & RP groups were instructed to complete a 6-week resistance training program. The RP and P groups were asked to consume probiotic for 6 weeks. Participants were asked to give their fasting blood samples, feces samples and to complete stroop test, fitness tests, body composition before and after the 6-week intervention. Plasma samples were analyzed plasma biochemistry markers and cytokines. Feces samples were analyzed gut microbiota.

RESULTS: The RP group significantly reduced fasting plasma glucose (p<.05), and the RP & R group significantly increased GLP-1 (p<.05) after the intervention. The insulin sensitivity assessed by HOMA-IR, QUIKI index and McAuley index were no

differences before and after intervention in each group (p>.05). The abundances of Fusobacteria and the Simpson index were significantly reduced (p<.05) in R group. The Firmicutes/Bacteroidetes (F/B) ratio were significantly negatively correlated to QUICKI index and TC/HDL-C (p<.05). There were no significant differences in plasma lipids profiles before and after intervention in each group (p>.05). Among the change of plasma cytokines concentrations, the R group was found a significant increase in IL-6 (p<.05) after intervention. Plasma brain-derived neurotrophic factor (BDNF) concentration was significantly increased following the R group and the RP group compared with the P group (p<0.05). In the stroop test, the R group and the RP group significantly reduced the time required to complete the word and color tests (p<.05), and the R group also significantly reduced the time required to complete the incongruent test (p<.05).

CONCLUSION: The current study suggested that the resistance training and probiotic supplement improved cognitive function and gut microbiota abundance in older adults. The changes in the proportion of dominant gut microbial species ratio may be closely related to the risk of metabolic disorders in the elderly. Regular resistance exercise program in combination with probiotics supplement is likely to have positive health effects in the elderly.

EFFECTS OF RESISTANCE EXERCISE WITH INSTABILITY ON PHYSICAL AND COGNITIVE FUNCTIONING OF MIDDLE-AGED AND OLDER ADULTS: SYSTEMATIC REVIEW WITH PRELIMINARY META-ANALYSIS

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INTRODUCTION: Resistance Exercise (RE) is an effective preventive and treatment strategy to combat many geriatric syndromes including sarcopenia, frailty, and cognitive impairment. Recent evidence suggests that RE with instability (REI) (e.g., weight-bearing, machine-based or free-weight exercise using unstable surfaces/devices: foam pads, Swiss ball, BOSU®) is a promising intervention to maximize the benefits of RE on health outcomes in older adults. With this in mind, we performed a systematic review with preliminary meta-analysis to examine the impact of REI on physical and cognitive functioning, falls risk and quality of life.

METHODS: We searched electronic databases (PubMed, APA/PsycInfo and PEDro) from inception to January 2023 to extract data of eligible hits who examined the chronic effects (>4 weeks) of REI, compared with a control group (lifestyle maintenance, wait list, usual care, health education or active control), on the physical and cognitive functioning of older adults living independently in the community. Included articles were peer-reviewed, randomised controlled trials and without establish language restrictions. Risk of bias and quality of reporting were assessed (PEDro Scale and CONSORT checklist, respectively). In our preliminary meta-analysis, we performed random-effects models using robust variance estimation to examine the effects of REI on physical function, cognitive function, falls risk, and quality of life.

RESULTS: Eighteen studies with participants from Brazil, Spain, German, and South Korea (Total n=525, aged 50+ year, %woman varying from 35-100%) were included in the qualitative review and 11 studies in the meta-analysis. Eleven studies provided 103 effect sizes examining the effect of REI on physical function, with Hedge's g ranged between -1.71 and 2.52. The summary effect was g=0.61 (95%CI: [0.35,0.86]; p<0.001), which is representative of a medium-to-large effect. More than two-thirds of the variance was estimated to be true effect size heterogeneity (I2=70.33%, tau2=0.27). Five studies provided 26 effect sizes investigating the effect of REI on cognitive function, with Hedge's g ranging between -0.27 and 1.90. The summary effect was g=0.67 (95%CI: [0.08,1.27]; p=0.035) which is indicative of a medium effect. Nearly half of the variance was estimated to be true effect size heterogeneity (I2=61.75%, tau2=0.21). The effects of REI on falls risk and quality of life the summary effect did not reach statistical significance (p's>0.05).

CONCLUSION: In summary, our findings suggest that REI is a promising strategy to promote physical and cognitive health of middle-aged and older adults. Further high-quality research is needed to strengthen the evidence in this field.

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WHAT IS THE LONG-TERM EFFECTS OF RESISTANCE TRAINING WITH INSTABILITY IN COGNITIVE FUNCTION OF OLDER ADULTS WITH PROBABLE MILD COGNITIVE IMPAIRMENT? A RANDOMIZED CLINICAL TRIAL

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UNIVERSIDADE FEDERAL DO VALE DO SÃO FRANCISCO

INTRODUCTION: An impaired cognitive function is a hallmark of mild cognitive impairment (MCI), an established risk factor for dementia. Systematic reviews with meta-analysis showed that exercise training, including resistance training is effective to promote cognitive health in cognitively impaired older adults. Some studies proposed that exercise paradigms that embody high motor complexity is promising to boost cognition. Resistance training with instability (RTI) featured by combining strength exercises with dynamic balance conditions– is a such strategy. Clinical trials with RTI in the short term show controversial results in cognitive function. Long-term effects of RTI were not established. Herein, we examined the effects of 24-weeks of RTI on cognitive function of older adults with probable MCI.

METHODS: This is a 2-group parallel, assessor blinded, single-site, randomized clinical trial (RBR-9bv3dc9). Non-disabled, sedentary, older adults with probable MCI, aged 65 years and older were included. They were randomized into twice-

weekly RTI program or a sham-training, attention-matched control group (CG). The RTI protocol involved 3-sets of 10-15 maximum repetitions, seven whole-body exercises, simultaneously performed with instability devices (e.g., foam-pad, Bosu®, Swiss ball), that were progressively implemented. The CG included low intensity/no progression of strength, balance, stretching, and relaxation classes. Measurement occurred at baseline, 12-, and 24-weeks. Global and domain-specific (executive functioning [EF] and memory) cognitive function were assessed using the Montreal Cognitive Assessment (MoCA), Stroop Test, Trails part A and B, Digit Span (DS) Forward and Backward, Digit Symbol, Verbal Fluency (VF), and Wechsler Memory Scale. Treatment effects followed the intention-to-treat and were determined through ANCOVA controlling for age and baseline levels.

RESULTS: Ninety-one older adults with probable MCI (MoCA=20.0, SD=4.5) were included in the study (RTI=45; CG=46), most were female (78%), mean age of 71 years (SD=4.8) with an average of 12 years of education. In 12-weeks, participants of RTI group had greater performance in delayed memory (Mean difference [MD]=3.8 recalls, 95%CI=0.2; 7.4) compared to CG. At the same time-point, we observed a significant deterioration in executive functioning (Trails B: MD=43.8 sec, 95%CI=13.0; 74.7; Trials B–A: MD=45.4 sec, 95%CI 13.0; 77.8). At completion of 24-weeks, the RTI had greater improvement in language (VF: MD=1.6 words, 95%CI=0.1; 3.1), attention and working memory (DS Forward: MD=1.0-point, 95%CI=0.3; 1.8; DS Forward–Backward: MD=0.8-point, 95%CI=0.3; 1.7) compared to CG.

CONCLUSION: Our findings indicated that long-term RTI is effective to promote executive functioning of older adults with probable MCI. Therefore, RTI a promising multicomponent intervention to combat cognitive decline during aging.

Key words: Aging, cognitive impairment, balance, resistance training, unstable devices.

EFFECTS OF "ECCENTRIC WALKING" ON PHYSICAL FUNCTION AND HEALTH PARAMETERS IN MIDDLE-AGED AND OLD REGULAR WALKERS

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INTRODUCTION: Walking does not increase muscle strength as resistance exercise does [1]. Our previous study [2] showed that eccentric exercises using body weight load such as sitting to a chair slowly increased leg extensor muscle strength and size, balance and mobility. Therefore, it is possible that adding eccentric exercise components in daily walking such as descending stairs or slopes and lunges (i.e., eccentric walking) improves muscle function. We investigated the effects of eccentric walking on physical function, blood and cognitive function tests in middle-aged and older adults who had been walking regularly for ≧3 years.

METHODS: Eleven adults (69.3±10.4 y) who had more than 5000 steps in exercise walking at least 5 days a week participated in this study. During the 12-week study period, participants walked as usual for the first 4 weeks and added eccentric walking into their walking routine by including lunges, and descending stair or slope walking for the next 8 weeks. The number of eccentric walking steps was gradually increased from 100 to 1000 steps over 8 weeks. Outcome measures included maximal voluntary isometric contraction torque of the knee extensors (MVC), 30-seconds chair stand (CS), 2-minutes step, balance ability assessed by center of pressure movement distance and area with eyes open (BAL-dis-EO, BAL-area-EO) and close (BAL-dis-EC, BAL-area-EC), sit and reach, a digit symbol substitution test (DSST) for cognitive function. These were assessed before, after the control period (week 4), after 4 weeks (week 8) and 8 weeks of eccentric walking intervention (week 12). Cholesterol, triglycerides and glucose in the fasting blood were measured before, week 4 and 12. Changes in the variables over time were analysed by one-way ANOVA.

RESULTS: The average steps per day were 10535±3516 in the first 4 weeks, and 10118 ± 3199 in the eccentric walking period without a significant difference. No significant changes in any of the measures were evident in the first 4 weeks. Significant ($P < 0.05$) improvements were observed in MVC (31.0±8.1→36.3±12.4 kg), CS (19.0±2.7→23.4±4.9 times), BAL-dis-EC (224.5±61.4→174.8±55.4 mm), and DSST (38.5±4.9→44.9±7.1 points) from week 4 to 12. Significant ($P < 0.05$) improvements were also observed for BAL-dis-EO (176.6±37.6→149.6±26.1 mm) and BAL-area-EO (117.6±40.1→84.3±30.9 mm2) from week 8 to 12. No significant changes in any of the blood tests were evident.

CONCLUSION: These results suggest that eccentric walking improved some physical and cognitive function that cannot be achieved by normal walking for the middle-aged and older individuals who had been walking regularly. It is possible that the intervention duration was too short to see changes in the blood tests. The eccentric walking should be implemented for a longer period to examine its effects on health and fitness using a larger number of individuals.

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FOUR YEARS OF PHYSICAL EXERCISE IMPROVED COGNITION: EPD (EXERCISE FOR PREVENTION OF DEMENTIA) RANDOMIZED CONTROLLED TRIAL

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UNIVERSITÀ DEGLI STUDI DEL MOLISE

INTRODUCTION: Practice of regular physical activity (PA) positively influences health, also regardless the dementia risk, with minimal side effects.

Aim of this Randomized Controlled Trial (RCT) was to verify whether a 48-month program of supervised and standardized PA can influence the cognitive decline among older adults at risk of dementia, with a differentiation among groups within healthy people, people with Subjective Memory Complaints (SMC) and Mild Cognitive Impairment (MCI) (Iuliano, 2019).

METHODS: 674 participants, divided in an experimental group (EG) who took part in three time per week physical activity, and a sedentary control groups (CG), underwent 12, 24, 36 and 48 months assessment sessions based on the neurocognitive battery that included Mini-Mental State Examination (MMSE), Frontal Assessment Battery (FAB), Rey's Auditory Verbal Learning Test, Prose Memory Test, Attentive Matrices Test, Raven's Progressive Matrices, Stroop Color Word Interference Test, Trail Making Test (TMT), and Copying of Drawings, to evaluate differences among time-points and groups.

RESULTS: Concerning the MMSE score, GLMM analysis showed significant differences between EG and CG ($F1,2364 = 4.215$; $p = 0.040$), and over time ($F4,2364 = 13.356$; $p < 0.001$). FAB scores showed significant differences between EG and CG ($F1,2364 = 4.113$; $p = 0.043$), and over time ($F4,2364 = 5.237$; $p < 0.001$). In the two memory participants reached significant better performance over time ($F4,2364 = 8.820$; $p < 0.001$) and than CG ($F1,2364 = 17.281$; $p < 0.001$), even after 24 months. The Attentive Matrices' Test, showed significant differences between EG and CG ($F1,2364 = 15.873$; $p < 0.001$), and over time for EG ($F4,2364 = 3.354$; $p = 0.010$) after 12 months.

CONCLUSION: At least 48 months of regular PA are needed to reach significant differences between active and sedentary subjects in the global cognitive level assessment, while the single cognitive domains, such as memory and attention, were influenced in a relative shorter time (12-24 months). The SMC showed a significant improvement overtime only in the two memory tests. The MCI participants showed no change in tests' results over the 48 months, except in all the memory tests and have the most unstable values.

These results suggested that the adherence to long term PA protocols ensures a conservative effect against the natural cognitive decline due to aging (Kumar, 2022). An active lifestyle, taken up in a healthy state, without the presence of full-blown pathologies, showed its effectiveness in terms of delay the cognitive decline.

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Oral presentations

OP-SH17 Disabilities

COACHES' SELF-EFFICACY TO INCLUDE ATHLETES WITH DISABILITIES IN BADMINTON: THE ROLE OF PSYCHOLOGICAL NEEDS' SATISFACTION

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UNIVERSIDAD PONTIFICIA COMILLAS1; FEDERACIÓN ESPAÑOLA DE BÁDMINTON 2

Introduction

Physical activity levels among people with disabilities are inadequate to reach recommended levels, lagging behind the levels achieved by typically developing people (King et al., 2013). How competent coaches feel to include athletes with disabilities in their daily practice has been identified as an important barrier to the development of inclusive sport contexts (Feltz & Lirgg, 2001). Literature suggests that coaches' motivational patterns can influence their professional beliefs and behaviours. This study aims to explore whether coaches' psychological needs' satisfaction might predict their self-efficacy to include athletes with disabilities in their practice sessions.

Methods

The sample consisted of 102 Spanish badminton coaches (72 male and 30 female) aging between 24 and 66 years old ($M = 40.72$ and $SD = 10.55$). Participants completed a validated questionnaire to measure their psychological needs' satisfaction as well as their self-efficacy to include athletes with disabilities in their practice sessions. A stepwise regression was used.

Results

The analysis revealed that only competence satisfaction acted as a predictor for self-efficacy to include students with disabilities in their lessons ($t = 2.63$, $p. <. .05$). Neither autonomy ($t = -.04$, $p. > .05$) or relatedness satisfaction ($t = .93$, $p.> .05$) emerged as significant predictors for self-efficacy to include students with disabilities.

Discussion

The findings of the present study highlights that competence satisfaction might be a relevant predictor of badminton coaches' self-efficacy to include athletes with disabilities. This fact is not surprising given the similarities between both constructs, and aspects such as their previous training experiences could be affecting both constructs. Interestingly, neither autonomy nor relatedness satisfaction seemed to be related to teachers' self-efficacy. While these psychological needs have been found to be linked with outcomes such as coaches' well-being or the creation of autonomy-supportive

settings, they might be playing a less relevant role when it comes to exploring teachers' ability to foster inclusiveness in contexts with athletes with disabilities. This study sheds some light in the understanding of constructs which might be provoking the difficulty to foster inclusiveness in sport.

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EXPLORATION OF BARRIERS AND FACILITATORS TO PHYSICAL ACTIVITY IN ADULTS WITH SCHIZOPHRENIA INVOLVED IN A LONG-TERM PSYCHOSOCIAL REHABILITATION PROGRAMME

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UNIVERSITÉ DE TOULON, CLINIQUE INICEA-LE-VAL-DU-FENOUILLET

Introduction

Regular physical activity (PA) has positive effects on cardiometabolic risk factors, cognition and quality of life in people with schizophrenia (pwSCZ) (Girdler et al., 2019). However, pwSCZ exhibit high levels of physical inactivity and poor adherence to exercise programs, making the identification of factors underlying positive PA behaviours important (Bernard et al., 2013). Barriers to and facilitators of PA have been mainly investigated in small samples of individuals or in pwSCZ hospitalised for an acute episode, sometimes also including other severe mental illnesses (Firth et al., 2016; Rastad et al., 2014). The results of these studies may not apply to clinically stable pwSCZ involved in a long-term psychosocial rehabilitation programme who may experience specific levers and barriers to PA.

Methods

Forty-one clinically stable pwSCZ (age = 32 ± 9 years; n = 12 women) residing in a French psychosocial rehabilitation centre underwent semi-structured face-to-face interviews, to assess their perceptions of barriers and facilitators to PA practice which were analysed using a qualitative content analysis. Poverty of speech being one symptom in this population, pwSCZ were also asked to rate items previously identified as barriers and facilitators to PA in pwSCZ (Bernard et al., 2013) on a 5-point Likert scale.

Preliminary results

Twenty-six interviews were analysed so far (mean duration = 30 ± 7 min). Qualitative content analysis revealed that weight loss, pleasure for PA and practicing with a group were the main facilitators of PA. The main barriers were fatigue, lack of motivation and addictive substance consumption. The highest-ranking facilitators from quantitative analysis were improvement of general health, improvement of well-being and weight loss. The barriers to PA with the highest scores were fatigue, high level of stress or depression, and poor general health.

Conclusion

The present findings should help structures welcoming pwSCZ such as rehabilitation clinics to promote PA practice. Helping pwSCZ find a PA they enjoy, organising collective programs focusing on weight loss and providing therapeutic care to help manage identified barriers such as fatigue, amotivation and substance consumption might help promote positive PA behaviours among pwSCZ.

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EFFECTS OF SPORT PARTICIPATION LEVEL ON THE STEREOTYPE CONTENT ASSOCIATED WITH PEOPLE WITH PHYSICAL DISABILITY

SEYTOR, L.A., HUNALP, I.B., CORRION, K., D'ARRIPE-LONGUEVILLE, F., CLEMENT-GUILLOTIN, C.

UNIVERSITÉ CÔTE DAZUR

Introduction

Stereotypes are captured by two fundamental dimensions : warmth and competence (1). People with physical disability (PWPD) are mostly perceived as warm but not competent. This perceived incompetence is the cause of the discrimination they may experience (2).

Studies on the exerciser stereotype applied to PWPD have shown that practicing a physical activity could be a promising strategy to increase perceived competence (3). In this study, we aimed to demonstrate the role of the level of sport participation (recreational vs elite vs no sport information) on the stereotype content associated with PWPD.

Furthermore, research on social perception has suggested that competence and warmth dimension can be, each one, divided into different facets (4). We therefore aimed to distinguish the facets in the stereotype content associated to PWPD in order to have a more precise picture of the stereotype and contribute to a better understanding of the exerciser stereotype phenomenon.

Method

593 participants were randomly assigned in three experimental target conditions (elite athlete, recreational athlete, or control with no athlete status) to read the description of a physical disabled target i n which information about the athlete status was manipulated. After reading the description, participants rated the level of competence (including capability, assertiveness and courage facets) and warmth (including morality and sociability facets) that they perceived towards the target. Participants responded on a 7-point scale (from 1 "strongly disagree" to 7 "strongly agree").

Results

The athlete targets were perceived as more competent than the control target. The elite target was perceived as more competent than the recreational athlete. The facets analysis showed that all facets of the competence dimension were influenced in the same direction. Assertiveness was the facet which benefited the most from the information about the athlete status.

Concerning warmth, our results showed a negative effect of the athlete status. Athletes targets were perceived less warmth than the control target. The facets analysis showed that only the sociability facet was responsible for these differences in perceived warmth.

Discussion

Our study highlights the importance of taking into account the facets of warmth and competence in research on the exerciser stereotype as this may reveal hidden effects and help to understand how overall effects may occur.

By allowing the reduction of stigma and contributing to their empowerment, sport participation at different levels appears as a real strategic tool to improve the living conditions of PWPD in society. Thus, displaying one's athlete status could be used as a self-presentation strategy, especially in a professional context where PWPD are traditionally discriminated.

References : 1. Fiske et al. (2002) ; 2. Cuddy et al. (2007) ; 3. Kittson et al. (2013) ; 4. Cohen et al. (2017)

THE FAMILIES POINT OF VIEW: FROM EUROPE TO THE ITALIAN FOLLOW-UP OF THE IKONS PROJECT IN PEOPLE WITH INTELLECTUAL DISABILITY (ID)

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UNIVERSITY OF ROME

INTRODUCTION

The effectiveness of an adapted karate program in Down Syndrome individuals in terms of cognitive and coordinative function improvement has been demonstrated in the framework of a European project (IKONS). Thus, an additional analysis of the local contexts through online surveys was performed. The aim of the study was to collect information directly from the families about the impact of three months of training with the IKONS method in people with ID. The attention was focused on the impact of adapted karate training on their daily living, on the barriers they can find in practicing regular physical and/or sport activity and to which extent this activity is perceived as inclusive.

METHODS

The surveys of 45 family members of individuals with ID were collected and analyzed. The surveys were carried out by qualitative and quantitative research with the surveys administration before and after 3 months of adapted karate training. Respondents were supposed to answer questions regarding the Relationship between Users and Sport; aspects of Inclusiveness of Sport; Sports as an element supporting Autonomy; Activity Obstacles and Facilitator Elements; Effects of the project on Users. The surveys included closed (measured with the Likert Scale) and open-end questions. For the open-end questions, grouping tables were created for the responses, and this process generated different macro-areas, named differently for each question. The analysis was focused on defining facilitators and obstacles encountered in the past to participate in physical activity programs.

RESULTS

Before training, respondents declared many obstacles in practicing physical activity, such as the inadequacy of structures (23.5%), hostility towards disability by coaches and team-mates (29.4%), teachers not well prepared (5.9%), fear to relate with others (11.8%), distance and inconvenience (11.8%), unwillingness (11.8%), health problems (5.9%).

After training 100% of the respondents answered that expectations were satisfied, and 93.9% expressed their will to continue to participate to adapted karate classes. Socialization (46,7%) and sharing (20%) were classified as main determinants in attributing to sport activity a relevant role in the inclusion process. Moreover, 71.9% of respondents noticed improvements in motor coordination (28.6%), posture (14.3%), tonicity (9.5%), slimming (9.5%), elasticity (4.8%), agility (9.5%), more energy (9.5%), body awareness (9.5%), and stereotypies disappearance (4.8%).

CONCLUSIONS

The main finding of this study was that three months of adapted training for people with ID was perceived by family members as effective in increasing their quality of life, as well as in improving physical, relational and behavioral aspects. The families highlighted the concept of "Autonomies" resulting from participation in sports. Adapted physical activity is thus confirmed as a valuable tool in this population in a logic of inclusion, and equal opportunity.

INFUSING DISABILITY AWARENESS IN EDUCATIONAL SETTINGS THROUGH REVERSE INTEGRATION: EXPLORING STUDENTS' KNOWLEDGE AND PERCEPTIONS OF DISABILITY AND INCLUSION IN WHEELCHAIR BASKETBALL

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NORTHUMBRIA UNIVERSITY, UK

Introduction: Students' knowledge and learning experiences within the field of sport, exercise and adapted physical activity will contribute to promoting physical activity and facilitate inclusive opportunities for disabled people. It is necessary for researchers and educators to understand and expand pedagogical approaches on how students acquire learning experiences and knowledge. By applying reverse integration, this paper explores a set of learning practices that can be considered and adapted in an educational setting. Through a collaborative design of practice between academic tutors and the lead researcher, the aim was to enhance students' knowledge and understanding of disability and inclusion.

Methods: The context of this study is a short educational course informed by disability studies perspectives focused on reverse integration. A qualitative analysis of the meanings from students' engagement and experience in a disability awareness workshop focused on reverse integration in wheelchair basketball. Fifty-three students were invited to attend a workshop which coincided with their module delivery and assessment at university. The students were invited to attend a lecture, a practical and a seminar across two days while actively engaging with national wheelchair basketball athletes. Questionnaires and informal recorded discussions were used to gain responses. A content analysis was conducted and reviewed, and all patterns, commonalities and student perceptions were noted.

Results: The data indicate that students before the course had limited knowledge and disability awareness in wheelchair basketball. During the course, the students found the practical element/reverse integration, by taking part in a wheelchair basketball session, had helped them to become more aware and have a sense of appreciation towards people who use a wheelchair daily and the strength that it involves to perform certain skills. After the course, once all lectures and practical's had taken place, the students shared they had gained much more knowledge about disabilities and overall felt more confident to work with, and engage with disabled athletes. Lastly, most students found that it was an invaluable experience and expressed that there should be more sports that include able-bodied and disabled people together as it helps to minimise and address certain barriers towards sport participation.

Discussion: In analysing the data it was apparent that the students expressed a meaningful shift in their thinking and their value of performance ability of disabled athletes and disability sports was much more of an appreciation towards their thinking around disabilities in sport. As a result, from the workshop, reverse integration in wheelchair basketball has contributed to changing perceptions of players with disabilities and their understanding of disabilities and inclusion. These insights have the capacity to influence educational settings and coach education pathways.

17:00 - 18:00

Conventional Print Poster

CP-BM01 Motor learning and motor control

BIMANUAL FORCE CONTROL FEEDBACK USING LISSAJOUS PLOTS: HELPFUL OR IN THE WAY?

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INTRODUCTION: Many daily tasks require precise coordination between the left and right limb to achieve a given task goal. Augmented visual feedback (e.g., Lissajous) is commonly used in bimanual coordination research to help facilitate skill acquisition (Kovacs, et. al. 2010). Subjects are able to take advantage of the integrated feedback provided by the Lissajous plot reducing attentional demands and utilize trial-by-trial errors to meet the goal coordination pattern when performing bimanual coordination tasks (Kovacs et al., 2009; Kennedy, et. al, 2016). The accuracy of force production has often been less emphasized during Lissajous guided task. Therefore, the first objective of the current study is to investigate the accuracy of bimanual force production when performing bimanual isometric force coordination tasks; the second objective is to examine whether the strength of force production influences the accuracy of producing the goal bimanual coordination patterns.

METHODS: Nine participants produced the maximum voluntary contraction (MVC) via abduction isometric contractions against fixed force transducers using the first dorsal interossei (FDI) muscles. The MVC was used to set the target force of 10% and 30% of subjects MVC. All subjects were required to complete 2 different coordination patterns (0° & 180°) using four Lissajous feedbacks, at two different force goals (10% & 30% MVC). Subjects completed 112 trials total. Lissajous feedback included classic Lissajous (CL), overshoot feedback (OF), target feedback (TF), color feedback (CF).

RESULTS: For absolute error (AE) of relative phase there was a main effect of task (p=<.001) indicating there were more errors produced for the 180° task (44.88±11.93) compared to the 0° task (10.18±2.54). For variability of relative phase (VE) there was a main effect of feedback (p=0.041) suggesting that additional feedback (CL: 21.48±2.07 compared to TF:24.90±4.63, OF: 23.87±2.56, CF: 23.91±2.724) can cause greater amounts of variability of bimanual force coordination. For the 0° task, force accuracy data revealed a main effect of feedback (p=<.001) with the CF condition having a higher percent accuracy compared to the other feedback conditions(CF: 21.94±14.34 compared to CL: 5.49±4.78 ,TF: 17.04±11.13 ,OF: 18.82±11.16). For the 180° task significant main effect of feedback (OF: 44.83±22.98 compared to CL: 29.74±28.11 ,TF: 43.406±19.04 ,CF: 39.57±24.83) found that the OF condition has the highest force accuracy measures compared to the other feedback conditions.

CONCLUSION: The results indicated that force accuracy was significantly better in the 180° task compared to the 0° task. It has been demonstrated that unimanual performance is more accurate than bimanual force performance during isometric force coordination tasks. Suggesting inphase and antiphase require different control strategies when approaching maximal force level for each limb (Fling & Seidler, 2011).

EXPLORING THE DIFFERENTIAL EFFECT OF MOVEMENT DISTANCE AND TARGET WIDTH ON AVERAGE MOVEMENT VELOCITY

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NATIONAL TAIWAN NORMAL UNIVERSITY

INTRODUCTION: Fitts' Law has been used extensively in sport performance as the basis for investigating the movement speed and accuracy relation (1, 2). There are two parameters, movement distance (D) and target width (W), in the index of difficulty (ID) of Fitts' Law, and increasing D or decreasing W will lead to an increase in ID. Fitts' Law predicted that movement time (MT) increases as ID increases. There have been observations that although the movement average velocity (AV) decreased with increasing ID when W was manipulated, the AV increased with increasing ID when D was manipulated (3). The purpose of the study was to investigate the influence of Fitts' ID on MT and the AV when both D and W were manipulated simultaneously.

METHODS: Twelve participants performed the line drawing task in 7 sets of ID conditions (1.9, 2.7, 3.8, 4.8, 5.9, 6.9, 8.0 bits) each with different combinations of D and W (10/5.5, 15/4.5, 25/3.5, 35/2.5, 45/1.5, 55/0.9, 65/0.5). The order of ID conditions was chosen at random. All participants practiced 10 trials before the 20 testing trials in each condition. The goal of the task was to draw a horizontal line to the target as quickly as possible. If the participant failed more than 4 trials to stop within the target in a condition, the condition would be re-tested for 20 trials. The linear and nonlinear regressions were performed on the average MT and AV over the IDs, and the one-way repeated measures ANOVAs were used to examine the effect of ID on MT and AV.

RESULTS: The exponential fit for MT over IDs had the R^2 of 0.99 whereas the R^2 for the linear fit on MT was 0.86. The quadratic equation fit for AV over IDs had R^2 of 0.99. The ANOVA result on MT showed significant ID effect, $F(1.57,17.31) = 90.05$, $p<0.001$. ID also had significant effect on AV, $F(2.76, 30.33) = 36.51$, $p<0.001$, where the AVs of the 2 middle IDs were significantly higher than those of lower and higher IDs (ps<.001).

CONCLUSION: The Inverted U shape of AV over the increased IDs demonstrates the competing influence of D and W in ID when both parameters were manipulated. The Lower IDs were dominated by the effect of shorter Ds where increasing D resulted in an increase of AV, whereas at higher IDs, smaller Ws lead to the decrease of AV. There appeared to be critical values for D and W for the changes of AV over the increase of IDs. Systematic manipulations of sets of Ds and Ws to create ID conditions may reveal these critical values.

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BALL OR NO BALL? DISTINGUISHING MOVEMENT COORDINATION OF ACTUAL VS SHADOW TABLE TENNIS STROKES

LIN, L.Y., LIU, Y.T.

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INTRODUCTION: During games, table tennis players pick up the information from the coming ball and use it to intercept the ball with optimal timing. Oftentimes, players also perform the shadow play to supplement their training, practicing stroke movements without balls. However, based on the constraint model [1], the movement coordination and control of players would be different between actual stroke and shadow play. We proposed that movement patterns of action conditions could be differentiated through visual perception of different levels of players. This is due to the impressive visual sensitivity human observers have to human movement, which can then be selectively enhanced by extensive visual experience [2]. Thus, this study aimed at investigating the movement coordination between table tennis shadow stroke and actual stroke in visual perception.

METHODS: Observers of different levels of table tennis (skilled, n = 34; less skilled, n = 30; naive, n = 31) viewed videos under the point-light display and answered if the actor was hitting a ball in each video. Each observer watched 48 videos that consisted of 24 trials from three actors (skilled; less skilled; novice). Each actor repeated the actions in four sessions

(shadow play; robot launched at 1.7s interval; robot launched at 1.1s interval; a player hitting the ball back and forth with the actor) in forehand and backhand positions. The number of correct answers were converted to score rate (SR), and the consistency rate (CR) was calculated from the answers of the duplicate videos. In addition, the correct information rate (CIR) was estimated using the correct answers from the trials and their duplicates. Observer (3) X actor (3) mixed-design ANOVAs were performed on SR, CR, and CIR, with repeated measures on the effect of the actor.

RESULTS: Interactions between the observer and the actor of SR [$F(3.66, 168.43)=7.59$, $p<.05$] and CIR [$F(3.53, 162.18)=7.13$, $p<.05$] were significant, revealing that both skilled and less skilled observers were superior at picking up information for the novice actors videos compared to the less skilled actors ($ps<.05$). In addition, SR and CIR of the naive observers were lower than the skilled and less skilled observers ($ps<.05$) for the novice player's videos. No significant results were found on CR.

CONCLUSION: Our results provide evidence to support the constraint model which states that the movement pattern of striking a table tennis ball is different compared to that of shadow play. The skilled players were better at differentiating the movement patterns, suggesting that visual sensitivity to stroke patterns was enhanced by extensive experience of the players. Lastly, we suggest that coaches should reconsider the purpose and effect of shadow practice for the beginner players.

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SPATIAL DISTRIBUTION AND ACTIVITY OF THE ERECTOR SPINAE MUSCLES IN CYCLISTS WITH RECENT HISTORY OF LOW BACK PAIN

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INTRODUCTION: Low back pain (LBP) is the most prevalent overuse injury in cycling, which accounts for ~58% of all musculoskeletal disorders (1). The pathomechanics is still unclear but potential major causes may include prolonged maintenance of forward trunk flexion, mechanical creep, high mechanical loads experienced during cycling, and overactivation of erector spinae (ES) muscles (2). Previous evidences on rowers with recent history of LBP reported an altered activation and spatial distribution of ES activity (3). Conversely, less is known about the specific lumbar region activation patterns in cyclists with LBP. Accordingly, we compared the spatial distribution of ES in cyclists with and without LBP using high-density surface electromyography (HDsEMG).

METHODS: Eighteen participants (age: 40.3±12.4 yr, body mass index: 22.9±1.6 Kg/m2) took part in this cross-sectional study. Based on their Oswestry Disability Index value (ODI-I, vr. 2.1a), they were assigned to either a LBP group (n=8, ODI-I score: 20.8±8.9%) or to an asymptomatic group (CG, n=10). Participants underwent an incremental cycling test, characterized by 4 bouts of 3-min at 70, 80, 90, and 100% of their functional threshold power (FTP), interspersed by a 2-min resting period. Concurrently, HDsEMG signals were recorded with 2 electrode-grids positioned on the ES muscles. The average normalized root-mean-square amplitude (RMS) and the y-axis coordinate of the barycenter of activation (RMS-map) were extracted and compared between sides, intensities, and groups.

RESULTS: The two groups displayed similar anthropometric characteristics and FTP values. No differences were observed in RMS amplitude with increasing loads and in both sides within each group. However, as the pedaling load increased, we observed a different RMS amplitude trend in ES activation between groups. In particular, the LBP group showed a significantly higher RMS amplitude in the right ES muscle at 100% FTP compared to the CG (142.3±63.1 vs. 93.3±24.7 %RMS; $p= 0.003$). In addition, LBP group exhibited a tendency to a caudal displacement of the ES activity as the load increased, which was not observed in the CG. However, the y-axis coordinate displacement did not differ between groups at each pedaling intensity.

CONCLUSION: This study provides new knowledge about lumbar ES muscles activity in cyclists with recent history of LBP. Our results suggest that LBP cyclists show a greater ES activation and a tendency to a caudal displacement of muscle activation at the highest pedaling intensities compared to healthy controls. Based on these preliminary results, we hypothesize that the observed altered activation of ES muscles in LBP cyclists may be confirmed by enlarging our sample size. Furthermore, future analyses should investigate whether the increased ES muscle activation is the cause or consequence of the LBP.

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DESPITE LEFT-HEMISPHERE SPECIALIZATION IN MORE COMPLEX FINGER-TAPPING TASKS, HANDEDNESS DOES NOT AFFECT MOTOR SKILL ACQUISITION AND ITS INTERLIMB TRANSFER

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INTRODUCTION: Our previous results (Négyesi et al., Sci. Rep, 2022) suggested left-hemisphere specialization for motor sequencing tasks. Here we examined whether handedness interacts with motor sequencing tasks with different complexity levels immediately and 24h after motor sequence practice. We hypothesize further improvements in accuracy, reaction time (RT), and movement time (MT) 24h after the practice, however, the level of improvement might differ between left- (L) and right-handed (R) participants.

METHODS: Participants performed finger key presses on a numeric keyboard with each hand in separate trials at 4 different complexity levels using our custom-made software. We analyzed the accuracy, RT, and MT of each trial. Participants underwent a short-term dominant-hand motor sequence practice, and then the changes in the dependent variables were measured in both the trained and non-trained hands immediately and 24h after the practice. We supplemented our study with EEG recordings but the current abstract reports only the behavioral data.

RESULTS: Each analyses of MT revealed similar gross patterns of changes as RT (all $r>0.9$, $p<0.001$). In line with our previous study, both R and L performed the motor sequence task more accurately and with shorter RT and MT when using their right hand. However, these effects appeared only in tasks with higher complexity levels (R: Level 3: $p<0.001$, Cohen's effect size $d=0.744$; Level 4: $p=0.034$, $d=0.311$; L: Level 3: $p<0.001$, $d=0.805$. Level 4: $p=0.008$, $d=0.334$). Motor sequence practice produced a similar magnitude of motor skill acquisition and interlimb transfer immediately after the practice which further improved the next day (all $p\leq0.002$). However, the changes were independent of handedness.

CONCLUSION: Overall, our results indicate that left-hemisphere specialization for these tasks might be present only above a certain complexity level. On the other hand, handedness seems to have effects on motor skill acquisition or interlimb transfer neither in simple nor in more complex tasks. Lastly, in line with our hypothesis, dependent variables further improved the next day as compared to their immediately post-practice values, however, the changes in skill retention were independent of handedness.

THE CONTEXTUAL INTERFERENCE EFFECT ON RETENTION AND TRANSFER IN MOTOR LEARNING - A LABORATORY ARTIFACT?

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INTRODUCTION: Contextual interference (CI)(Battig, 1966) affect performance, retention, and transfer differently depending on whether the practice was scheduled in random or in blocked order. Random practice condition hinders performance during acquisition, although it facilitates retention and transfer, while blocked practice is supposed to have the opposite effect. Many publications have confirmed the CI effect since Shea and Morgans (1979) classical study on the CI effect in motor learning. In 2004, Brady published a meta-analysis concluding that the CI effect is conspicuous in motor learning in the laboratory but not in applied settings. Given the broad interest in the CI effect, we aimed to update the somewhat obsolete Brady's meta-analysis and re-analyze the results of independent studies on the CI effect.

METHODS: The study was registered in PROSPERO (CRD42021228267). The following databases were searched: Scopus, EBSCO, Web of Science, PsycINFO, and ScienceDirect, supplemented by the search engine Google Scholar. The quality assessment was done with the Quality Assessment Tool for Quantitative Studies (Thomas et al., 2004) including elements: sample selection, study design, identification of confounders, blinding, reliability and validity of data collection methods, withdrawals, and dropouts. These elements are rated as strong, moderate, or weak. Studies with two or more weak ratings are considered weak, those with less than four strong ratings and one weak rating are considered moderate, and, subsequently, studies with no weak ratings and at least four strong ratings are regarded as strong.

RESULTS: We found that most of the studies on CI in motor learning are of poor quality and are potentially biased, and the CI effect was more conspicuous in laboratory than in applied studies. 59 studies were included in the analysis on retention. Only three articles presented moderate or high quality. The analysis of studies on the CI effect on transfer yielded similar results: none out of 42 studies included in the review was assessed as strong and only two articles were assessed moderate. Twenty-six studies scored weak on the Selection Bias criteria.

CONCLUSION: It may be concluded that studies on CI may be biased. Therefore, the question initially asked by Al-Mustafa and re-asked by Brady (2004) has to be re-stated again: is "contextual interference a laboratory artifact or sport-skill related?

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THE EFFECTS OF ACUTE EXERCISE ON CORTICAL HEMODYNAMICS DURING EARLY STAGES OF MOTOR MEMORY CONSOLIDATION: AN FNIRS STUDY

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INTRODUCTION: Current studies suggest that a single bout of cardiovascular exercise enhances motor memory consolidation. With increasing number of experiments, however, the findings have become equivocal. Discrepancies have been debated to stem from differential effects of exercise on prefrontal and motor cortex activity potentially depending on cardiorespiratory fitness. Thus, the aim of the study was to investigate the effects of post-practice exercise on prefrontal and motor cortex activity during the early stages of motor memory consolidation.

METHODS: 14 healthy males (24.1±3.1 yrs) participated in a counterbalanced within-subject design. At study enrollment peak oxygen consumption (VO2peak) was assessed in a graded exercise test to determine cardiorespiratory fitness. During the main experiment participants practiced an explicit motor sequence learning task followed by either (i) high-intensity interval exercise at 90%/60% Wmax (EXE), or (ii) seated rest (REST). Resting-state prefrontal and motor cortex activity was measured using functional near-infrared spectroscopy (fNIRS) before as well as 10, 30, and 60 min after EXE or REST. Consolidation was tested in a retention test 24 h later. Changes in prefrontal and motor cortex activity as well as normalized differences between cortical areas were analyzed using separate 3 (time) x 2 (condition) repeated-measures ANOVA. Paired t-test was used to examine memory consolidation (i.e. percent skill change from end of practice to retention test). Potential associations between consolidation, cortex activity, and VO2peak were tested using Pearson's correlation.

RESULTS: EXE resulted in a significant higher activity of the prefrontal ($F_{1,13} = 22.134$; $p < .001$) and motor cortex ($F_{1,13} = 31.941$; $p < .001$) compared to REST, while the difference between cortical areas indicated a greater increase of prefrontal cortex activity ($F_{1,13} = 8.546$; $p = .012$). EXE did not significantly improve memory consolidation ($t(13) = -0.291$; $p = .775$). Pearson correlation suggested no significant relation between global exercise-induced changes in cortex activity and consolidation (prefrontal: $r = -.073$, $p = .805$; motor: $r = -0.199$, $p = .496$) or VO2peak (prefrontal: $r = -.296$, $p = .305$; motor: $r = -0.085$, $p = .773$). However, separate analysis of participants with lower fitness (i.e. median-split of VO2peak) revealed a significant negative correlation between changes in prefrontal-motor cortex difference and VO2peak ($r = -.841$, $p = .018$) indicating a greater activity shift to the prefrontal cortex in lower fit participants.

CONCLUSION: Our results confirm an exercise-induced increase of prefrontal and motor cortex activity during early stages of consolidation with a greater increase in prefrontal cortex activity. Interestingly, this activity shift to the prefrontal cortex appears to be more pronounced in participants with lower cardiorespiratory fitness. These findings provide further insights into the differential effects of exercise on the prefrontal and motor cortex.

CAN HAND GRIP FORCE BE A PREDICTOR OF MOTOR COMPETENCE?

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INTRODUCTION: Motor competence (MC) in children and adolescents may be an essential correlate of subsequent physical activity and the development and maintenance of physical fitness (Hardy et al., 2012; Stodden et al., 2009). MC can be conceptualized as the person´s ability to perform different movements, including both gross and fine motor skills. Hand grip force is found to be positively related to other muscle groups. The hand grip force also presents an indicator for valid evaluation of the overall body strength (Bohannon, 2001). The aim of this study was to investigate the association between hand grip force and motor competence in adolescents.

METHODS: Data from 210 boys (mean age: 13.6±1.1 years; body height: 167±1.1cm, body weight: 59.1±14.2 kg) and 177 girls (mean age: 13.4±1.1 years; body height: 161±0.9cm, body weight: 55.1±12.4 kg) were used in this study. The Movement Assessment Battery for children-2 (MABC-2) was used as an objective measurement of adolescents motor competence. The MABC-2 provides an assessment of gross and fine motor coordination and is designed for the age group from 13-16 years. The test consists of three tasks measuring manual dexterity, two tasks measuring ball skills, and three tasks measuring balance. Hand grip force was measured by a hand dynamometer with an adjustable grip. Correlations between the hand grip force and MABC-2 tests, for both girls and boys, were obtained by calculating Pearson's correlation from Jamovi software.

RESULTS: In girls, no significant correlations were found between hand grip force and MABC-2 tests. The only significant correlation, although weak, in boys, was observed between hand grip force and two tasks measuring ball skills, i.e., aiming & catching ($r=0.255$; $p=0.001$).

CONCLUSION: In the present study, results indicate that hand grip force was not correlated with motor competence. It can be explained in part by the fact that the component of the MABC-2 test includes fine motor skills where maximal strength does not play a relevant role. Moreover, even though gross motor skills rely more on strength, no correlation was found between grip strength and gross motor skills tasks in the MABC-2 test, except for a weak correlation between aiming and catching in boys. Grip strength is not an accurate predictor of motor competence.

The current study was conducted in a specific country (Iceland); hence, cross-cultural generalization of the findings is limited. Future studies should consider the development of gender differences from a long-term perspective, and in that sense, longitudinal studies could give better explanations.

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FREQUENCY-DEPENDENT LEARNING EFFECTS OF THE BIMANUAL FIVE-DAY TRAINING

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INTRODUCTION: From daily life to sports performance, skilled experts can properly coordinate limbs both temporally and spatially to fulfill specific purposes. Professional drummers could maintain bimanual coordination accurately in an anti-phase pattern with maximum speed, while novices tended to be away from an anti-phase to an in-phase pattern (1). Since certain skillful performances need to coordinate in an anti-phase, an enormous effort is needed to obtain the coordination skill. In other words, experts have been exposed to a variety of movement conditions throughout the practice, and we assume that one of them is movement tempi. Therefore, we set the different training frequencies based on participants' inter-limb coordination profiles and investigated whether the training frequency affects the stability of performance or not.

METHODS: A total of 30 participants were divided into three groups, Group1, 2, and 3, who had engaged in five-day training of index fingers' flexion-extension in anti-phase mode at allocated frequencies. Before and after the training session, they performed the repetitive flexion-extension movement of the index fingers in anti-phase mode continuously with increasing metronome frequency by 16 beats from 60 to 260 beats per minute (bpm), then in-phase maximum trials for 10 sec. From recorded movies at 120 Hz, the coordinates of anatomical landmarks of both hands were extracted using DeepLabCut. The flexion angles of the index fingers and the relative phase between both hands were calculated. Since the relative phase of the anti-phase mode means 180 degrees, we calculated the root mean square (RMS) using the absolute errors of the relative phase from 180 degrees to evaluate the coordination performance. We assigned the training frequency for each participant based on the results of the trials before the training; 60 bpm for Group 1, the bpm over twice from RMS at 60 bpm for Group 2 (168 ± 47.3 bpm), and the averaged bpm of both hands at in-phase maximum trials for Group 3 (314 ± 32.7 bpm). A three-way ANOVA was performed on the RMS (Training pre/post, 11 bpm, and 3 Groups).

RESULTS: Although the three-way interaction of RMS was not significant, $F(7.45, 100.63) = 1.451$, $p = 0.19$, the main effects of the training and the bpm were significant, $F(1, 27) = 14.138$, $p < .001$, $F(2.53, 68.44) = 108.278$, $p < .001$, respectively. To compare the training effect on RMS at training frequency, we subtracted the RMS of pre from that of the post; -5.1 ± 7.0, -27.8 ± 35.8, and -14.8 ± 17.1 degrees, respectively.

CONCLUSION: Our findings showed that the learning effect of the five-day anti-phase movement training was not differentiated among individual frequency conditions, while the general improving effect on movement stability was evident. Therefore, further studies on training conditions including intensity, duration, or term are needed to elucidate the potential specific effects of the training.

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THE EFFECT OF AN ACUTE BOUT OF PHYSICAL AND COGNITIVE EXERCISE ON EXPLICIT SEQUENTIAL MOTOR LEARNING

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INTRODUCTION: Sequential motor learning is characterized by at least two distinct phases: a fast, online acquisition stage followed by a slow, offline consolidation process. Recent findings revealed that an acute physical exercise (PHY) before implicit motor learning promoted online and offline gains in performance as compared to no exercise. The physiological cascade induced by PHY may facilitate the activity-dependent neuroplasticity associated to motor acquisition and in turn consolidation. Similar findings have been observed on implicit motor learning but following cognitive exercise (COG). It is well-known that the nature of motor skill acquisition, either explicit/conscious or implicitly/unconscious, involves different neural substrates. Up to know, whether PHY and COG inductions before explicit sequential motor learning have been understudied. Therefore, we investigated the effect of PHY and COG inductions separately on explicit sequential motor acquisition and consolidation, and further explored their combined effects.

METHODS: To date 36 out of 48 expected participants were enrolled in this study. Participants were asked to perform either PHY (15 8-s sprints), COG (Time load Dual-back task), combined PHYCOG or a no-exercise (CTRL) condition prior sequential motor acquisition. The effectiveness of PHY and COG inductions was assessed by means of objective lactate collections and subjective NASA-TLX (i.e. cognitive and physical workload perception). Each induction type lasted 20 min, and then participants trained on the explicit sequential finger movement. Motor performance was evaluated before and after online training (i.e. acquisition), and following offline 24 h and 7 days delays (i.e. consolidation).

RESULTS: There was an increase in lactate concentration right after PHY and PHYCOG ($p < 0.001$) inductions, as compared to COG and CTRL. Subjective mental demand raised after COG and PHYCOG inductions relative to PHY and CTRL ($p < 0.001$). Other than the aforementioned findings, there was no other differences between groups. We observed an improvement of performance during acquisition ($p < 0.01$) whereas performance remained unchanged across consolidation (no further offline effect; $p = 0.68$).

CONCLUSION: Overall, the objective and subjective effects of mental and physical inductions have been effective as revealed by the modulations of lactate concentration and subjective measure of mental demand. These preliminary findings, with underpowered statistical analysis according to the small sample size, preclude any conclusion on the effect of PHY and COG inductions on explicit motor skill acquisition and consolidation. Data collection is ongoing.

Conventional Print Poster

CP-SH04 Mentoring coaching

EFFECTS OF A REPEATED HIGH-INTENSITY EFFORTS TRAINING COMPARED TO REPEATED SPRINT TRAINING ON REPEATED HIGH INTENSITY EFFORT ABILITY AND IN GAME PERFORMANCE IN PROFESSIONAL RUGBY UNION PLAYERS.

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INTRODUCTION: This study investigated the effects of a repeated high-intensity efforts (RHIE) training compared to repeated sprint exercises (RSE) training on repeated high-intensity effort ability (RHIEa) and in-game performance in professional rugby union players. In recent decades, the ability to repeat sprints has been considered as a major determinant of performance in team sports. However, rugby union is not only characterized by repetitions of running phases, but also by contact efforts.

Therefore, an evolution of the RSa concept has been proposed in rugby union: the Repeated-High-Intensity Exercises ability (RHIEa). RHIE have been defined as a sequence of three or more intense efforts interspersed with less than 21 s of recovery between each. Thus, in rugby union, the ability of a player to repeat RHIE bouts is considered as a crucial element and appears to be more relevant than the RSa for measuring performance. The high-intensity repetition training programs based on sprinting (RSE training) and based on alternating high-intensity running and contact efforts (RHIE training) generate specific adaptations on RSa and RHIEa, respectively. However, the efficiency of these methods for developing RHIEa has never been compared, and it still unknown whether these training methods differentially impact in-game efforts in rugby union.

METHODS: Thirty nine male rugby union players (age, 26.4 ± 4.2 years ; height, 184.4 ± 7.6 cm; body mass, 97.2 ± 15.5 kg; 4 skinfolds body fat, 15.7 ± 4.1 %) from French second professional division were distributed into three training groups (RHIE training, RSE training, and Control groups). RHIE ability and high-intensity efforts characteristics during official games were assessed before (Pre-training) and after (Post-training) a ten-weeks specific (RHIE, RSE or control) training period.

RESULTS: Concerning RHIEa, both RHIE training and RSE training led to significant improvements in average sprint velocity ($p < 0.001$), average sled push velocity ($p < 0.018$) and RHIE score ($p < 0.001$). However, gains in average sprint velocity were higher in RSE group (+ 4.1 + 2.6 %) while gains in average sled push velocity were higher in RHIE group (+ 8.1 + 5.5 %). Concerning high-intensity efforts in game, while both groups showed significant improvements in total distance, accelerations and contact rate, the number of sprints was higher in RSE group ($p<0.001$). Conversely, increase in contact rate was higher in RHIE (+ 40.5 + 18.3%) compared to RSE (+ 11.13 + 8.2 %, $p<0.001$) group and CONT group (-7.8 + 8.5%, $p<0.001$).

CONCLUSION: These results suggest that both RSE and RHIE training are effective methods to develop RHIEa and athletic performance in professional rugby union games. As the gains of certain abilities and game performance data differ depending on the chosen training method, we suggest that coaches may choose the most appropriate method according to the type of player, their position, and according to the style of play they want to develop.

(1) Austin et al., 2011 ; (2) Johnston & Gabbett., 2011; (3) Sheehan et al., 2022; (4) Vachon et al., 2021; (5) Johnston et al., 2016.

PHYSICAL PERFORMANCE OF AMERICAN FOOTBALL PLAYERS: THE ROLE OF CHRONOTYPE

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INTRODUCTION: Several differences existing between individuals are related to the different expression of the circadian rhythmicity of biological functions. This inter-individuality allows to distinguish three chronotypes: Morning-, Neither- and Evening-types (MT, NT and ET) [1]. MT and ET differ in sleep-wake timing and mental/physical activation, with an early peak in the MT. NT have intermediate characteristics. Despite several studies showed a chronotype influence on sports performance [2], no one investigated them in the American football game. The study aimed to verify if the physical performances of American football players differ in relation to the chronotype, also considering the time of day in which the tests are performed.

METHODS: Athletes filled out the Morningness-Eveningness Questionnaire to evaluate their chronotype. After, they performed 4 physical tests: 40 yards (40y), 3-Cone drill (3Cd), two-Armed Shot Put (2-ASP), and Broad Jump (BJ), in order to evaluate different physical abilities: speed/acceleration, agility, arms and legs power respectively. The tests were carried out in the morning (8:30-10:00 am) and in the evening (8:30-10:00 pm), on two different days and with 3-4 day break.

RESULTS: 43 male athletes were recruited (21.8 ± 4.6 years). The sample consisted of 12% (n=5) MT, 60.5% (n=26) NT, and 27.9% (n=12) ET. Comparing the three chronotypes in each test session, no differences were found between them. The time of day in which the tests were carried out influenced the sports performance in ET and NT. MT showed no difference in performance between the morning and evening sessions, possibly due to the small number of participants. ET performed better in the evening session than in the morning for all tests (40y: 5.4 ± 0.3 vs 5.3 ± 0.2 sec., p=0.001; 3Cd: 5.4 ± 0.3 vs 5.2 ± 0.2 sec., p=0.005; 2-ASP: 5.1 ± 0.5 vs 5.2 ± 0.5 m., p=0.001; BJ: 2.1 ± 0.2 vs 2.2 ± 0.2 m., p=0.016; morning vs evening sessions respectively). NT performed better in the evening than in the morning: 3Cd (5.2 ± 0.2 vs 5.1 ± 0.2 sec., p=0.013), 2-ASP (5.2 ± 0.4 vs 5.3 ± 0.5 m., p=0.042), and BJ (2.2 ± 0.2 vs 2.3 ± 0.2 m., p=0.004). A trend of improvement in performance during the evening session was found for 40y in NT (5.40 ± 0.2 vs 5.36 ± 0.2 sec., p=0.06).

CONCLUSION: Based on this evidence, we can assume that chronotype is able to influence the performance of American football athletes, in relation to the times of the day in which the tests take place. This provides useful information for coaches, and personal trainers to consider when evaluating the football athletes performance and in planning their workout, in order to obtain the maximum benefits from the training.

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DIFFERENCES IN PHYSICAL FITNESS AND TECHNICAL-TACTICAL PERFORMANCE IN ELITE, SUB-ELITE, AND NON-ELITE YOUTH MALE SOCCER PLAYERS

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INTRODUCTION: Successful match performance depends on the interaction of physical, psychosocial, technical and tactical qualities [1]. Such characteristics influence the players selection by the coaches (i.e. elite vs. non-elite players) in the youth categories. [2, 3]. The primary aim of the current study was to examine the differences in physical fitness between elite, sub-elite and non-elite youth male soccer players . The secondary aim was to investigate the association between physical fitness and technical-tactical performance.

METHODS: Two-hundred forty-three young male soccer players (16-17 years) participated in this study. The physical fitness parameters assessed included cardiorespiratory fitness (VAMEVAL test), countermovement jump test (CMJ), 10 and 40 m sprints, and the Illinois agility test. Skinfolds measurement was used to estimate body fat. Technical and tactical data were recorded during a competitive soccer match using a multicamera, semiautomatic optical tracking system (InStat Fitness, Instat Limited, Limerick, Republic of Ireland). The InStat index was considered an index of technical-tactical performance.

RESULTS: Body fat percentage was significantly higher in the non-elite players compared to the sub-elite and elite players. Between groups differences were observed in the VAMEVAL test CMJ, 10 m sprint and agility, with the elite players demonstrating superior performance in all the tests compared to the sub-elite and the non-elite players. Also, the elite and sub-elite players had faster 40m sprints than the non-elite players. Technical-tactical performance (as expressed by the InStat index) was significantly better in the elite group compared to the sub-elite and the non-elite players (216.8±28.4 vs 170.5±20.6 vs 154.9±31.5; $p < 0.050$). A moderate correlation was found between the InStat index and 10m sprint ($r = -0.578$, $p < 0.001$), and strong correlations were found between the InStat index and CMJ ($r = 0.616$, $p < 0.001$), 40m sprint ($r = -0.610$, $p < 0.001$), agility ($r = -0.669$, $p < 0.001$) and cardiorespiratory fitness ($r = 0.609$, $p < 0.001$).

CONCLUSION: Elite youth soccer players performed significantly better in the physical fitness and technical-tactical performance compared to their sub-elite and non-elite peers. Moreover, physical fitness parameters correlated with technical-tactical performance during competitive matches. Taking all into account, physical fitness in youth soccer players should receive special attention as this appears to affect both technical and tactical performance.

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EXPLORING POSSESSION-BASED PERFORMANCE INDICATORS IN DIFFERENT LEVELS OF BASKETBALL

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INTRODUCTION: Basketball possessions are the foundations for scoring. The number of possessions in a game reflects the pace of the game and opposing teams tend to have similar number of possessions in a game. Therefore, possessions provide a useful basis for evaluating the effectiveness of team performances. Possession efficiency (PE) is the percentage of possessions that have at least one field goal attempt. Floor percentage (FP) is the percentage of possessions that have at least scored 1 point. Both are considered the offensive performance indicators. The recovered balls per ball possession (RB), calculated as the ratio of the sum of the steals, opponents turnovers, and fractions of blocked shots to the total of the possessions, reflects the defensive performances. The purpose of the study was to analyze PE, FP, RB, and the proportion (λ) of blocks that turned possessions, between winning and losing teams in different levels of basketball.

METHODS: We analyzed 150 games of the 2020~2021NBA (30 games from the playoff), 92 games of the 2019FIBA men's World Cup (FIBA) (48 games from the preliminaries), and 56 games of the 2021FIBA Under-19 World Cup (U19) (24 games from the preliminaries). Two independent observers recorded data from two games that were not part of the study for reliability testing. Cohen's Kappas were 0.92 and 0.9 for the intra- and inter-observer reliability, respectively. Data was recorded for 298 games by one principal observer. Outcome (2) by stage (2) mixed design MANOVAs were used to analyze the three possession variables for the NBA, FIBA, and U19 games. Additional one-way ANOVA was used to analyze the proportion (λ) of blocks that turned possessions among the 3 groups of games.

RESULTS: The winners had significantly higher FP than the losers in all 3 groups (ps <.001). A similar trend was also observed on the RB for the NBA, U19, and the preliminary stage of FIBA games (ps < .05). The stage effect on RB was also significant for the 3 groups, and the rate was higher at the advanced stage for U19, while the opposite was true of the other two groups. For PE, the advanced stage of the FIBA showed significantly higher rate than the preliminary stage, (p<.001). Lastly, there was a significant group effect on λ (p<0.001) where both NBA (0.71) and FIBA (0.64) were significantly higher than U19 (0.48).

CONCLUSION: The higher rates of FP and RB of the winners demonstrate that the data derived from possessions not only serve as the indicator for offensive performance, but also for the defensive performance. In addition, the increasing possession converting rate of blocks from less than 50% in U19 to over 70% in NBA seems to suggest that blocking is an important defensive tactic that not only prevents scoring by the opponent, but also allows a greater degree of recovering the ball possession in high level basketball.

CALLING AT WORK: ILLUMINATING ONESELF AND ACHIEVING OTHERS

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Introduction

School sports coaches play a critically important role in youth sports. They listen, motivate, support, encourage, and challenge young student-athletes. Therefore, how to enhance job performance among school sports coaches is important. A number of studies have demonstrated that employees with a higher level of work engagement would produce a higher level of work performance. The job demands-resources model (JD-R model) is a well-established theory and it has been widely applied in predicting health and workplace outcomes. The core concepts of the JD-R model are negative and positive job performance arose from job demands and job resources, respectively. In addition, studies have indicated that calling may be seen as a kind of resource in the workplace and would buffer the stress of job demands and intensify personal motivation at work. Hence, this study examined the moderating role of calling among school sports coaches on the relationship between work engagement and job performance with the JD-R model.

Methods

Cross-sectional data in the form of a questionnaire were collected from 192 school sports coaches. Except for the demographic data of the participants, the measures of the focal variables in the study adopted scales from published research with appropriate reliability and validity. All of the Cronbach's alpha values in this study were above .7, indicating adequate reliability.

Results

Work engagement and calling were standardized to examine the interaction effect on job performance. The results of hierarchical regression analyses showed that the main effects of work engagement positively and significantly predict job performance, and the interaction between work engagement and calling positively moderates job performance.

Discussion

The findings in the study revealed that the higher the work engagement of school sports coaches, the better their job performance. And the higher the calling of school sports coaches, the stronger the relationship between their work engagement and job performance. Our findings correspond with previous studies that employees with high work engagement are more energetic and enthusiastic regarding their jobs, which could lead to increased individual and team performance. In addition, calling-oriented employees consider working an intrinsic source of personal meaning and a means to fulfill the value of helping others. Previous researchers have considered calling the "climate for engagement",

where employees are more likely to respond by investing time and energy and by being psychologically involved in their work, which in turn leads to better performance at work.

DUAL CAREER - TUG OF WAR BETWEEN ELITE SPORTS AND VOCATIONAL SCHOOLING

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Introduction

In secondary school settings, dual career support services exist almost exclusively for high school students [1]. For vocational schools, less is known about students' challenges particularly resulting of school-based and vocational education and participation in elite sports (ES). The research project comprises an adjusted curricular framework to promote a dual career at a vocationally-oriented school for the first time nationwide. It includes a two-year extension of school time period and is focused on reducing the double load of requirements. Thus, the aim of the study was to evaluate the curricular framework's effects on daily school and exercise routines of ES students.

Methods

Between 2016-2022, N=160 ES students and N=171 regular students participated in evaluation program. Based on annual standardized questionnaires students were asked about their management of time resources, satisfaction with various support services and their academic and sports performance development (1="very dissatisfied" to 6="very satisfied"). Additionally, teachers' and coaches' point of view derived from interviews. All regular students were used as a control group. Data were analyzed descriptively based on mean and standard deviation. To calculate between-group-effects an independent t-test ($p<0.05$) was used.

Results

Descriptive analyses resulted that ES students have a higher workload due to athletic training (9.1±0.9 training sessions per week) in addition to daily study time. The organized support service of exemption from lessons was used significantly more by ES students than by the control group ($p<0.001$) and was rated higher with regard to satisfaction ($p=0.007$). Furthermore, ES students were "rather satisfied" with school routines (4.6±0.8). At the end of their school time, ES students rated satisfaction with their academic (4.3±1.0) and sports performance (4.4±1.1) development nearly the same. However, there were no significant differences in ratings of satisfaction with academic development between both groups ($p=0.964$). Overall, ES students were "fairly satisfied" with the extended school time period (5.2±0.9).

Discussion

Despite the double burden, there is a high level of overall satisfaction among the ES students with their academic and sports performance development. Special support services could help ES students coping with daily requirements at the vocationally-oriented school. The positive evaluation of the school routines reflects the structured organization and implementation of the adjustments in school time. According corona-related experiences, the increased application of digital teaching tools should lead to higher flexibility in everyday school life and support the offer to promote a dual career.

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A QUALITATIVE ANALYSIS OF THE PROCESS OF COACHING EXPERTISE OF EXPERT COACHES FROM AN UNLEARNING PERSPECTIVE

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Introduction

It is difficult for instructors to become proficient simply by accumulating coaching experience. Unlearning, in which one looks back on ones own experiences from a meta-perspective and repeats contemplation, is indispensable. For this purpose, it is important to have an opportunity to question ones own current situation and a cycle of repeated experience of exploration and contemplation from a meta-perspective. However, there is insufficient accumulation of empirical research on specific strategies and practices of unlearning in actual instructional settings. This study focuses on the unlearning experiences of expert instructors and aims to clarify how unlearning works in their development as instructors through qualitative analysis.

Method

Eight Japanese expert coaches were selected as participants. The participant selection criteria were: 1) highly regarded for their coaching practices, 2) proven track record of developing outstanding players, and more than 10 years of coaching experience. Semi-structured, open-ended, in-depth interviews were used for data collection. Interviews lasted approximately 90 minutes. During the interview, participants were informed that their cooperation in the study was voluntary, that they could refuse or withdraw at any time, and that anonymized data would be used. Consent to use personal information for research purposes was obtained under ethical considerations. Interviews were systematically transcribed verbatim from IC recorders immediately after each interview. Analysis was conducted by qualitative analytical methods using inductive procedures.

Results

A total of 126 meaning units were collected as a result of the data analysis. They were composed of the subcategories "diversely know," "diversely understand," "diversely able," "discover unknown," "notice unknown," "notice not possible," "want to know more," and "convince." These subcategories were further divided into the categories of "experience of noticing discomfort," "understanding from diverse angles," and "pursuit of further questions."

Discussion

While the expert instructors who were the participants of this study formed beliefs about their own coaching and increased their confidence as they accumulated coaching experience, they also had an awareness of the problem of constantly questioning and questioning their own coaching behavior. It was inferred that the diffuse thinking style, which creates a learning loop of repeated questioning and verification of fixed beliefs about ones own coaching style, is critically important in the process of instructional mastery. In addition, it became clear that by involving further diffuse thinking styles based on unlearned experiences in such a learning loop, it is possible to generate a new learning loop and promote proficiency. Such double-loop learning is thought to have led to the occurrence of unlearning experiences.

INVESTIGATING CORTICAL HAEMODYNAMIC AND PHYSIOLOGICAL CORRELATES OF EXERCISE COGNITION IN TRAINED AND UNTRAINED CYCLISTS OVER AN INCREMENTAL SELF-PACED PERFORMANCE TEST, WHILE THINKING ALOUD

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Objectives: Few studies have directly investigated changes in cortical haemodynamics during a self-paced interval endurance activity, while collecting conscious cognition and physiological performance data. This pilot study used functional Near Infrared Spectroscopy (fNIRS), while capturing conscious cognition using Think Aloud (TA) during an incremental paced cycling exercise.

Methods: A mixed design was implemented with cycling expertise (untrained vs. trained) as the between groups variable and incremental self-paced stage (5 stages of increasing effort) and site (12 optodes across the PFC) as the within groups variables. Dependent measures were the changes in cortical O2Hb, and physiological indicators (% heart rate max (%HRmax), average power output (APO), peak power output (PPO), rate of perceived exertion (RPE) and blood lactate (Bla)) over time. Participants used TA throughout their second interval trial.

Results: Trained cyclists had higher APO and maximum power output (MPO) from stages 2–5, in addition to a greater increase in PPO over the whole trial. There were significant main effects of stage on %HRmax, Bla and RPE. Differences in cortical haemodynamics were found specifically in areas in the mid left and right PFC. TA

data demonstrated that untrained participants verbalised more irrelevant information and feelings of pain and fatigue, in addition to both groups verbalising significantly more motivation-related thoughts during the final stage.

Conclusion: This pilot is the first to capture changes in Cox, physiological measures and conscious cognition through the use of TA. We demonstrate the potential role of mid- PFC, and how conscious cognition may change over time. This study has implications for coaches and sport psychologists who may want to understand the

cognitions of their athlete during an event and support low level athletes in developing a better understanding of the own cognitions.

EFFECTS OF LIFE-SKILLS DEVELOPMENT PROGRAM INTERVENTION ON YOUNG ELITE FEMALE FOOTBALLERS

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INTRODUCTION: Researchers have stated that life-skills are important in positive youth development. Life-skills Development Program (LSP) is revealed to be one of the essential components for the positive youth development framework. However, few studies have applied Life-Skills Development Interventions to Young elite athletes. We reported the results of LSP for three years to young elite women footballers. The objective of this study was to investigate the effect of LSD, for three years, on athletes' psychological competitive abilities on young elite athletes.

METHODS: Eighty-one female young footballers of elite academy in Japan, aged 13 to 15yrs, participated in the LSP for three years. the LSP was age-specific and consisted of several group-work lessons designed to develop psychological skills (goal setting, emotion control, self-recognition, empathy with colleagues, decision making, problem-solving, management for stress, leadership and career planning). The LSP was delivered to players in the classroom of their dormitory every other month. To assess their psychological skills, two questionnaires of life-skills were conducted about the daily life and the sport domain before and after the intervention.

RESULTS: Wilcoxon signed-rank test were performed for the changes on both scores before and after the LSP. The scores of both scales in the two questionnaires significantly increased after the LSP(life-skills of Daily life: $Z=4.13$, $p<0.001$; Life-skills of sport domain: $Z=3.368$, $p<0.001$. Scores for several factors also improved after the intervention.

CONCLUSION: Our results showed that the continuous intervention of the LSP had positive impacts on the psychological development of young elite athletes in both domains of "Daily life" and "Sport field". This finding revealed that LSP could enhance athletes' psychological skills in the athletic field. The results also showed that our LSP also had little impact on participants about several factors. Therefore, it is also suggested that we need to improve our context of the LSP. To

achieve more effective intervention, practitioners of the youth development framework need to develop programs that adopt practical context based on their sport field.

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TWELVE-WEEK LASTING OTAGO EXERCISE PROGRAM PROMOTED THE ELDERLY'S MOBILITY AND NEURAL FUNCTION WITH CORRELATION IN SPECIFIC BRAIN AREAS: A RANDOMIZED CONTROLLED TRAIL

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INTRODUCTION: Physical exercise has become a widely recommended training method to reverse the decline of older adults' mobility and cognition, of which the Otago Exercise Program (OEP) was designed to get rid of falls effectively[1]. OEP was featured with medium intensity, mild training movements, and well-combination with the elderly's daily activities, thus could improve elderly's mobility and prevent risks. The neurological mechanics of this kind of physical training have not been further explored yet, so the presented abstract focus on disclosing the changes of brain structure and functional connection after the physical training. Furthermore, this study aims to find some correlations between behavioral promotion and functional changes of the brain after the intervention.

METHODS: Thirty-five older adults (age: 64±6, female:43%) were randomly divided into exercise intervention group (EIG) and control group (CG), receiving intervention for 12 weeks, respectively. EIG took part in OEP with two sessions, the muscle strength and balance training (30 min each time; twice a week), and walking more in their daily life (30 min each time, 3 times a week). EIG, for total, received 720 min functional training and 1080 min daily physical activities thoughout the intervention. CG just kept their lifestyle and was not required to do exercises. The structural and resting state functional MRI data (fALFF, ReHo, and DC) before and after the intervention were obtained and analyzed, in connection with behavioral mobility measures (grip strength, 30-s chair-stand test, single leg station with eyes closed, and timed up go).

RESULTS: Physical exercises could improve the participants' 30-s chair-stand test, single leg station with eyes closed, and timed up go performances. EIG showed increased fALFF in the posterior central gyrus and superior temporal gyrus (Z=4.17), and central front gyrus (Z=3.55). EIG also showed increased DC in the dorsolateral prefrontal lobe and dorsal medial prefrontal lobe (Z=4.02). While CG showed no significant changes in the mobility measures after the intervention. Additionally, the change of EIG's 30-s chair-stand test is significantly correlated with ReHo in the left putamen, while the EIG's performance of "timed up go" can predict ReHo in the left caudate and the right insula.

CONCLUSION: Physical exercises adopting OEP could improve the elderly's mobility, and the exercise intervention might promote the elderly's mobility through regulating the sensorimotor cortex. Moreover, the correlation between mobility promotion and specific brain areas' MRI measurements could predict some neural changes of the brain structure and function.

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THE EFFECTS OF EXERCISE SNACKING AND TAI-CHI ON MUSCLE ACTIVATION AND PHYSICAL ACTIVITY IN OLDER ADULTS

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INTRODUCTION: Improving muscle strength and maintaining physical function is important for being independence in later life. Short bout 'snacking' exercise is designed to overcome typical barriers to older adults' participation in muscle strength and balance exercise and is acceptable and effective. Moreover, Tai-chi being performed with slow and gentle movements and mental concentration can improve balance and lower extremity strength as well as decrease fear of falling in older adults. To our knowledge, no prospective research has investigated the effects of exercise snacking, Tai-chi, and traditional resistance training on acute muscle activation.

METHODS: This study recruited 18 individuals aged 65 to 80 years who did not regularly engage in recreational sports or structured exercise. Individuals with any chronic illness, contraindications to exercise, or who scored less than 8 on the Short Physical Performance Battery were excluded. Participants were given a demonstration on how to safely perform

exercise snacking and Tai-chi activities at home and asked to do and log 3-days of each activity after two familiarised sessions. In the final session, participants performed exercise snacking, Tai-chi, supplementary unloaded exercises, traditional resistance exercises, and 5-minute treadmill walk in a randomised order. Muscle activation was recorded in the calf, quadriceps, and hamstring muscle groups, using Delsys EMG electrodes. The sample t-test was employed to identify differences in muscle activation variables between exercise snacking/ Tai-chi in comparison to traditional leg press exercise. Statistical significance was accepted at $p<.05$.

RESULTS: Eighteen healthy older adults aged 65 to 80 were recruited for this study. In this study, we found that participants' physical activity levels were slightly higher in the intervention week compared to their regular activity levels. In terms of the EMG integrated activity, the vastus lateralis had greater activities in sit-to-stand compared to leg press. The EMG integrated activity of the gastrocnemius was significantly greater in three of five exercise snacking movements compared to leg press. The EMG integrated activity of the soleus was significantly greater in marching, calf raise, and snake creeps than leg press. The EMG integrated activity of the vastus medialis oblique was significantly lower in four of five Tai-chi movements than leg press.

CONCLUSION: Specific exercise snacking movements could trigger more motor units than traditional leg press exercise. However, it seemed that muscle activated less in Tai-chi movements on thigh muscles. Presumably, motor unit recruitment highly depends on the specificity of training. It is necessary to investigate the effects of long-term exercise snacking and Tai-chi on physical functions.

FEMALE WORLD CHAMPION POWERLIFTING AT 71: THE BENEFITS OF EXERCISE AT AN OLDER AGE

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INTRODUCTION: Demographics indicate that aging is associated with a progressive decline in skeletal muscle mass, strength, and metabolic health. However, these observations are based on population data and certainly do not apply to the individual. Here, we assessed body composition, muscle strength, cardiorespiratory fitness, and metabolic health of a female world champion powerlifter at 71 years of age, who started resistance exercise training at 63 years of age with no prior experience with structured resistance exercise training.

METHODS: Body composition (Magnetic Resonance Imaging, Computed Tomography, Dual-energy X-ray absorptiometry), strength (One repetition maximum leg press and handgrip strength), cardiorespiratory fitness (peak oxygen consumption: VO2peak), and metabolic health (oral glucose tolerance test, blood pressure) were assessed. In addition, a muscle biopsy was collected to assess muscle fiber cross sectional area (CSA). Where possible, data were compared with sex- and age-matched data obtained in our laboratory. Skeletal muscle mass index was calculated by dividing limb muscle mass by height squared. Data from the control groups are expressed as mean ± 95% confidence interval.

RESULTS: Our participant reported a 33% greater skeletal muscle mass index when compared to healthy, older female control subjects (7.9 vs 5.9 (5.7 to 6.2) kg/m2; n=61). In addition, we observed 37% greater muscle quadriceps CSA (63.8 vs 46.6 (44.5 to 48.7) cm2; n=48) and 46% greater type II muscle fiber CSA (4536 vs 3097 (2707 to 3488) µm2; n=19). Absolute leg press muscle strength was 36% greater (190 vs 140 (132 to 147) kg; n=30) and handgrip strength was 33% greater (33 vs 25 (23 to 26) kg; n=48) when compared to healthy, age-matched controls.

CONCLUSION: From this case study it is evident that even at an older age, improvements in body composition and strength can be achieved by regular exercise training up to the level of a world champion.

DOES MINIMUM AMOUNT OF MODERATE-VIGOROUS PHYSICAL ACTIVITY MATTER FOR MUSCLE STRENGTH AND STATIC BALANCE IN OLDER ADULTS? A 12-MONTH PROSPECTIVE COHORT STUDY

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INTRODUCTION: Whether a minimum amount of moderate-vigorous physical activity (MVPA) is beneficial for maintaining and improving physical function in older adults is unclear. Therefore, this study examined the association between daily 15-minute MVPA and subsequent muscle strength and static balance in older adults.

METHODS: Data on community-dwelling older Taiwanese adults (mean age: 69.5 years ± 4.88) were collected during the baseline period (2018) and through a 12-month follow-up survey (2019). Time spent for MVPA was objectively assessed using a triaxial accelerometer (Actigraph wGT3x-BT) during baseline. Upper and lower limb muscle strength was measured through handgrip strength and 5-times sit-to-stand test (STS), respectively. One-leg standing test was performed to record the static balance performance. The 12-month variations in muscle strength and static balance were calculated by subtracting the follow-up data from the baseline data (categorized as maintenance/improvement and decline). Forced entry adjusted logistic regression was conducted to examine the association between achieving daily 15-minute MVPA in the baseline period and subsequent muscle strength and static balance.

RESULTS: In total, 65.2% of participants engaged in at least 15-minute MVPA per day at baseline. After adjusted potential confounders, older adults who achieved daily 15-minute MVPA during the baseline period were more likely to maintain or improve static balance performance (odds ratio [OR], 95% confidence interval [CI] = 8.12 [1.61-40.97], p = 0.01). For muscle strength, the unadjusted model found that older adults who meet the daily 15-minute MVPA had a significant relationship with STS performance (OR [95% CI] = 4.644 [1.80-11.96], p = 0.001).

CONCLUSION: This study observed that 15-minute MVPA per day might be beneficial for older adults' subsequent performance of balance and lower limb strength. Our findings could be applied for developing future strategies of health promotion, to maintain and improve the static balance and lower limb strength in older adults.

EFFICACY OF A MULTICOMPONENT EXERCISE PROGRAM TO PROMOTE MOTOR AND COGNITIVE RESOURCES FOR NURSING HOME RESIDENTS AS A FUNCTION OF THE RESIDENTS MOBILITY STATUS

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INTRODUCTION: Nursing home residents are often characterized by heterogeneity in motor and cognitive performance with different mobility restrictions. Additionally, it is clearly stated that without exercise, motor and cognitive performance in nursing home residents decreases over time. Multicomponent exercise interventions may enable older people with different mobility status to promote or maintain motor and cognitive resources. However, most interventional studies investigated ambulatory older adults. Less is known about the efficacy of chair-based multicomponent exercise programs for those who are unable to walk. A higher level of mobility might have an influence on the effectiveness of a multicomponent exercise intervention to improve motor and cognitive resources. The aim of this study was to examine the efficacy of a multicomponent exercise program to promote motor and cognitive resources for nursing home residents as a function of the residents mobility status.

METHODS: A quasi-experimental study integrated N=55 nursing home residents (78,90 ± 15,56 years, n=41 female n=14 male, 74.5% female) assigned either to an ambulatory training group (n=20), a wheelchair training group (n=16) or a control group without exercise (n=19). Training duration was 16 weeks for both groups (twice a week; 60 minutes). Type of training was either a multicomponent exercise program for ambulatory residents or a wheelchair-based multicomponent exercise program for residents who are unable to walk. Primary outcomes to assess motor and cognitive resources were independence with the Barthel index, hand grip strength, cognitive status (MoCA), and depressive symptoms (CES-D). Statistics was performed using ANOVA for repeated measures.

RESULTS: The ANOVA revealed no interaction effect between the ambulatory group and the wheelchair group over time. Motor and cognitive resources of both groups remained stable while the control group decreased in all parameters from pre to post ($p < .001$). However, there was a significant time x group interaction between the training groups and the control group for Barthel index ($F(1, 52) = 24,515$, $p < .001$, $\eta_p^2 = .320$), hand grip strength ($F(1, 52) = 68.082$, $p < .001$, $\eta_p^2 = .567$), MoCa ($F(1, 51) = 51.320$, $p < .001$, $\eta_p^2 = .502$) and CES-D ($F(1, 53) = 16.540$, $p < .001$, $\eta_p^2 = .238$).

CONCLUSION: The multicomponent exercise program is beneficial to maintain motor and cognitive resources for nursing home residents regardless of the residents' mobility status, in contrast to a control group with no exercise. The results showed that both, exercise for ambulatory residents and exercise in a wheelchair for those who are unable to walk, can reduce the natural decline of motor and cognitive resources. A higher level of mobility has no influence on the effectiveness of an exercise program for nursing home residents. However, the absence of exercise leads to a decrease in motor and cognitive performance.

HEART RATE AND OXYGEN UPTAKE RESPONSES IN PRE-FRAIL SENIORS USING A PASSIVE-ASSISTIVE HIP EXOSKELETON

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INTRODUCTION: Maintaining walking abilities has been suggested to preserve the quality of life, independence, and social interaction within the senior population (1). Passive-assistive walking exoskeletons are designed to store and release energy during movement and provide walking aid (2). Passive ankle exoskeletons have been shown to reduce by 7.2 ± 2.6% the cardiopulmonary demands during walking (3). Thus, the purpose of this study was to assess a passive-assistive hip exoskeleton influence on heart rate, oxygen uptake, and respiratory exchange ratio (RER) during treadmill walking.

METHODS: Twenty-three pre-frail seniors (72.7±4.6 years, 1.6±0.1 m, 73.1±13.7 kg) walked at their preferred speed (1.9±0.6 m/s) on a motor-driven treadmill (Woodway Pro XL; Woodway Inc., Waukesha, WI, USA) with an exoskeleton (C1), without (C2) and with a sham version (C3). Recordings were made in a balanced order. A bilateral passive-assistive exoskeleton (aLQ) was used (IMASEN, Aichi, Japan). A 7-min walk test was performed in each condition with a 5-min warm-up and 2-min data collection. Heart rate was recorded using a chest strap (Polar RCX5 GPS system, Kempele, Finland). Pulmonary O2 and CO2 were measured by an automated on-line breath-by-breath system (Vyntus CPX, Vyaire Medical, Mettawa, IL, USA). Oxygen uptake and RER were extracted. Paired t-tests were performed for C1 vs C2, C1 vs C3, and C2 vs C3. A p-value of .05 or less was considered significant.

RESULTS: No significant differences in heart rate were observed between the three walking conditions (C1: 100.0±17.0 bpm; C2: 102.3±17.6 bpm; C3: 99.7±17.3 bpm), with $p = .18$ for C1 vs C2, $p = .67$ for C1 vs C3, and $p = .11$ for C2 vs C3. Similar results were found for oxygen uptake showing only a 2.5% difference between C1 (771.8±195.4 ml/min) and C2 (791.3±207.6 ml/min, $p = .14$), around 1.3% difference between C1 and C3 (781.9±188.6 ml/min, $p = .28$) and 1.2% difference between C2 vs C3 ($p = .47$). Similarly, no significant differences were found for the RER between the exoskeleton conditions (C1: 0.85±0.03; C2: 0.85±0.03; C3: 0.85±0.03), with $p = .67$ for C1 vs C2, $p = .36$; C1 vs C3, and $p = .19$ and C2 vs C3.

CONCLUSION: Walking at the preferred speed with aLQ or its sham version did not influence heart rate and oxygen uptake of pre-frail seniors, although the device does add a weight of approx. 1kg to the person wearing it. Unaffected RER

values also suggest that the relative contribution of fat and carbohydrate oxidation is maintained during walking. Therefore, this device could potentially be worn by other more at-risk populations without adverse effects from this perspective.

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TRAINING IMPULSE (TRIMP) EVALUATION IN OLDER AMATEUR CYCLISTS: EFFECTS OF HEALTH STATUS

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INTRODUCTION: Ageing is typically associated with a decline in aerobic power, even in exercisers[1]. In addition, disease status can impact this rate of decline both directly and through altering exercise and physical activity levels.

The aim of the present study was to investigate the effects of diseases of various aetiologies on the training characteristics of amateur road cyclists.

METHODS: Fifty-three older amateur road cyclists were categorised into three groups based on either i) no declared health issues (Group 1, 14=M (males), 8=F (females)), ii) exhibiting new but well-controlled health condition(s) unlikely to affect exercise (Group 2, 13=M, 6=F) or iii) having any other underlying condition(s) that may compromise the ability to exercise (Group 3, 8=M, 4=F). Two self-selected rides on the road (100km for males, 60km for females) were tracked using a Garmin watch and heart rate sensor. Cycling intensity was quantified as training impulse (TRIMP) using the methods of Banister[2] and Edwards[3]. Percentage of time spent in 5 pre-determined HR zones was also determined (Zone 1=50-59%, Zone 2=60-69%, Zone 3=70-79%, Zone 4=80-89%, Zone 5=90-100% of maximum HR). Self-reported cycling volume was collected and actigraphy was performed over a 7-day period. Maximum heart rate (MHR) and maximal aerobic power (VO2max) were determined from an incremental exercise test. Depending on normality, One-Way ANOVA or Kruskal-Wallis H-test were used to compare health groups. Data are presented as mean±SD.

RESULTS: Results are presented in order of Group 1 to Group 3. There was no significant difference ($p>0.05$) in age (71.5±1.2, 71.6±1.3, 70.9±.1.8 yrs), VO2max (39.4±1.0, 35.4±2.7, 35.4±1.9 ml/kg/min), MHR (159.9±3.3, 156.0±4.4, 154.6±3.8 bpm), self-reported cycling volume (480±72, 576±83, 514±88 km/month), average velocity (18.3±1.0, 17.5±1.0, 17.2±0.9 kph) or total ascent (597.6±48.6, 621.9±67.1, 561.8±84.5 m) between groups.

There was no significant difference in Edward's TRIMP (260.8±13.7, 260.6±18.6, 266.0±18.0), Bannister's TRIMP (315.9±26.0, 399.1±58.3, 325.0±32.5) or time spent in zones 1,2,3,4 and 5 between groups. Actigraphy also revealed no differences in time spent in any activity zone.

CONCLUSION: Counterintuitively, these data show that in older amateur road cyclists their training characteristics need not be adversely affected by the presence of some diseases.

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RELATIONSHIP BETWEEN EXERCISE TYPE, FREQUENCY AND COGNITIVE FUNCTION IN COMMUNITY DWELLING ELDERLY

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INTRODUCTION: Exercise has been suggested to prevent age-related cognitive decline and neurodegenerative diseases, and the usefulness of exercise interventions for cognitive decline in the elderly is also recommended. However, the effects may vary depending on the type and frequency of exercise. In this study, we investigated the relationship between type and frequency of exercise and cognitive function in the elderly.

METHODS: The subjects of this study were 273 elderly residents of Kasama city (74.4 ± 5.0, aged 65-93 years). They were divided into three groups: ① a non-exercise (NEX) group, ② an exercise (EX) group, which consisted of those who practiced regular exercise, and ③ a DEX group, which consisted of those who practiced exercise combining brain training and physical exercise. The ② and ③ groups were further divided into two groups (high- and low-frequency groups), and the results were compared and verified according to the frequency. The Five Cognitive Tests (5-Cog) was used for the cognitive function evaluation in the study. The 5-Cog test is a screening method used in Japan to detect cognitive decline in the elderly. The test material (DVD) consists of performing five elements such as attention, memory, spatial cognitive ability, language ability, and judgment. Amyloid beta (Aβ1-42) in plasma was determined as the secondary outcome.

RESULTS: The total score of the 5-Cog test was not significantly different, but the DEX group scored the highest (NEX group = 82.1 score, EX group = 80.2 score, DEX group = 85.7, p = 0.070).

In addition, the DEX group performed significantly higher on the memory subscale, with the post-hoc test results showing that the DEX (21.8 score) group scored significantly higher than the NEX group (19.1 score) and the EX group (19.2 score) (p = 0.009). On the other hand, the DEX group showed higher, although not significant, concentrations of Aβ1-42 in plasma (NEX group = 4.91 pmol/L, EX group = 5.55 pmol/L, DEX group = 6.07 pmol/L, p = 0.441, higher the better). The results of the analysis by frequency showed no significant differences in any of the items (p = 0.220-0.958)

CONCLUSION: The study showed that older adults who habitually practice DEX showed a tendency to maintain better cognitive function. In particular, memory score was significantly higher than that of other groups. The DEX in this study is an exercise method to remember and replicate the pattern of steps (1). Therefore, it is possible that the memory and replicate operation may have a favorable effect on memory maintenance/improvement. On the other hand, no significant difference for frequency of practice was obtained. Approximately 40% of elderly Japanese do not exercise. The results of this study showed that those who had an exercise habit (1time more than 30 minutes, twice a week, more than one year) maintained good cognitive function. Therefore, it is desirable to practice DEX at least twice a week for more than 30 minutes each time.

(1) Nature, 2021.

EARLY LIFE SPORTS PARTICIPATION AND LATER LIFE HEALTH-RELATED OUTCOMES IN JAPANESE ADULTS OVER 60 YEARS OLD

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INTRODUCTION: Childhood experiences of sports and physical activity are strongly associated with physical activity and health later in life. High levels of physical activity in childhood and adolescence predict high levels of physical activity in adulthood (Telama et al., 2005). Maintaining physical activity from adolescence to young adulthood is associated with a lower risk of cardiovascular disease in later life (Rangul et al., 2012). In addition, recent studies suggest early life physical activity enhances the cognitive functions later in life. However, associations of participation in sports in childhood and adolescence and health-related outcomes such as muscle mass, muscle function, executive function, and quality of life in old age are not well understood. The aim of this study was to investigate the associations between sports participation in childhood and adolescence and the health-related outcomes in Japanese adults aged over 60 years old.

METHODS: One hundred and fifty-four older adults (71.6 ± 6.6 years; male, n = 61; female, n = 93) participated in this study. Experience and weekly frequency of participation in sports during primary school, secondary school, and senior secondary school were obtained by face-to-face interviews. Current total physical activity was assessed using the IPAQ-short form. Body compositions including lean soft tissue mass and fat mass were assessed by dual-energy x-ray absorptiometry. Muscle function was assessed by the Timed Up and Go test and 30-second chair stand test. Executive function was assessed by the Digit Span Forward and Backward tests for working memory, the Stroop test for inhibition, and the Trail Making test for cognitive flexibility. Health-related quality of life was measured by a WHOQOL-26 self-report questionnaire.

RESULTS: Experience of early-life participation in sports was significantly associated with current total physical activity ($P < 0.05$). The participation in sports during primary school was significantly associated with the Timed Up and Go test ($P < 0.05$), while no association between early life sports participation and body composition was observed. The participation in sports during senior secondary school was significantly associated with the results of the Trail Making test in males ($P < 0.01$). The experience of early life sports participation and the frequency of participation in sports during secondary school were significantly associated with the health-related quality of life in females (Ps < 0.05). After adjusted for confounders such as age, education level, and current total physical activity, those results remained.

CONCLUSION: The results of this study revealed that participation in sports in childhood or adolescence positively predicts the muscle function, executive function in males and quality of life in females later in life. These findings suggest that early intervention should promote sports participation in childhood and through adolescence for lifelong physical and psychological health.

MUSCLE DAMAGE MAY BE DETRIMENTAL FOR EXERCISE-INDUCED COGNITIVE IMPROVEMENT IN OLDER MEN: PILOT RESULTS FROM THE BRAIN-M TRIAL

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INTRODUCTION: It is well documented that resistance training can augment muscle function and preserve brain health in older adults. It is also known that high-intensity resistance training can cause muscle damage, associated with low-grade inflammation, which has a negative effect on cognitive function. In this randomized controlled trial we hypothesized that muscle damage (expressed by increased creatine kinase, CK) would be associated with decreased cognitive performance in older adults. To examine this hypothesis we compared two resistance exercise intervention protocols consisting of either a high mechanic (high CK) or a high metabolic (low CK) loading.

METHODS: Twenty-two older men (60-74y old) were randomly allocated to a single session of accentuated eccentric-only resistance training (ECC, n = 6), blood flow restriction training (BFRT, n = 10), or 45-min seated rest (n = 6). Both exercise groups performed three lower body exercises at an equal relative volume of 57.6% (number of exercises x sets x repetitions x % one repetition maximum, 1RM). ECC consisted of 4 sets and 4 repetitions each at 120% 1RM. BFRT consisted of 4x12 repetitions at 40% 1RM and 50% lower limb occlusion pressure. Two-way ANOVA (Group X Time) with repeated measures on the Time factor was used to assess pre-to-post 5-min changes in cognitive function and pre-to-post 48h changes in blood CK (U/L). Cognitive tests included a 2-Choice Reaction Time test, Go/No-Go test, Memory Search test, and a Switching task. The main cognitive outcome measures were response time (RT, ms) of the correct responses, and changes in performance index (PI; 100×[accuracy/response time of all responses]).

RESULTS: A significant Group x Time interaction was found for CK level changes ($p=0.049$, partial $\eta^2 = 0.315$). CK levels significantly increased in the ECC group (+14.14 ±16.63 U/L), but not in the BFRT (+3.21 ±3.21 U/L) and control group (-0.12 ±0.97 U/L). The Group x Time interaction for RT in the Memory Search Test was not significant ($p=0.139$, partial $\eta^2 = 0.218$). Based on the large effect size it appears that RT improved only in the ECC group (-99.72 ms) but not in the BFRT (+64.36 ms) and control (+95.87 ms) groups. However, in the ECC group, improvement in RT on Memory Search test was significantly lower with higher Pre-Post increases in CK ($R = 0.921$, $p = 0.026$). There were no significant changes on other cognitive function tests.

CONCLUSION: A single bout of ECC tended to improve memory function compared to BFRT and control groups. However, muscle damage may have detrimental effects on the magnitude of this improvement. Our findings suggest that resistance training may benefit cognitive function in older adults, however high level of muscle damage should be avoided.

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Conventional Print Poster

CP-MH10 Lifestyle I

WHY IS HIMT SUCH A HIT? AN ONLINE SURVEY EXPLORING SUBJECTIVE RESPONSES IN HIGH-INTENSITY MULTIMODAL TRAINING.

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INTRODUCTION: High-Intensity Multimodal Training (HIMT) has recently gained interest as a time-efficient method of promoting physical health. Despite the proposed health and fitness benefits of HIMT, the subjective response to HIMT remains unclear. Previous studies suggest HIMT participation promotes increased exercise enjoyment and intrinsic factors related to adherence. In contrast, other studies have demonstrated feelings of pain and displeasure following similar aerobic-based high-intensity exercise. These conflicting findings limit the understanding of the subjective response to HIMT, in particular exercise enjoyment. The purpose of this study was to investigate exercise enjoyment in HIMT and identify factors associated with HIMT that mediate exercise enjoyment and motivation. This may provide a clearer understanding of subjective responses in HIMT and assist in explaining long-term training behaviours, in particular exercise-adherence.

METHODS: A web-based survey was distributed to a cross-sectional voluntary convenience sample of current HIMT participants and drop outs. The 124-item survey was distributed via email, and social media from August through to the end of September 2021. The final sample included 469 responses (completion rate: 61.6%). Of the total eligible respondents, 379 were current HIMT participants, 55 were drop outs.

RESULTS: The most frequently reported reasons for increased exercise enjoyment and motivation to continue HIMT in current participants included (1) it keeps me fit, (2) training in a group and (3) there is variety in a session. The most frequently reported reasons for reduced motivation to continue HIMT among drop outs included (1) other (injury, COVID-19 restrictions, low motivation, personal preferences), (2) work commitments were a priority and (3) I started another type of sport, exercise or training.

CONCLUSION: The findings of this study indicate that HIMT is an enjoyable training method among current participants. The most commonly reported reasons for increased exercise enjoyment and motivation were associated with the combination of aerobic and resistance training as well as the group environment. In contrast, reasons for reduced motivation to continue HIMT among drop outs were associated with commonly reported barriers to exercise and personal factors or interests. These findings identify some of the factors that may underlie subjective responses in HIMT. This may assist in better understanding the growing popularity of the training mode and guide tailored service delivery in the community for increased exercise adherence.

EFFECT OF LOW-INTENSITY EXERCISES ON CIRCULATING ENDOCANNABINOID LEVELS AND ITS IMPACT ON PSYCHOLOGICAL STRESS REDUCTION: A RANDOMIZED AND COUNTERBALANCED CROSSOVER STUDY

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INTRODUCTION: Exercise has the decreasing effect of psychological stress and there is a growing attention on blood endocannabinoids (eCB) as one of the candidate molecules that cause the effect. However, no optimal exercise program (i.e., intensity, duration) in consideration of the level of eCB to reduce psychological stress has been established. Hence, this study investigated the changes in blood eCB levels before, during and after low-intensity exercises and examine whether the eCB reduces psychological stress and is appropriate for a biomarker of affective improvement.

METHODS: Fifteen healthy male college students were participated in a randomized and counterbalanced crossover trial that consists of two different low-intensity exercises at intensities corresponding to 30% and 50% of heart rate (HR) reserve. They performed 60-min cycle exercises at the same time (13:00–17:00 h) to avoid the effect of a circadian rhythm under the two conditions separated with a one-week washout interval. At rest, 10 min and 30 min during exercise and immediately after exercise, blood samples were collected and plasma N-arachidonoylethanolamine (AEA) and 2-arachidonylglycerol (2-AG) concentrations were measured. The participants responded to the survey of the physical activity affect scale (PAAS) as an affective index including four subscales, positive affect, negative affect, tranquility, and fatigue before and immediately after the exercise. Statistical significance was set at $p < 0.05$.

RESULTS: The two-way repeated measures ANOVA regarding plasma AEA and 2-AG concentrations showed that no significant interaction between exercise intensity and time, and no main effects of exercise intensity and time were found. Exercise had no significant impact on "positive effect". However, main effects of time were observed in both "negative affect" ($p = 0.05$) and "tranquility" ($p < 0.00$). Although a significant interaction was found in "fatigue" ($p = 0.02$), multiple comparison did not reveal any significant differences between individual data. Interestingly in more lower intensity exercise (i.e., 30% HR reserve), there was a significant negative correlation between the changes in plasma AEA levels from rest to 10 min after beginning of the exercise and in "negative affect" scores from rest to immediately after exercise ($r = -0.64$, $p = 0.04$).

CONCLUSION: There was no significant variation in plasma AEA and 2-AG concentrations during and after low-intensity exercises. However, we found that low-intensity exercise decreased "negative affect" likely caused by psychological stress. In addition, since the increase in plasma eCB concentration relates to the decrease in "negative affect", eCB might be useful as one of the biomarkers of low-intensity exercise-induced affective improvement.

DEVELOPMENT OF BEDTIME STRETCHING PROGRAM ENHANCING MOOD AND COGNITIVE FUNCTION

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INTRODUCTION: University students are at risk to experience a decline in their mental health (mood and cognitive function) due to lifestyle changes that often include poor sleep hygiene. To resolve this, practicing simple stretching exercise before falling asleep, might be helpful. Previous studies have demonstrated that bedtime stretching improves sleep and mental health [1,2]. Better sleep quality also positively affects cognition: more deep sleep that presents with slow-wave oscillations can enhance executive function and memory performance [3,4]. Therefore, a bedtime stretching program could have a positive impact on mood and cognitive function through improved sleep quality.

METHODS: Twelve male university students participated and ten of them completed all experimental procedures (21.6±1.0 yr) and reported an average Pittsburgh Sleep Quality Index (PSQI) score of 5.3±2.1. In a within-group crossover design, participants either stretched or rested for ten minutes before bedtime; each participant completed both experimental conditions (stretching/resting control) in randomized order and at least two weeks apart, and sleep electroencephalogram and subjective sleep quality were recorded for five days. On the sixth day, participants visited the experimental room and performed the Stroop task and mnemonic discrimination tasks (to assess executive function and memory respectively) completed the Profile of Mood State questionnaire (POMS).

RESULTS: Although paired t-test revealed no significant differences by condition for all parameters, stretching positively influenced sleep and cognition. The effect sizes were large for sleep latency ($d = 0.93$, $p = 0.07$) and Stroop interference time ($d = 0.85$, $p = 0.08$); medium for subjective sleep quality ($d = 0.60$, $p = 0.09$) and the lure discrimination index (LDI) for medium-similarity lures ($d = 0.67$, $p = 0.09$); small for the appearance ratio of stage N3 (deep slow-wave) sleep ($d = 0.25$, $p = 0.40$). In addition, differences by condition in the appearance ratio of stage N3 sleep were positively correlated with differences by condition in Stroop interference times ($r = 0.52$) and LDI for low-similarity lures ($r = 0.54$).

CONCLUSION: Performing ten minutes of a bedtime stretching program positively influenced sleep latency, subjective sleep quality and a deep slow-wave sleep. While five days of the stretching intervention had no effects on mood, they did yield positive effects on executive and memory performance. In addition, these cognitive benefits are related to increased deep slow-wave sleep. Although the sample size of this study was not large enough to provide sufficient statistical power, these results support our hypothesis that a bedtime stretching program has a positive impact on cognitive function through improved sleep quality.

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AGE-VARYING EFFECT BETWEEN DOMAIN-SPECIFIC PHYSICAL ACTIVITY AND STRESS PERCEIVED: THE KOREA NATIONAL HEALTH AND NUTRITION EXAMINATION SURVEY (KNHANES)

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INTRODUCTION: We examined the association of stress perceived according to physical activity(PA) by age-varying in Korean. Physical function decreases as aging lead to a lack of PA, which eventually negatively impacts mental health(i.e., stress). However, the effect of physical PA technology and industry, many people are re-employed in their old age, and resuming economic activities has a positive impact on PA and mental health. Therefore, it is necessary to confirm the effect of domain-specific PA (i.e., work, leisure time, transfer) and mental health according to the lifespan. The age-varying effect model can help develop more age-targeted and effective interventions for improving mental health through PA.

METHODS: This study used the Korean National Health and Nutrition Survey (KNHANES), and a total of 31,051 participants included those aged 20-80. All data were obtained through self-report questionnaires. Amount PA was calculated for moderate-various work, leisure, and transport related PA from the Global Physical Activity Questionnaire (GPAQ, and common stress perceived level from the mental healthy questionnaire part. Association between PA and stress perceived level was examined by time-varying effect models (TVEM). All statistical analyzes were adjusted for covariates (e.x., gender, education level, occupation, income level, marital status, alcohol assumption, smoking, BMI, and chronic diseases). All data cleaning and analysis were performed using the R and SAS program.

RESULTS: Those who participate in work-related moderate to vigorous intensity PA show a pattern of gradual stress reduction with age-varying. In addition, stress perceived level was also founded to be reduced in the context of leisurely moderate to vigorous PA and transport PA. Moreover, compared with those who did not meet WHO PA guidelines(≥150min/week), those who did show a pattern of rapid decrease in stress with age. The association peaked at around age 30-45(95% CI:1.1, 1.45; 95% CI:0.75, 0.95).

CONCLUSION: The association of PA and common stress perceived level was confirmed according to the time(age)-varying effect model. The significant associations of domain-specific PA and stress level across age groups. As a result, a commonly perceived stress level negatively impacts mental health in previous studies. PA is essential in all lifespans, and it has been reported that work-related PA has an inverse association with stress, but this study showed that all types of PA positively affect mental health.

THE EFFECT OF PROLONGED AEROBIC EXERCISE AT MODERATE INTENSITY ON CARDIAC DIASTOLIC FUNCTION

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KYORIN UNIVERSITY

INTRODUCTION: It is generally known that regular exercise training has beneficial effects on human health, especially on the cardiovascular system. However, some previous studies showed that long-duration exercise might acutely impair heart function. These findings are often based on fieldwork studies, in which it is not practical to evaluate cardiac function during exercise. Therefore, time course changes in cardiac diastolic function during prolonged exercise are still unclear. This study aimed to observe the cardiac diastolic function during and after a moderate-intensity bicycle exercise for 3 hours. We hypothesized that diastolic function would be impaired as exercise duration increases and that it would not be recovered after exercise.

METHODS: Nine healthy adult male subjects (36 ± 6 years) participated in the study. Subjects were required to attend the laboratory with conditions set to 20-22◦C and 50-70% humidity on two occasions separated by a minimum of 1 week. On the first day, subjects completed incremental exercise tests according to guidelines by the American College of Sports Medicine in order to assess maximal oxygen consumption (VO2 max). On the second day, subjects performed bicycle exercises at the intensity of 60-70% VO2 max for 3 hours on a pedal-equipped echocardiography bed. Echocardiographic measurements were performed before exercise (PRE), every 30 minutes (30, 60, 90, 120, 150, and 180 minutes) during exercise, and 15 minutes after exercise (POST). We measured heart rate (HR), mitral annulus blood flow and tissue motion velocities in early (E or e) and late (A or a) diastole, and isovolumic relaxation time (IVRT).

RESULTS: The subject's average VO2 max was 43.7±8.8 mL/kg/min (±SD). HR was higher during exercise as compared with PRE, and gradually increased during exercise, which reached statistical significance after 90 minutes as compared with 30 minutes. HR was higher at POST than at PRE. E/A was lower during exercise as compared with PRE, which did not change during exercise. E/A was lower at POST than at PRE. e' was higher during exercise as compared with PRE, which did not change during exercise. e' did not differ between PRE and POST. E/e did not change either during or after exercise. IVRT was shorter during exercise as compared with PRE, but gradually prolonged during exercise, which reached statistical significance after 120 minutes as compared with 30 minutes. IVRT was longer at POST than at PRE.

CONCLUSION: The present results that IVRT became shorter just after the exercise began, but prolonged as the moderate intensity exercise continued indicated that LV diastolic function was acutely enhanced by exercise itself, but impaired due to the long duration of exercise. However, the present results that e' did not change during and after exercise may indi-

cate that diastolic function was not affected by the long duration of exercise. Since IVRT reflect the early phase of diastolic relaxation, while e' reflec

SPORT-SPECIFIC-ORIENTED ADAPTATION IS REVEALED BY MICROBIOME CHARACTERISTICS.

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INTRODUCTION: The gut microbiome is a live community of interacting components including bacteria, implicated in human health and disease. Studies comparing sedentary individuals to athletes have identified numerous characteristics of a healthy microbiome, and features correlated with athletic performance. However, the range of work on the intestinal composition among groups divided by physical exercise levels is limited. Therefore our study aimed to compare basic differences in the microbiome of trained and non-trained physically active men as well as to assess post-exercise microbiome response dependent on the sport specification to identify microbiome characteristics.

METHODS: The participants comprised 15 strength-oriented, 15 endurance-oriented athletes, and 12 physically active male participants as a control group. All completed Wingate Anaerobic Test followed by Bruce (aerobic) Test. Basic anthropometric characteristics (age, height, weight) and test results (average and max power during Wingate Test, VO2max during Bruce Test) were gathered for each participant. Stool samples were collected immediately before and twice after the testing (3 time-points per intervention). Taxonomic and functional profiles were obtained from sequenced samples using Metaphlan4 and Humann3.6 and further analyses were conducted using Qiime2 and custom python scripts.

RESULTS: Comparison of Control, Strength, and Endurance groups revealed no significant differences in microbiome richness. However, 34% of identified bacterial species and 7% of functions were unique to either of the groups. The longitudinal analysis detected Alistipes_communis as significantly enriched in the Strength group during Wingate Test, and diverse individual trends in abundance of 88 species during Bruce Test. Those included short-chain fatty acids producers with probiotic properties (Bacteroides_xylanisolvens, Ruminococcus_bromii, Roseburia_hominis). The individuals were also compared based on their biomechanical and physiological results. A machine learning approach identified Bifidobacterium_longum (a probiotic tested on athletes) as the main predictor of VO2max and average power at baseline. Species longitudinally enriched in high versus low average power group (high >= 8.5, low <= 8W/kg) during Wingate Test included Bacteroides_uniformis and Phocaeicola_dorei. Similarly, Phocaeicola_vulgatus and Bacteroides_thetaiotaomicron were more abundant in high versus low VO2max groups (high >= 62, low <= 55 mL/kg/min) during Bruce Test. Also, a greater microbiome richness was observed in the high versus low VO2max group.

CONCLUSION: The study identified microbiome characteristics previously known to be implicated in elite-level performance and revealed differences between strength- and endurance-oriented athletes and non-trained physically active men. Ultimately, the results in this area carry a great potential to develop strategies for microbiome alteration to optimize human performance.

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PHYSICAL ACTIVITY LEVELS AND SLEEP QUALITY IN AFRICAN AND ASIAN STUDENTS DIFFER FROM EUROPEANS AND AMERICANS. A GLOBAL SURVEY ON 3366 STUDENTS FROM 49 COUNTRIES

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INTRODUCTION: Poor sleep and low physical activity (PA) levels has become a major scourge among university students worldwide [1], with sleep issues becoming a common problem in this population [2]. We assessed subjective reports of sleep quality (SQ) and PA in university students globally.

METHODS: We surveyed 3366 students (aged 22.7±5.5 years) from 49 countries, continentally located in: Africa (n=1095); Asia (n=1562); America (n=182); and Europe (n=527); and regionally from: North Africa (N=571); Sub-Saharan Africa (n=521); Southeast Asia (n=186); Middle-east-GCC (Gulf Cooperation Council) (n=498); Non-GCC Middle-East (n=898); North America (n=157); South America (n=25); and Europe (n=526). Our online survey included four questionnaires validated in three languages (Arabic, English & French): (i) Pittsburgh Sleep-Quality Index (PSQI), (ii) Epworth sleepiness-scale (ESS), (iii) Insomnia severity index (ISI) and (iv) International PA Questionnaire (IPAQ) assessing SQ, daytime sleepiness, insomnia and PA, respectively.

RESULTS: SQ of the African and Asian students was significantly lower than that of Americans and Europeans (mean±SD of PSQI scores: 6.4±2.8; 6.5±2.8; and 5.7±2.7; 5.5±2.4; respectively, $p<0.001$). The sleepiness and insomnia of African and Asian students were significantly higher compared to Americans and Europeans (ESS scores: 9.4±4.6; 10.0±4.7; 8.0±4.1; 7.5±3.9; ISI scores: 9.6±6.0; 10.0±5.8; 8.3±5.4; 7.5±5.3, respectively $p<0.001$). Africans and Asians were less physically active than Americans and Europeans. The SQ and PA were significantly lower for students from, Middle East (GCC and non GCC), North- and Sub-Saharan-Africa and South East-Asia compared to Europeans ($p<0.05$ to $p<0.001$). Students from Middle East and North Africa had higher sleepiness compared to those from other sub-regions ($p<0.001$). The global insomnia scores of this sample of international students were higher than the normal but with significantly higher values for students from Middle-East and North-Africa compared to Europe, North America and sub-Saharan-Africa ($p<0.001$).

CONCLUSION: We showed that students from Africa and Asia have poorer SQ and lower PA levels than Americans and Europeans. More investigation into sub-regional specificities would identify the associated causes. As the importance of SQ and PA in supporting physical and psychological health, these topics should be considered with particular attention in students from Asia and Africa.

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EFFECT OF DIFFERENCE IN TIMING OF EXERCISE ON HUMAN CIRCADIAN CLOCK GENE EXPRESSION

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INTRODUCTION: It is well known that circadian rhythm disorders progress to development of various disease such as diabetes, cancer, depression, and sleep disorders. The circadian rhythm is thought to have been regulate to the light stimulation, diet, exercise, thermoregulation, and hormonal balance. From the perspective of disease prevention, it is extremely important to consider the effects of lifestyle modification on the progress of the circadian rhythm. It has been reported that circadian rhythm is controlled the clock gene, and a few animal studies shown a single bout of exercise is effective in advancing clock gene expression. However, the effect of difference in timing of exercise on circadian clock gene expression had not been clarified. This study was designed to examine the effects of difference in timing of exercise on human circadian clock gene expression.

METHODS: Five healthy young males (age, 23.8 ± 1.9 years; BMI, 23.1 ± 3.1kg/m2) participated in a two-night, three-day residential study. This study set the following four conditions of timing of exercise; 1) morning exercise (exercise starts at 8:00 am), 2) daytime exercise (exercise starts at 12:00 pm), 3) night exercise (exercise starts at 5:00 pm), and 4) control (no exercise). All of participants were performed to exercise using a bicycle ergometer for 60 min at the lactate threshold (LT) intensity. The hair of head was collected a total of 6 times every 4 hours starting at 7:00 am on the test day, and the expression levels of Clock, Bmal1, and Per2 mRNAs were analyzed from the hair follicle cells using real-time PCR method. Salivary sample was collected from 20:00 to 23:00 on every 30 min the test day, and from 6:00 to 8:00 on every 30 min the next morning to measure the salivary melatonin, serotonin and cortisol secretion. This study was examined the difference in relative expression levels of clock gene, and changes in salivary melatonin, serotonin and cortisol secretion levels among the above four conditions.

RESULTS: The mean LT intensity and maximal oxygen uptake in all of participants were 95.8 ± 13.9 watts, and 47.5 ± 6.5 ml/min/kg, respectively. The relative expression level of Bmal1 mRNA increased after exercise in the morning and daytime exercise conditions. However, there was no difference in the relative expression levels of Clock and Per2 mRNA among the four conditions. Although there was no difference in the change in salivary melatonin secretion level among four conditions, DLMO (Dim Light Melatonin Onset) was the fastest in the morning exercise condition compared to the other three conditions. However, there was no difference in the changes in salivary serotonin and cortisol secretion levels among the above four conditions.

CONCLUSION: These results suggested that morning and daytime exercise may increase the expression level of circadian clock gene, particularly Bmal1 mRNA, and morning exercise may promote melatonin secretion level.

POTENTIAL FOR LONG-TERM HEALTH DAMAGE IN MULTI-MARATHONERS – AN OBSERVATIONAL STUDY

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INTRODUCTION: Introduction: The sport of multi-marathoning, where participants frequently complete marathon distance with a goal of completing >100 marathons, is not well researched. This study documented the sport and examined the participants readiness to participate in vigorous activity and their potential for long-term health damage. Multi-marathoning is administered at a national level by 31 loosely connected 100 marathon clubs. These virtual clubs provide registration, community, events, motivation, and awards to their members. Several clubs do the same internationally. There are 961 athletes on the current multi-marathoning world rankings (>300 marathons), and 10k are documented by the clubs as having achieved >100 marathons. There are many more on the journey to this goal.

METHODS: Methods: Health awareness and the readiness to partake in vigorous physical activity was examined by using the globally accepted Physical Activity Readiness Questionnaire PARQ+ [1]. Given the geographic spread of participants and the virtual nature of their clubs, an online survey was the most practical way to gather data from this group. This survey was developed and hosted on the Qualtrics platform and was distributed with the help and support of all the major multi-marathon clubs, including 100 marathon clubs from Germany, UK, The Americas, Japan, Finland, Italy, Estonia, Ireland, Australia and New Zealand via their closed Facebook or email groups. The survey was anonymous, presented in English and optimised for mobile devices. Section 1 of the PARQ+ questionnaire on General Health was embedded in the survey.

RESULTS: Results: The survey had 691 respondents from 6 continents and 39 countries. The average number of marathons completed by respondents was 156. 57% of participants had at least one contravention to section 1 of the PARQ+ physical activity readiness questionnaire, while 25% had 2 or more contraventions. 11% had heart conditions, 13% had high blood pressure, 10% had lost balance due to dizziness or had lost consciousness in the previous 12 months, and 34% had bone, joint or soft tissue problems in the previous 12 months that could be made worse by vigorous exercise, 17% had other chronic conditions with 15% taking medication for chronic conditions.

CONCLUSION: Conclusion: Due to the high level of vigorous activity in the sport of multi-marathoning, participants have a high risk of long-term damage to health or succumbing to health-related incidents and should seek further information and/or seek advice from a qualified health or exercise professional before partaking in the sport and have continuous health monitoring [1]. To minimise health risks, multi-marathon clubs and Race Directors should promote awareness campaigns that encourage proper medical assessment based on PARQ+ and ongoing health monitoring by qualified health or exercise professionals.

1. Bredin et al. (2013)

CAN SELF-SELECTED MOTIVATIONAL MUSIC AFFECT HEART RATE DURING AND POST AEROBIC WORKOUT?

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INTRODUCTION: Listening to self-selected motivational music (Terry, 2020) during aerobic exercise may induce an excitatory stimulus on physiological parameters (Ballman, 2021), such as the heart rate (HR), in correlation with exercise intensity. However, the effect of music on the recovery phase seems to present an entirely new area of research in the available literature, particularly regarding short-time recovery (Karageorghis, 2012). The purpose of this study was to investigate the influence of self-selected motivational music on HR during recovery.

METHODS: Forty university students (age 22.7±2.6 yrs; BMI 21.8±2.5 kg·m-2; VO2max 39.7±7.9 mLO2·kg-1·min-1) performed different training sessions with (+M) and without (-M) self-selected motivational music. They were divided into three percentile categories (high, average and low) according to their cardiorespiratory fitness level (VO2max), assessed by a submaximal cycling direct test. During each training session, two 6-minute square-wave cycling bouts were performed, interspersed with 10 min of recovery, at two different intensities: 60% of VO2max (Mod) and 90% of VO2max (Vig). Each condition was replicated during two different moments of the day, morning (MO) and evening (EV), for a total of four training sessions. HR was continuously monitored in order to analyse HR peak during exercise (HRpeak), HR at the 1st minute of recovery (HRrec) and the difference between HRpeak and HRrec (ΔHR%).

RESULTS: For the entire group of subjects, no influence of music or time of the day was found. Subjects with high and average VO2max obtained a significantly ($p<0.05$) faster recovery when compared with those with low VO2max, independently of music condition (high VO2max: EV+M 12,4±4,4; EV-M 12,4±4 ΔHR%; average VO2max: EV+M 10,7±3,9; EV-M 10,8±4,2 ΔHR%; low VO2max: EV+M 6,3±2,8; EV-M 5,7±3,4 ΔHR%). At Mod intensity, subjects with high VO2max, independently of the time of the day, obtained significantly greater HRpeak and HRrec values in +M condition compared to -M (HRpeak: MO+M 138.4±11.7; MO-M 136.5±12.6; EV+M 138±8.9; EV-M 134.7±8.3 bpm, p=0.0278; HRrec: MO+M 118.8±11.1; MO-M 119.5±15.5; EV+M 120.2±9.9; EV-M 116.9±8.9 bpm, p=0.0364). In general, listening to motivational music during recovery phase does not affect ΔHR%. No differences emerged for Vig condition.

CONCLUSION: Untrained subjects have a slower recovery phase compared with more trained subjects, and listening to music after the workout doesnt help bridge the gap. Moreover, listening self-selected motivational music, during aerobic exercise and during recovery, in trained subjects, seems to negatively affect recovery capacity, independently of the time of the day.

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Conventional Print Poster

CP-SH05 Management and sociology

INTER-ORGANISATIONAL RELATIONSHIPS BETWEEN GOVERNMENTAL STAKEHOLDERS IN SOUTH AFRICAN ELITE SPORT: RESOURCE DEPENDENCY AND INTER- ORGANISATIONAL THEORETICAL PERSPECTIVES

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INTRODUCTION: Stakeholder relationships within high-performance sport are critically important for the success and growth of nations elite sporting systems. The characterisation of the varying type of inter-organisational relationships can

directly influence the implementation of the sport policies within practise. Herewith, it is critically important to understand the dynamics these relationships present. If inter-organisational relationships between stakeholders in elite sport are aligned more strategically by nations, then stronger elite sporting systems will be created. The aim of the study was to evaluate the inter-organisational relationships between governmental stakeholders in order to identify the influences it has on the effectiveness of elite sport policies in South Africa (SA). The study contributed to academic scholarship by juxtaposing two theoretical frameworks, namely, the resource dependency (RDT) and inter-organisational (IOR) theoretical perspectives. The case study evaluated the vertical IOR's between national and provincial stakeholders in one province in SA, namely the Western Cape.

METHODS: The IOR partnership was examined with the use of an exploratory qualitative method by means of 10 face-to-face, semi structured interviews on the elements identified in the theoretical perspectives. A purposive sampling method was used including only key informants namely; the national and provincial stakeholders in the elite sport portfolio's, respectively. Data were analysed by means of thematic analysis in order to apply inductive and deductive reasoning in Nvivo (v.12) software.

Results and discussion:

The theoretical contribution of using both the RDT and the IOR theories in this study, jointly assisted in the knowledge pertaining to why governmental IOR partnerships are formed, in what way they are managed, what the outcomes are, and lastly, how financial resources played a role in the dynamics of these relationships. The major findings illustrated that: (1) there is a perceived lack of clarity relating to the roles and responsibilities of governmental sport stakeholders, (2) too many entities are involved in sport which led to power struggles and non-cooperation, and (3) a lack of funding introduced issues of power within IOR's. The current results of this study have confirmed what has been found in the literature which relates to the challenging and often overwhelming influence of IOR management (Alexander et al., 2008). The findings of this study add's to the field of sport management research by illustrating the issues and concerns which obstructed the implementation of elite sport policy in this case study. Similarly, it identified the factors which facilitated the formation, management and outcomes of IOR's between governmental stakeholders. Jones et al. (2017) argued that a lack of collaboration within IOR's may impact upon sport entities ability to deliver consistent services.

AN ANALYSIS OF VALUE SYSTEM OF TAEKWONDO FREESTYLE POOMSAE'S TRAINEES: BASED ON MEANS-END CHAIN THEORY AND APT LADDERING TECHNIQUE

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Introduction

Today, Taekwondo gyms are experiencing a continuous decrease in the number of trainees, due to the oversupply of the gyms, excessive competition, and the COVID-19 pendemic. To solve the problems, various programmes are needed to satisfy the needs of Taekwondo trainees. Among them, Freestyle Poomsae allows trainees to feel more fun, artistry, and creativity than other Taekwondo events. In this context, it is necessary to study what kind of decision-making process trainees start and continue the Freestyle Poomsae. Therefore, the purpose of this study is to explore the attributes, benefits and values of Freestyle Poomsae perceived by trainees, and then to understand the connection relationship and cognitive process based on a Means-End Chain method proposed by Gutman(1982).

Methods

First, data were collected by in-depth interviewing with 10 Taekwondo-related participants, including trainees, coaches and professionals in 2022 by using judgement sampling. Transcribed data is categorised by grouping similar concepts through open coding. After that, each attribute, functional benefit, psychological benefit and value group was finally derived through member checking and cross-validation among professors and PhD researchers. Second, based on the previous results, data were collected from 317 students learning Freestyle Poomsae through Structural Implication Matrix survey. Lastly, Hierarchical Value Map(HVLM) through frequency analysis is created to identify the connection structure between attributes, benefits and values.

Results

Attributes, functional and psychological benefits, and values of Freestyle Poomsae were derived in 12, 11, 8, and 8, respectively. As a result of analysing the value system based on the above findings, three main value systems were derived. First, Freestyle Poomsae's creativity led to a sense of accomplishment through originality and showing myself to others. Second, expressions of individuality led to a sense of accomplishment through originality, and showing myself to others. Lastly, a event with music led to self-satisfaction and a sense of accomplishment through maximising expressions with actions and music, and a fine piece of work.

Conclusion

It was found that Freestyle Poomsae contained creavity, individuality, and music compared to other Taekwondo events. Taekwondo instructors should help trainees to develop their originality and show themselves with great works, and further they should guide trainees in a way that ultimately feels a sense of accomplishment and self-satisfaction. Thus, Taekwondo gyms are needed to emphasise the main benefits and values mentioned above when establishing a marketing communication strategy, contributing to expanding the base of Freestyle Poomsae and strengthening its competitiveness.

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AN INTRODUCTION TO THE INTERNATIONAL CONFEDERATION OF SPORT AND EXERCISE SCIENCE PRACTICE AND THE NEED FOR GLOBAL ADVOCACY

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INTRODUCTION: The International Confederation for Sport and Exercise Science Practice (ICSESP) was formed by the American College of Sports Medicine (ACSM), British Association of Sport and Exercise Sciences (BASES), Canadian Society for Exercise Physiology (CSEP), Exercise and Sports Science Australia (ESSA), and Sport and Exercise Science New Zealand (SESNZ) to promote and support the interests of Sport and Exercise Science (SES) practitioners across the world. To support this agenda, the ICSESP undertook a survey of practitioners worldwide to understand the context of their practice and the challenges and opportunities facing them in their roles locally and internationally.

METHODS: The survey was developed by the representative directors of the five organisations who each have extensive national leadership in SES practice and links to international networks. The survey was promoted to practitioners through national organisation official media channels and via international member networks and social media (Twitter, Facebook), and was open for approximately 5 months from March to August of 2022. Context data were extracted and summarised descriptively and text responses about future opportunities and challenges were collated into common themes.

RESULTS: A total of 750 people completed the survey, with 103 removed due to not having a tertiary degree background in SES, leaving 647 eligible responses. There were 37 discreet countries represented although the majority of responses (>90%) were from the ICSESP member countries of Australia, Canada, UK, USA and New Zealand. The predominant fields of practice were clinical exercise physiology (28%), exercise and sports science (25%), and Kinesiology (15%). The most common populations practitioners worked with were general healthy population (17%), musculoskeletal injury and disease (15%) cardiovascular disease (12%), sub-elite athletes (11%), metabolic disease (10%), and others including elite athletes, people with a disability, and people with a neurological disease, mental illness and cancers. The most pressing challenge identified was lack of recognition of the skills and qualification of SES practitioners, and the greatest opportunity was the increasing recognition of the role of exercise in improving and maintain health.

CONCLUSION: There is evidence of degree qualified practitioners of SES in many parts of the world. Issues faced by practitioners are common across the world, which support the value of the ICSESP in advocating for these professionals globally. The international community of SES practitioners, educators and researchers can work together to lift the profile of this industry and reduce the global burden of non-communicable disease.

A QUALITATIVE RESEARCH ON THE PARTICIPATION BEHAVIOR OF CHINESE DISABLED RUNNERS IN MARATHON

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Purpose – The purpose of this research is to explore the evolution process and formation path of marathon participation behavior of disabled people from injury to participating.

Design/methodology/approach –In this study, literature review, field investigation, case study and qualitative research method were adopted. Through multiple interviews with 8 disabled runners from 'Home of Hope' Rehabilitation Center for spinal cord injured Patients in Jiaxiang County, Shandong Province of China. The interview data were analyzed by open coding, axial coding and selective coding.

Findings –Results showed that: a) during the process of marathon participation, the disabled participants experienced respectively the trauma confusion period, individual transformation period, competition adjustment period and competition growth period successively. The changes in the four periods reflected the positive physical and psychological changes of the disabled participants, and finally reached a good result of accepting themselves and actively integrating with the society. b) In the process of marathon participation by the disabled, it occurred positive changes in values and psychological cognition. c) The external factors like family environment and social support, especially the family and friends, such as parents, spouses and friends, had a great role in promoting the mental health status of the disabled participants.

Practical implications –It is expected that this study can draw more attention to the disabled runners, a special group, in order to improve the service level and social support for this group of events so as to help disabled people build a positive lifestyle and help them actively integrate into society, and eventually promote the implementation of the 'Healthy China' strategy while improving the level of marathon running in the post-epidemic era.

Originality/value –The findings contribute to the following aspects. Firstly, this research found that the process of disabled participants participating in marathon was divided into four periods to explore the different psychological and behavioral characteristics of the four periods, which provides a theoretical basis for promoting the generation of disabled participants marathon behaviors. Secondly, it broadened the research of psychology and sports of the disabled. Thirdly, it confirmed the connection between marathon and physical and mental health of disabled people.

Limitation: Owing to the high physical requirements of the disabled runners and the inner sensitivity of some disabled runners, they do not want to be too disturbed in their own lives, so the number of people interviewed is limited. In addition, the current epidemic situation is relatively severe, and most marathon events are suspended because the epidemic does not allow large-scale gathering, which poses a certain challenge to the search of interviewees in this study.

INNOVATION IN SPORTS MEDICINE AND SCIENCE - A GLOBAL SOCIAL NETWORK ANALYSIS OF STAKEHOLDER COLLABORATION IN RUGBY UNION

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Introduction: Innovation in sport is crucial for maximising athletes' health and performance. A key component of innovation is collaboration and engagement with stakeholders. Stakeholders may span multiple disciplines and sectors forming a network of interactions which drive the innovation. Therefore, gaining a better understanding of how stakeholders collaborate may provide a basis for enhancing future innovation success in sport. To investigate the network of stakeholders involved in rugby union research across the globe.

Methods: Using author affiliation listed on scientific publications, we identified the organisations that contribute to rugby union research. Co-authorship on scientific publications serves as an indicator of collaboration between authors from different organisations. Once the organisations were identified, we determined their location (country) and sector (healthcare, universities, professional sports teams, sport's governing bodies, industry, sports institutes, and science and support). Outcome measures included collaboration networks, degree centrality, betweenness centrality and inter-sectoral and intra-sectoral density. Collaboration networks were generated using UCINET for the years 2016-2020. In the network, each organization is represented by a node, while edges represent publications in which organizations collaborated. For each year, the top 5 organizations with the highest degree and betweenness centrality are reported. Organizations with high betweenness and degree centrality indicate collaboration and influence. High inter-sectoral and intra-sectoral density give an indication of interconnectedness within and between sectors.

Results: Actors producing knowledge were from the university (47%), healthcare (24%), professional sports team (9%) and sport's governing body (7%) and industry sector (3%), although industry plays a small role. Most actors are located in England, Australia, France, New Zealand, Ireland and South Africa (22%, 15%, 9%, 6%, 5%, 4%). Australian Catholic University, Leeds Beckett University, Stellenbosch University, Swansea University, University College London and the University of Cape Town are the most influential actors between 2016-2020 for rugby union innovation. Inter-sector collaborations show that Sports Governing Bodies are highly collaborative and act as a broker between actors across sectors.

Conclusion: We have shown that scientific knowledge for rugby union has been created at an increasing rate overtime and that the organisations that produce this knowledge are primarily located in countries that are Tier 1 rugby-playing nations and belong to the university sector. There is a preference for inter-sectoral collaboration with Sports Governing Bodies for knowledge creation, however, overall collaboration between and within sectors is inefficient. These results highlight an opportunity for collaboration as the organizations creating knowledge have been identified.

THE IMPORTANCE OF SOCIAL CAPITAL INDICATORS FOR MEMBER RETENTION IN SPORTS CLUBS IN TIMES OF PANDEMIC

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HU BERLIN

Objectives: Even before the corona pandemic, more and more sports clubs reported declining memberships, episodic engagement, and difficulties in recruiting and retaining volunteers. Given the complex constraints on sports clubs and social activities during the corona pandemic, the question arises as to how this exceptional social situation affected membership retention in clubs and the importance of social capital. This lecture addresses a research gap by estimating membership commitment in the aftermath of the corona pandemic, focusing on the relevance of different social capital indicators.

Methods: The empirical analyses are based on a representative online population survey conducted in late 2020/early 2021. The survey sample comprises about 3200 persons 18 years of age and older, with a quota according to age, gender, education and region. In order to compensate for distortions of the sample compared to the population, the data were weighted by adjusting the socio-demographic characteristics to the corresponding data of the official statistics. The Effectiveness of the weighting is approx. 82 %. In order to establish comparability with other studies, items and scales from empirical studies of engagement and sports club research were used. In some cases, the items were modified to reflect the pandemic situation. The values for the internal consistency of the short scales are $\alpha = 0.61$ and 0.81, with one exception.

Findings: Membership retention of the sports club members remains quite high. Social capital indicators that are narrowly related to the sports club explain little in predicting member retention. In addition to perceived norms of reciprocity in the club, helpfulness and ingroup trust increase retention, while sociability orientation and outgroup trust decrease the likelihood of still being a member of the club after the pandemic. When all predictors are included, the model goodness of fit increases to almost 26%. In addition to a few sociodemographic characteristics, membership-related characteristics (e.g., crisis management of the association) contribute to the variance clarification. Willingness to help, outgroup trust, and a tendency towards sociability are the only significant social capital indicators in the overall model, although they contribute with considerable weights to the variance explanation.

Discussion and Conclusion: Solidarity orientations were already relevant predictors of member retention in other surveys. The Corona pandemic does not seem to have changed this. During the pandemic, however, the bridging potential of sports clubs seems to have suffered. The extent to which negative effects of a high social bonding capital are indicated here must be examined in further trend analyses. Preliminary conclusions but also limitations of the study are presented at the end.

DEVELOPMENT, VALIDATION AND UTILISATION OF THE TALENT DEVELOPMENT ENVIRONMENT QUESTIONNAIRE FOR PARENTS (TDEQ-P) TO HELP DRIVE EFFECTIVE TALENT DEVELOPMENT PROCESSES IN SPORT

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Talent development environments are multifaceted and dynamic, involving a range of stakeholders to ensure coherent messages are reinforced to young developing athletes as they progress. Parents are known to be important influences in the process but are often overlooked. As such, there is a need for coaches, clubs and NGBs to educate and foster relationships with parents of developing athletes. Furthermore, as part of an ongoing need to improve and reflect, it is important to provide opportunities for parents to feedback to coaches, clubs and NGBs. This may provide valuable insight helping coaches to understand the parents perspective better, educate parents about important TD processes, act as a mechanism to drive communication and build relationships. Importantly, it may also facilitate reflection from which improvements can be made. As such, this study aimed to design and validate the talent development environment questionnaire for parents (TDEQ-P). After adapting the wording of the original TDEQ questionnaire to make sense from a parents perspective, 485 parents of pathway athletes completed the questionnaire. The TDEQ-P included 28 items and two open ended questions related to perceived strengths and weaknesses of their childs TDE. The results showed support for a 28 item, 5 factor solution (Chi Square test x2 1039.342; DF 340; p< 0.001; CFI 0.993; RMSEA 0.065; SRMR 0.05), with robust discriminant validity and adequate internal reliability. The analysis of the TDEQ data and the open-ended questions provided both quantitative and qualitative feedback for coaches, clubs and NGBs to reflect upon in their drive for improved practice. The TDEQ-P is shown to be a valid, reliable and practical tool which could be used on its own or in tandem with the TDEQ for athletes to enable practitioners to glean feedback from key stakeholders within their talent development environment.

A STUDY ON THE RELATIONSHIP BETWEEN SPECTATORS BEHAVIORAL INTENTION AND SATISFACTION, EVENT QUALITY AND EVENT IDENTITY OF MEGA-EVENTS – THE 2019 WTA ELITE TROPHY ZHUHAI

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Purpose – Taking the 2019 WTA ELITE TROPHY ZHUHAI as an example, this study aims to explore the relationship between spectator behavioral intention (BI) and event quality: core quality (CQ) and peripheral quality (PQ), event identity (EI), and satisfaction (SAT) of mega-events.

Methods – This study used a convenience sampling method to conduct a questionnaire survey of the on-site audience of the 2019 WTA ELITE TROPHY ZHUHAI, and 355 valid data were collected.The StataMP 17 structural equation model (SEM) was built and estimated (standardized) to compare the path coefficients, significance, and also the fit indices: root mean square error of approximation (RMSEA), standardized mean square residual (SMRM), comparative fit index(CFI), and goodness of fit index (GFI).Hypothesis based on the research model: (a) Hypothesis 1 (H1).EQ will positively influence SAT. (b) Hypothesis 2 (H2).EQ will positively influence EI. (c) Hypothesis 3 (H3).SAT will positively influence BI. (d) Hypothesis 4 (H4).EI will positively influence BI.

Results and Findings – The results support all hypotheses, with EQ and SAT (= 0.871, $p < 0.001$), being positively correlated, and EQ having a positive effect on EI (= 0.559, $p < 0.001$), supporting H1,H2, respectively. sat on BI (= 0.285, $p < 0.001$) and EI on BI (= 0.458, $p < 0.001$) Both were positively correlated, supporting H3,H4, respectively. Spectators of major sporting events perceived that event quality, satisfaction, and event identity all had positive effects on their behavioral intentions. Among them, satisfaction and event identity are direct influences on behavioral intention, while event quality indirectly influences behavioral intention through satisfaction and event identity.

Discussion – This study investigates the relationship between spectator behavioral intention and satisfaction, event quality and event identity, thus providing a new understanding and insight into the study of spectator behavioral intention in the fields of sports economics, sports marketing and sports management, which helps to better understand the mechanism of spectator behavioral intention formation of large sports events, so as to more effectively meet the needs of spectators and improve the quality of sports events. This will help to improve the quality of sporting events and the social impact of sporting events. The results of the study can provide reference for sport event organizers to better meet the needs of spectators, enhance the attractiveness of sport events, improve the satisfaction of events, enhance the quality of events, increase the recognition of spectators, and thus improve the market value of sport events.

INVESTIGATING THE ANTI-DOPING KNOWLEDGE AND EDUCATIONAL NEEDS OF REGISTERED PHARMACISTS

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Objective: Taiwan implements national health insurance, and the widely used Chinese herbal medicine (CHM) has many uses, such as diet therapy, health care, and disease treatment. This may increase the risk of athletes inadvertently using doping substances and being stripped of medals or ineligible from the competition. The prevention of sports doping requires the assistance of a pharmacist. This study aimed to understand the status quo of anti-doping knowledge and the education needs of licensed pharmacists in Taiwan and to explore the reasons for these differences.

Method: A cross-sectional study was conducted using an anonymous online questionnaire survey. The questionnaire has five sections: demographic characteristics, source of prohibited substances, identification of prohibited substances, and understanding of education needs on anti-doping. It was distributed to registered pharmacists in Taiwan. Analyses were performed using SPSS version 20.0 using chi-square, independent sample t-test, and one-way analysis of variance (ANOVA) to determine associations and differences among the interviewed pharmacists' demographics, anti-doping knowledge scores, and educational needs.

Results: The respondents were 491 pharmacists, 64.6% female, aged 41.9 ± 11.4 years, and 68.4% with bachelor's degrees in pharmacy. Respondents' knowledge scores on sports doping were negatively correlated with age, with younger respondents having higher knowledge scores ($p < 0.001$). Respondents in southern Taiwan (vs. northern Taiwan) and those working in clinics (vs. hospitals) had less knowledge of sports doping. Only 38.3% of the respondents knew that furosemide was prohibited in sports, and CHM (7%) containedβ2 agonist higenamine. On average, respondents scored 73.02 ± 9.63 points on a scale of 0-100. Among them, 71.5% of the respondents exhibited moderate anti-doping knowledge (between 50-79 points). More than 90% of the respondents indicated that they needed to participate in sports doping education courses.

Conclusion: There are differences in anti-doping knowledge among licensed pharmacists, and they have a high willingness to accept sports doping education courses and to provide directions for planning the theme of sports doping education courses in the future. benefit and improve drug safety and health for the general public and athletes.

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CP-SH01 Physical Education

PHYSICAL ACTIVITY ON PRESCRIPTION 'NOT A QUICK FIX': SCHOOL NURSES' EXPERIENCES OF PROMOTING AND TAILORING PHYSICAL ACTIVITY TO CHILDREN IN SWEDISH COMPULSORY SCHOOL

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SPORT SCIENCE

Introduction

The number of children who reach the recommendations for physical activity (PA) is decreasing globally (1). Physical activity on prescription (PAP) is an individually written recommendations of PA. It can be used in school by school nurses to support children who do not reach the health recommendation for PA and are at risk of illness (2). The prescription can include individualised PA, for example, everyday exercise or organised PAP activities led by an activity organizer or sport clubs after school. Since school nurses provide PAP in school, they have an important role in evaluating PAP´s effectiveness. Therefore, this study aimed to explore school nurses' experience of using PAP with children in compulsory school.

Methods

In this study, semi-structured individual interviews were conducted with 24 school nurses who had the competence to prescribe PAP. Qualitative content analysis with an inductive approach was used. To understand how different system levels influence when prescribing PAP, Bronfenbrenner's ecological systems theory has been used.

Results

The analysis resulted in one overarching theme: 'A delicate process of tailoring physical activity on prescription to a child social context', and two categories: 'Promoting joyful physical activity through individualisation and support' and 'Dealing with dilemmas and challenges', with related subcategories. The results demonstrate the importance of tailoring prescriptions of physical activity to each individual child, their living conditions, and the school context.

Discussion

The results demonstrate that school nurses' use of PAP with school children is not a 'quick fix'. Using PAP in school is a complex and delicate process of tailoring to the needs and social conditions of each child. In congruence with the Convention on the Rights of the Child (3), it is important that children are involved and participate in deciding which PA they will perform. Physically inactive children, without a sports background, often request activities based on their own interests, such as playing, walking or jumping (4). Such PA is possible to obtain via a PAP and is in line with the school nurses thoughts about individualising the PAP.

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CONCEPTS AND DEFINITIONS OF RACISM IN PHYSICAL EDUCATION: A SCOPING REVIEW

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Introduction

Racism is a ubiquitous entity in society. Not only can the phenomena be found in everyday life, but also does it illustrate a common entity in Physical Education (PE). Researchers who investigate structures of racism in PE need to draw on theoretical outlines to support their investigation. Thus, by addressing racism in PE studies from different perspectives (i.e., pupils, teachers, researchers), the aim was to elaborate the existence of consistent racism concepts and definitions, respectively.

Methodology

A scoping review was conducted with PRISMA standards. Article selection was based on three criteria: a) peer-reviewed journals b) keywords (e.g., racism, PE) targeting international (i.e., English) or national (i.e., German) publications, respectively, and c) pupil, teacher, or researcher-centred studies. Lastly, included studies from eleven databases were analysed according to a framework analysis.

Results

In total, 5213 articles were found with 53 (pupils n=16, researchers n=22, teachers n=22) meeting the set inclusion criteria; overall, 23 coding categories were generated with articles allocated to different codes and categories.

The pupils' perspective mostly refers to the concept of the racialized 'other' 20% or, less prominent and mostly applied, to the concept of racist stereotypes 15% and the idea of biological racism 10% or institutional racism 10%. The researchers' perspective frequently mentions the notion of Whiteness as a race or ideology 18 %, followed by the concept of the racialized 'other' 17 % and the Critical Race Theory (CRT) 9%. The teachers' perspectives align with the researchers' perspectives, except rather drawing on the concept of racist stereotypes 11% than on the CRT.

Discussion

Evidently, for different perspectives in PE there is no unified concept or definition of racism that is ingrained in the numerous aspects of life marking diversity (e.g., politics, social practices, Gender Studies). However, Whiteness as an ideology is often put into relation with the concept of the racialized 'other' [1]. That is to say that Whiteness is seen as the highest norm which operates to normalise and naturalise the 'other.' It prevents 'others' from seeing their own individuality and thus subtly, as overtly perpetuates the idea of a racialised and inferior 'other' [2].

To conclude, the scoping review illuminates various possibilities of defining racism while illustrating similarities with respect to different perspectives in PE. We are confident that the more we debate racism, the more likely it is to generate new voices who stand against it.

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HEALTH PROMOTION FOR APPRENTICES IN THE CRAFTS SECTOR - A THEORY-BASED BLENDED LEARNING HEALTH PROMOTION INTERVENTION IN VOCATIONAL SCHOOLS

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Background: Current and future public health and health policy challenges demonstrate the need for quality-assured prevention and health promotion. Apprentices in the crafts sector have been rarely selected as target group for health promotion interventions, although their state of health can be considered as a cause for concern. Hence, the objective is to develop a quality-assured health promotion intervention for apprentices in the crafts sector that can be implemented in vocational schools on a long-term basis and can serve as a driver of sustainable behavioural change.

Method: The blended learning health promotion intervention was designed evidence-based according to the holistic approach. As first step, the problem definition was specified systematically to identify the current state of research. Subsequently, the strategy was derived. Additionally, a workshop with relevant stakeholders from science, industry and government was conducted in order to define the methodological and content-related cornerstones. Based on this, the health promotion intervention was elaborated and implemented at vocational schools.

Results: The theory-based blended learning health promotion intervention #missionmacher - get fit for your future was developed and implemented in vocational schools. Four teaching units were developed on the subjects of self-management skills, stress management skills, nutritional behaviour as well as exercise and regeneration behaviour. Teachers were provided with a comprehensive set of ready-to-use teaching materials. The intervention starts with a health day at the respective vocational schools facilitated by experts. In addition to the health day and teaching units as face-to-face interventions, a digital application was designed to be used in both, school classes and in the students free time. The digital content includes quizzes as well as physical and behavioural challenges. Additionally, a podcast series on stress management and videos to support behavioural change were developed.

Discussion: #missionmacher - get fit for your future is a theory-based health promotion intervention with a comprehensive set of face-to-face and digital content. It was developed in stakeholder-oriented and resource-efficient way to consider the limited time resources of the apprentices and teachers. Subsequently, it was optimised according to the needs and wishes of the involved stakeholders in a participative mode. In future interventions, the target group and multipliers should be involved at an earlier stage in order to consider their needs and interests right from the beginning. This results in a higher level of quality and reduces subsequent change requests. As craft apprentices are a small target group in vocational schools, a transferability assessment should be carried out and tested to expand the target group.

THE INFLUENCE OF THE INITIAL MOTIVE SITUATION ON MOTOR LEARNING PERFORMANCE IN RELATION TO POSITIVE AND NEGATIVE REINFORCEMENT

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The influence of the initial motive situation on motor learning performance in relation to positive and negative reinforcement

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Introduction

The question of the effectiveness of successful coach instructions is not only very important in competitive sports, but also an elementary part of learning new motor skills. The different successes of the coaches as well as an observable large influence of the mental processes on the learning performance illustrate the necessity of considering existing motive structures for sporting success. The aim of the present study was to show dependencies between existing achievement motive structures and motor learning performance as a function of positive or negative reinforcement.

Method

13 participants who are between 16 and 19 years old and do competitive sports were examined (girls=5, mean age=16.8, boys=8, mean age=16.88). It was assumed that nobody had previous experience in juggling, so that there was no specific starting level. The groups were questioned with the help of the UMS-10 (German, Schönbrodt, F.D., & Gerstenberg, F.X.R., 2012) regarding their achievement motive expression (Cronbach's α usually >.75). The participants were randomly divided into two groups, which watched a 6-step instructional juggling video while actively following the methodical steps with standardized balls (ball=100g; 62mm). In addition, skin conductivity was measured using biofeedback in order to establish dependencies to possible stress reactions (Biograph InfinitiTM Software, ProComp Infiniti System).

results

The two randomized groups showed major differences in learning performance. The positively reinforced group (N=7; *M*=5.13, SD=0.38) differed from the negatively reinforced group (N=6, *M*=4.58, SD=1.11). No significance could be determined, which was probably due to the small sample. In addition, a large difference in skin conductance was measured, which was higher in the positively reinforced group (positive group: *M*=8.91, SD=4.86 and negative group: *M*=4.12, SD=3.99). The T-test for independent samples showed no significance (p=.07).

Furthermore, it could be shown by means of a co-variance test that the learning performance depends on the initial motive situation if the learning process is positively or negatively reinforced.

discussion

The present study is to be understood as a pilot project, which is to be followed by a larger sample. This ensures that there are generalized statements on the dependencies of learning performance on the motivation structure of the athletes and on the instructions of the coaches. This requires a larger sample so that the same number of genders and a comparable starting point for motives is also present in the two groups due to the randomness. Furthermore, a larger sample and further biofeedback data should show dependencies between the trainers instructions, the initial motive situation and the learning performance.

RELATIONSHIP AND DIFFERENCE BETWEEN INTRINSIC MOTIVATION CLIMATE OF PE LESSONS AND PHYSICAL ACTIVITY (PA) OF HIGH SCHOOL STUDENTS

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Relationship and difference between intrinsic motivation climate of PE lessons and physical activity (PA) of high school students

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Introduction

Motivation is considered to be one of the most essential factors associated with engagement in physical activity throughout childhood and adolescence (Hagger and Chatzisarantis, 2007; Sallis et al., 2000). The study of motivational processes in sports for adolescents is crucial because their PA level decreases by age, annually by 7% (Chu & Zhang, 2018). The aim of this study was to investigate the relationship between MCPES's variables and PA of Iranian female high school students and the differences in motivational components of students PA.

Methods

The sample consists of 295 Iranian female students between 13-15 years of age. Participants were selected from 5 schools (wealthy, moderate, and lower income districts) they filled out the intrinsic motivation climate of PE lessons questionnaire (MCPES), international physical activity questionnaire (IPAQ), and general information, demographic data questionnaire online. The ethical committee of the Hungarian University of Sports Science granted permission for this study. The MCPES (Soini et al.,2014) consists of four subscales comprising Ego/competitive, Task involving, Social relatedness supporting and Autonomy supporting climate on a 5-point Likert scale (anchored from not at all important=1 to extremely important=5). The IPAQ consists of three levels of PA (low, moderate, and high levels) which were measured based on MET. The low level was less than 600 MET, moderate level was between 600 to 3000 MET and high level was at least 3000 MET. For data processing IBM SPSS v. 26. software was used. Descriptive statistics indicators (frequencies, mean and standard deviation were reported. Furthermore, in order to determine the relationships and differences between variables, Spearmans rank correlation coefficient, as well as Kruskal-Wallis tests were performed respectively.

Results

The results showed a significant positive relationship between PA and ego, task, social, autonomy, enjoyment, and physical activity. There were significant differences in the levels of students PA influenced by intrinsic motivational climate in PE. In addition, with the increase of motivational climate in PE lessons, levels of students' PA increased as well ($p \leq 0.05$).

Discussion and conclusions

The findings of this study revealed that variables of subscales of MCPES (including ego, task, social relatedness supporting, autonomy supporting climate) and even enjoyment and physical activity that are not part of MCPES have a significant positive relationship with PA. Also, with the increase in PA levels of the students, the amount of MCPES's variables increased, and a significant difference was observed between MCPES's variables and PA of the students. In summary, based on the findings of the present study, conclusion can be drawn that intrinsic motivational climate in PE, which is examined by the theory of goal orientation, is an effective and reinforcing factor for doing PA.

Keywords: MCPES, IPAQ, Iranian female students

PROMINENCE OF BASIC SWIMMING SKILLS IN GERMAN CHILDREN'S BOOKS

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Introduction

Previous research on British children's books has shown that they may serve a transfer of knowledge to society but create a distorted representation of the importance of required water competencies (i.e., submerging, floating, gliding [1]). Considering possible cultural differences in the learn-to-swim process, this study aims to investigate how essential water competencies are addressed in German children's books.

Methods

The selection of children's books is based on the principle of the most up-to-date and well-known works, with no further restrictions on the selection. Thus, 9 books were identified eligible for the analysis of this study. The analysis is limited to the macroanalysis of the content and representation of the text and pictures as well as their interdependence [2].

Results

The basic skill submerging, initially and not as part of a swimming technique, is described in detail in 56% of the books, of which submerging is illustrated in 44% by retrieving an object, however, with varying degrees of detail (e.g., eyes are always shown open except once when goggles are used). Floating is addressed in 67% of the books, described as both, floating on front and back; gliding is depicted in 22% of the books. Often, it's either gliding or floating, but mostly the protagonists learn propulsion. A distinction must also be made whether buoyancy aids are used or not. In addition, the books vary in representing the head's posture.

Discussion

Submerging is portrayed in the children's books congruent with scientific literature. One reason for such prominent consideration is certainly the importance of submerging, since this is not only a prerequisite for learning to swim, but in Germany also one task of the first swimming badge. Floating and gliding, on the other hand, is scattered depicted in the German children's books. A scientific discussion of the methodological steps necessary to learn the two basic skills of floating and gliding does not take place in any of the books. It can be assumed that the German swimming badges may

lead to a shift in the importance of basic swimming skills. Future studies may consider the choice of the first swimming technique in children's books.

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PROMOTING STUDENTS' HEALTH THROUGH PHYSICAL EDUCATION WITH DIGITAL METHODS: A SYSTEMATIC REVIEW

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Introduction

Young peoples engagement with digital health technologies is often discussed in terms of risk. However, there is limited evidence on the problems and opportunities that can arise from digital health technologies (Goodyear et al., 2018). The use of digital media in physical education can support and optimize teaching and learning processes (Gómez-García et al., 2016). Therefore, the aim of the current systematic review was to identify the state of research on digital methods for promoting students health in physical education.

Methodology

In order to address the research question of what research is already available on health promotion using digital media in physical education, a literature review of English language studies was conducted. The literature search was performed from July 2022 to December 2022 in the databases Web of Science, ERIC, Scopus and PubMed. A sample size of N=1492 studies was included in the analysis at baseline.

Results

After title, abstract, and full text screening, N=47 empirical studies were included in the literature review. The results show, among other things, that digital media can impart knowledge in physical education with similar results without the need for a teacher. Furthermore, digital categories such as gamification are reported to increase intrinsic motivation and fun on the part of school students. Digital media can also appeal to different types of students in physical education, making it possible to reach previously less responsive students.

Discussion

Schools, physical education classes, and peers are important contexts in which to foster the development of effective pedagogy by examining how young people use digital health technologies. In order to take advantage of digital applications with the goal of promoting health in physical education, results show a need for empirically tested implementations regarding the school setting.

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EMPIRICAL FINDINGS ON STUDENTS EMOTIONAL EXPERIENCES OF MASTERING JUMPING TASKS IN PHYSICAL EDUCATION

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Introduction

Emotions interact with motivational consequences in physical education. Emotional experiences are shaped by situational contexts, social conditions and subject matter (Ahns, & Amesberger, 2021). While empirical studies focus on general emotional experience in PE and pay little attention to the specific content or task context (e.g., Leisterer, & Jekauc, 2019), the aim of the present study is to elaborate facets of emotional experience in close relation to a specific subject matter. We ask, how students experience jumping tasks emotionally.

Method

We taught a didactic lesson at a sixth grade in an Austrian high school that focused on offering different open tasks of jumping with the aim of encouraging self-referential goal setting and to foster emotional experiencing. Subsequently, 12 (6m/6f) episodic narrative interviews (Mueller, 2019) were conducted. For analysis, the documentary interpretation (Nohl, 2010) is used to reconstruct orientation patterns of students, describing their emotional experience.

Results

Analyses show that jumping in general spans a wide emotional range from aversive to joyful, while some students also experience it as unemotional. In particular, the experience of mastering a jumping task is emotionally charged: students

explicitly and implicitly refer to fearful situations (e.g., height, unsafe tread, social pressure) or making the decision to jump as emotion-triggering moments (i); they describe the task-related action emotionally as states of clutch or as an intense perception of the emotion (e.g., trembling legs) (ii); and they emphasize the experiential qualities of fulfilling or mastering a jumping task (e.g., unexpectancy comes with pride or shock) (iii).

Discussion

The results show that the emotional experiencing is formed along specific subject matter, respectively that students differ in how they reference their experience (i-iii). Didactical implications should consider ways of individual accompaniment of the emotinal experience to unleash motivation, e.g. to create awareness of implicit emotional triggers or to strengthen joyful action orientation.

Literature

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A STUDY ON THE CORRELATION BETWEEN LEARNING EFFECTIVENESS AND SPORTS ENJOYMENT AMONG ELEMENTARY SCHOOL CHILDREN IN THE NORTH OF TAIWAN

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Introduction: Physical education programs often give people the impression that they are tool- and skill-oriented, emphasizing "content" at the expense of "students," and lacking the function of encouraging students to take action to improve their own physical fitness, not to mention improving the environment in which people live, exercise, relax, and work, and promoting community development. Therefore, we explored the current situation of sports enjoyment and learning effectiveness of P.E. classes among elementary school children in the Northern part of Taiwan after the implementation of the 12-year National Curriculum.

Method: In this study, elementary school students in Northern Taiwan were used as the independent variable, and their learning effectiveness and sports enjoyment were used as the dependent variables. The learning effectiveness variables in this study included cognitive, affective, and skill categories; the sport enjoyment variables included social opportunities, sport enjoyment, social identity, and health needs. The questionnaire was distributed in September, 2022. 1,500 questionnaires were randomly distributed by stratified random sampling of which 117 invalid questionnaires were excluded, resulting in 1,383 valid questionnaires.

Result: The KMO value and Bartletts spherical check method were used to understand the appropriateness of sampling, and the result of the KMO value was .82 and the Bartletts value of 3346.04 also reached a significant level. The internal consistency coefficient of the first factor "parental support" was .90; the internal consistency coefficient of the second factor "teacher support" was .88; and the internal consistency coefficient of the third factor "classmate support" was .94. Overall, the coefficient values of this study ranged from .88 to .95, which is considered high. The Cronbach alpha value for the total scale was .94.

Discussion: The study showed "cognitive", "affective", and "skill". The factors of "cognitive", had the highest importance over "affective", and "skill". The factors that contributed to the enjoyment of physical education for elementary school children in Northern Taiwan included "social opportunities," "sports enjoyment," "social identity," and "health needs. The four factors were "social opportunities", followed by "social identity", "health needs", and "sports enjoyment". This result is the same as that of Guo Yisan (2015). The reason for this is that Guo Yisans (2015) study was conducted on upper elementary school students in Taipei City, and the result was that self-orientation was positively related with extrinsic/achievement in sports enjoyment, indicating that students are more mentally developed at the junior high school level, and they are still able to experience the sports enjoyment by training hard for their own competition.

CHILDREN'S NEED FOR PHYSICAL ACTIVITY IN PHYSICAL EDUCATION - A CROSS-SECTIONAL SURVEY OF PRIMARY SCHOOL TEACHERS.

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INTRODUCTION: Physical activity (PA) is important for children´s development and is associated with many positive effects (e.g. better academic performance). Especially in children of primary school age, a high need for PA or a high urge to move is often reported. However, it is unclear which characteristics can be used to operationalize the need for PA. As experts on this topic, physical education (PE) teachers in primary schools can provide information on how the need for PA

is expressed. As an exploratory approach, this study aims to get an overview of the characteristics that primary school PE teachers use to identify a high or low need for PA and whether they rate it as good or bad, helpful or disturbing.

METHODS: Primary school PE teachers were asked to participate in a cross-sectional online survey. Besides demographic information, teachers were asked to name signs for high or low need for PA before PE lessons, during passive phases in (e.g. exercise explanation) PE, during active phases (e.g. exercise execution) in PE and after PE lessons based on their experiences (qualitative data). All mentions were analyzed in an inductive and deductive analysis and assessed according to their frequencies. In addition, the PE teachers were asked to what extent a high or low need for PA is good or bad for the student and the achievement of learning goals, and how helpful or disturbing it is for the PE lessons and the classmates (quantitative data on seven-point scales: 1 good/helpful - 7 bad/disturbing).

RESULTS: 70 primary school PE teachers (female = 59; male = 11) with a mean age of 45,69 (SD = 7,96) participated in the online survey. The need for PA can be observed in all PE-phases (before, during, after). Three categories could be derived from the mentioned signs of PA-need identification: PE-environment-related (e.g. interaction with classmates or materials), person-related (e.g. physical signs), task-related (e.g. performance).

The PE teachers rated a high need for PA rather positively to medium (for student M = 2,06, SD = 1,12; for achievement of learning goals M = 2,60, SD = 1,32; for PE M = 2,14, SD = 1,11; for classmates M = 3,13, SD = 1,51). A low need for PA was rated rather negatively to medium (for student M = 5,50, SD = 1,09; for achievement of learning goals M = 5,33, SD = 1,46; for PE M = 5,26, SD = 1,26; for classmates M = 4,96, SD = 1,30).

Discussion:

The categorization shows that the need for PA is expressed at/in different times and ways. Thus, teachers should focus on students´ behavior during whole PE. This is supported by the fact that teachers tend to rate a high need for PA positive and a low negative for PE. Raising awareness for observing PA-need can therefore help to ensure that PE is adequate for students and psychological variables like motivation or self-efficacy can be promoted individually.

Further research is needed to theoretically substantiate the need for PA in children and to systematize the measurement.

Conventional Print Poster

CP-BM02 Biomechanics and Neuromuscular Physiology

COMBINED EFFECTS OF ELECTRICAL MUSCLE STIMULATION AND CYCLING EXERCISE ON COGNITIVE PERFORMANCE

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INTRODUCTION: Acute aerobic exercise has been shown to improve cognitive performance. We have recently reported that a combination of electrical muscle stimulation (EMS) to lower limbs and arm cranking exercise improves cognitive performance [1]. However, acute effects of a combination of EMS and cycling exercise on cognitive performance remains to be elucidated. In the present study, we hypothesized that a combination of EMS and cycling exercise improves cognitive performance. The purpose of this study was to test if a combination of EMS to lower limbs and cycling exercise improves cognitive performance.

METHODS: Eighteen participants (7 females) were recruited in this study. The participants performed a Go/No-Go task before and after 20 minutes of 1) a combination of EMS and cycling exercise (EMS+EX), 2) cycling exercise (EX), and 3) rest (Control). EMS was applied to bilaterally to the abdomen, glutes, thighs, and lower legs with an electrical stimulator at 4 Hz (Auto Tens Pro; Homer ion, Tokyo, Japan). Exercise intensities in the EMS+EX and EX conditions were adjusted so that heart rate (HR) was maintained at 120 beats per minute (bpm). Cognitive performance was assessed using reaction time (RT) and percentage of correct responses. We performed two-way of analysis of variance with condition and time (pre vs. post) as factors. Bonferroni correction was applied to correct for multiple testing.

RESULTS: Mean HR was 120.3 ± 1.4 during EMS+EX and 120.6 ± 0.5 bpm during EX, which indicates that HR was matched between EMS+EX and EX conditions. We observed a significant interaction on RT ($p = 0.007$). Cognitive performance tended to improve after cycling exercise (Pre: 335 ± 31 ms, Post: 327 ± 25 ms, $p = 0.031$). However, cognitive performance did not change after the combination of EMS and cycling exercise (Pre: 333 ± 28 ms, Post: 327 ± 29 ms, $p = 0.24$). Accuracy of cognitive performance was not altered in all conditions ($p > 0.11$).

CONCLUSION: Acute cycling tended to improve cognitive performance (i.e. selective attention and response inhibition). However, despite similar HR, cognitive performance did not change in the combination of EMS and cycling exercise. These results suggest that effects of EMS with cycling exercise are different from those of cycling exercise. Furthermore, the present findings are not consistent with our previous results showing that the combination of EMS and arm cranking exercise improved cognitive performance. Collectively, the present findings suggest that that neural activations during EMS with cycling exercise may be insufficient to improve cognitive performance.

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PREFERRED DIRECTION OF ELECTROMYOGRAPHIC ACTIVITY OF THE HIP ADDUCTORS DEVIATES FROM THE ANATOMICAL LINE OF ACTION

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INTRODUCTION: The hip adductors [adductor magnus (AM), adductor longus (AL), and gracilis (Gra)] have functions of hip extension and flexion as well as adduction (1). The hip joint is a joint with a high degree of freedom of movement and thus we can exert force in various directions at the joint, such as a combination of extension and adduction. However, little is known about which direction of force exertion will show high electromyographic (EMG) activities in the hip adductors. This study aimed to investigate the preferred direction (PD) of EMG activities in the hip adductors by comparing PD with adduction (0°) and with the lines of action anatomically determined in the previous study (1).

METHODS: Eighteen healthy young males performed maximum voluntary isometric contraction (MVIC) for 3 s in five directions [1) hip flexion (90°), 2) flexion + adduction (45°), 3) adduction (0°), 4) extension + adduction (−45°), 5) extension (−90°)] at 0° of hip flexion and 90° of knee flexion. Surface EMGs were recorded from AM, AL, and Gra. The electrode positions were carefully determined using ultrasonography according to a previous study (2). The exerted force was measured using a load cell. The direction of the load cell was measured from recorded video during MVIC and used as the direction of the force. Root mean square (RMS) of EMG was calculated for 1 s during MVIC for each muscle. The RMS and the direction of the force were plotted in a polar coordinate system as radius and angle from the polar axis, respectively. The centroid of the polar coordinates of the five MVICs was calculated for each muscle. The angle of the centroid in the polar coordinate system was defined as PD of each muscle. The Wilcoxon signed-rank test was used to analyze the differences between PDs and adduction (0°) and between PDs and the anatomical lines of action [AL: 30.0°, AM: −59.6°, Gra: 10.4° (1)]. Data were presented as median (interquartile range).

RESULTS: The PDs of AL [19.8 (15.9 to 27.1)°] and AM [−38.2 (−48.7 to (−32.0)°)] were significantly different ($p < 0.001$) from adduction (0°). Meanwhile, there was no significant difference ($p = 0.276$) between PD of Gra [−3.5 (−12.3 to 3.8)°] and adduction (0°). In addition, PD of AL, AM, and Gra was significantly different from the anatomical line of action in each muscle ($p < 0.001$ to $p = 0.002$).

CONCLUSION: The PD of AL was inclined to flexion and that of AM was inclined to extension compared to adduction (0°). Although AL and AM have been considered as adductors, this study showed that their PDs of EMG activity deviated from "adduction". Additionally, PDs of AM, AL, and Gra were inconsistent with the anatomical lines of action (1). These results suggest that the physiological characteristics of hip adductors are different from the anatomical characteristics.

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DYNAMICS OF NEUROMUSCULAR ADJUSTMENTS TO THE PROGRESSIVE REDUCTION OF EXTERNAL FORCES

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INTRODUCTION: Previous studies have investigated the running pattern adjustments to sudden perturbations, such as unexpected changes in terrain stiffness or height (1). Interestingly, lower body positive pressure treadmills (LBPPTs) allow for progressive unweighting. During the transition phase, positive correlations have been reported between changes in braking force and changes in vasti and soleus muscle activity (2). However, these correlations have not been examined separately for each participant. The current study investigated the dynamics of neuromuscular adjustments to the progressive reduction of external forces, considering individual differences.

METHODS: Forty men (19±1yr) ran on a LBPPT at 100 and 60% body weight. The unweighing transition included 18±3 right strides. Normal ground reaction force and surface EMG activity of 11 lower limb muscles were averaged over the braking phase and normalised to their mean value recorded at 100% body weight. Spearman's correlation tests were used to quantify the relationship between the normalized braking force and EMG activity during the unweighting transition phase. Chi-squared tests were used to compare the proportions of positive and negative significant correlations.

RESULTS: Braking force was positively correlated with VM (ρ=0.67±0.11), VL (0.66±0.10) and RF (0.68±0.10) activity in 65, 60 and 63% of the participants, respectively. It was negatively correlated with STSM (-0.67±0.10) and BF (-0.68±0.10) activity in 50 and 28% of them. Braking force was positively correlated with shank muscle activity in few participants (<13%), but negatively correlated with SOL (-0.59±0.13), GaM (-0.58±0.15), GaL (-0.70±0.15), TA (-0.59±0.10) and PL (-0.63±0.10) activity in 8, 13, 28, 23 and 25% of them. Positive correlations predominated for the quadriceps (VM: X^2=26, VL: 21.2, RF:25, p<.001), whereas negative correlations predominated for the hamstrings (STSM: X^2=20, BF:20, p<.001) and three shank muscles (GaL: X^2=6.4, TA: 6.2, PL: 3.8, p<.05).

CONCLUSION: The progressive reduction of external forces mainly affected thigh muscle activity. It showed a decrease in quadriceps activity, as previously reported (2), but an increase in hamstring activity in most participants. Operating in the optimal range of their force-length relationship, the hamstrings may have contributed to the reduced peak knee flexion during the stance phase (3). On the other hand, unweighting resulted in opposite adjustments in shank muscle activity between participants. Nevertheless, their activity increased in most of them, suggesting an increased ankle stabilisation.

This is attributed to the shift towards a more forefoot strike pattern (3). This adjustment appears be transient as it is no longer observed after 3 minutes of unweighted running (4).

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THE EFFECT OF EXERCISE-INDUCED MUSCLE DAMAGE ON RUNNING BIOMECHANICS AMONG HIGHLY-TRAINED RUNNERS

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INTRODUCTION: The metabolic and inflammatory responses induced by downhill running are well known. Yet, the resulting muscle damage and its influence on biomechanics remain unclear. This study aimed to examine the effects of exercise-induced muscle damage (EIMD) on running biomechanics across a 48-hour recovery period post-exercise.

METHODS: Twenty-six (33.8 ± 9.17 years, 76.2 ± 11.5 kg, 24.8 ± 3.26 kg/m2) healthy participants completed four experimental sessions. The first session participants completed maximal O2 uptake test and anthropometric measurements. Within 14 days, participants performed 60 minutes of downhill running (slope: -10%) at 65% of maximal heart rate. Before (BL), immediately-post (IP), after 24-hour (24H) and 48-hour (48H), participants underwent biomechanics assessments on an instrumented 3D treadmill to investigate changes in kinetic responses (first and second peak of ground reaction forces [GRF] magnitude). Blood markers (i.e., creatine kinase, lactate dehydrogenase and C-reactive protein) and subjective questionnaires by the means of a visual analog scale (VAS) were measured up to 48H post-protocol. Magnetic resonance imaging (MRI) of the quadriceps muscle were performed at BL, 1H and 48H to measure muscle integrity. Mixed-effects models were used to examine differences across all time-points.

RESULTS: Compared to BL, significant decreases in the magnitude of first GRF peak of the left leg were found at IP (-454.01N, $p = 0.015$), 24H (-420.37N, $p = 0.026$) and 48H (-396.14N, $p = 0.033$) while the second GRF peak showed significant decreases at IP (-532.8N, $p = 0.020$), 24H (-524.7N, $p = 0.023$) and 48H (-498.2N, $p = 0.029$) compared to BL. The right leg showed a significant decrease of the first GRF peak at IP (-348.4N, $p = 0.036$), while A significant decrease was observed in the second GRF peak at IP (-467.44, $p = 0.019$) and 24H (-396.89, $p = 0.049$). Significant (all $p < 0.05$) negative correlations were observed between CK concertation at IP and changes in the second GRF peak in both right ($r = -0.685$ and -0.509) and left ($r = -0.701$ and -0.562) legs at 24h and 48h respectively. No significant associations were found between running biomechanics and muscle integrity or subjective perception.

CONCLUSION: Biomechanics measurements remain impaired up to 48 hours following EIMD. These effects are associated with markers of muscle damage and biochemical stress.

RELATIONSHIP BETWEEN THE INITIAL DORSIFLEXION ROM AND THE GASTROCNEMIUS ACTIVATION DURING HEEL DROP STATIC STRETCHING.

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INTRODUCTION: Heel drop static stretching (HDSS) has been commonly applied in gyms and rehabilitation clinics with the purpose of increasing the range of motion (ROM) during ankle dorsiflexion. However, distinctly from other static stretching exercises, HDSS has an eccentric component (1) which may induce a different neuromuscular response of the triceps surae. Indeed, recent evidence has demonstrated an acute increase in the gastrocnemius stiffness following HDSS (1). The purpose of this study was to investigate whether there is an association between gastrocnemius activation during the HDSS and the values of ROM and maximum voluntary isometric torque (MVC) before and after HDSS.

METHODS: 21 participants (10 men) performed 3 sets of 60 s of unilateral HDSS on the dominant leg. Before and after the HDSS the plantar flexion MVC and the dorsiflexion ROM were assessed using an isokinetic dynamometer (Biodex System). During the MVC and HDSS sets, the activity of both gastrocnemius medialis (GM) and lateralis (GL) was measured using high-density surface EMG (64 channels; 8mm IED). The global level of GL and GM activity during the HDSS was estimated from the averaged, normalized (%MVC) root mean square (RMS) amplitude of the active channels (i.e., channels with RMS ≥ 70% of the maximum RMS). The average across sets was considered for the analysis. T-tests were used to compare the ROM and peak MVC before and after HDSS. Pearson correlations were applied between pre- and post-ROM measures, and global activation of GL and GM.

RESULTS: There was a statistically significant increase in ROM after stretching (PRE: 31.12 ± 6.99 degrees, POST: 36.20 ± 8.80 degrees; $P<0.0001$) with a large variability among subjects (relative ROM change from -3% to 44%). Conversely, no significant change was found for the peak MVC (PRE: 115 ± 38,31 Nm, POST: 113.33 ± 35.78 Nm; $P=0.48$). Muscle activity during the stretching was 6.92 ± 5.57 %MVC for the GL and 6.85 ± 5.50 %MVC for GM. The Pearson correlation showed a significant, negative correlation between the pre dorsiflexion ROM and normalized muscle activation for the GL ($r=-057$, $p = 0.010$) and for the GM ($r =-0.516$ $p = 0.023$).

CONCLUSION: The negative correlation between the initial ROM and the muscle activity during HDSS might be explained by an increased muscle length demand for the participants with lower muscle extensibility, who might have a higher

difficulty/discomfort during the HDSS, possibly enhancing miotatic reflexes. In future investigations, Achilles' tendon and gastrocnemius stiffness measures, with elastography, could help elucidating the mechanisms underlying the current results.

SHORT INTER-ELECTRODE DISTANCES UNDERMINE THE SENSITIVITY OF SURFACE ELECTROMYOGRAMS

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INTRODUCTION: With surface electromyography (sEMG), there is an inherent tradeoff between sensitivity and specificity. While specificity is generally acknowledged in the sEMG literature (e.g., crosstalk), only recently has the sensitivity been systematically studied (1, 2). The existence of Type II errors in surface EMG has been formalized (3), but their practical importance has not yet been documented. Specifically, how much does sensitivity affect inferences regarding muscle excitation when using bipolar sEMG?

METHODS: In this study, we used a dense array of surface electrodes to systematically assess this issue for two muscle geometries. With this array, we were able to compute bipolar EMGs for progressively greater inter-electrode distances (IEDs)—from 5 mm to 50 mm, with greater IEDs having greater spatial sensitivity—with all pairs of electrodes being centered roughly at the same skin region over biceps brachii (BB) and gastrocnemius medialis (GM) of 20 healthy subjects (7 women; age: 21–38 years; body mass: 48–88 kg; height: 158–187 cm). Using these signals, we investigated how much the onset of muscle excitation, the quality of surface EMGs (signal-to-noise ratio; SNR), and the coherence between EMG and joint moment were affected by IED. Non-parametric statistics and a Bayesian hierarchical model were used to test the hypothesis that excessively reducing IEDs limits the biomechanical and physiological validity of sEMG signals.

RESULTS: Our results revealed a significant influence of IED on the onset of muscle excitation, quality of the detected signals (SNR), and the association between EMG amplitude and joint torque. The greater the IED, the more sensitive the bipolar signal was to changes in joint torque. In contrast, IEDs shorter than 30 mm resulted in EMG descriptors of dubious validity: physiologically unplausible onset values, spuriously low SNR values, and weaker EMG-force associations.

CONCLUSION: Inter-electrode distance imposes a biophysical constraint on EMG sensitivity. Short IEDs yield EMG descriptors of dubious physiological validity, including the inflation of Type II errors. Owing to sEMG's ubiquitous use, our findings are of general biomechanical and physiological interest. We propose a potentially valid procedure for defining the most appropriate IED to help balance sensitivity and specificity in single bipolar sEMG recordings.

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THE EFFECT OF FATIGUE ON THE MUSCLE ACTIVITY OF ATHLETES WITH AND WITHOUT CHRONIC ANKLE INSTABILITY DURING THE SIDE HOP TEST

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INTRODUCTION: Ankle sprains often occur late in a sports competition. It is important for those returning to sports after an ankle sprain to avoid recurrent injury during fatigue. Although the side hop test is one of the most useful functional performance tests for ankle sprains, the effect of fatigue has not been considered. The purpose of this study was to investigate the effect of fatigue on the muscle activity of athletes with and without chronic ankle instability (CAI) during the side hop test.

METHODS: The study included 24 collegiate athlete volunteers. Among these athletes, there were 13 ankles with CAI (9 men [10 ankles] and 3 women [3 ankles] ; age = 19.4 ± 1.1 years, height = 167.9 ± 6.9 cm, weight = 65.9 ± 10.7 kg, Identification of Functional Ankle Instability [IdFAI] score = 18.8±4.6, mean ± SD) were matched with 13 control ankles without CAI (9 men [10 ankles] and 3 women [3 ankles] ; age = 19.7 ± 1.3 years, height = 168.8 ± 7.3 cm, weight = 65.3 ± 8.2 kg, IdFAI score = 0.5 ± 1.2) by age, height, weight, and sex. Electromyography of the tibialis anterior (TA), peroneus longus (PL), medial gastrocnemius (MG), and lateral gastrocnemius (LG) were measured during the side hop test. The measurements were recorded using surface electromyography (sEMG) and a force plate. For the side hop test, all participants were instructed to hop on one limb laterally over a distance of 30 cm. The force plate defined the lateral and medial contacts during the side hop test. The side hop test was conducted before and after applying the fatigue protocol in the Webster's study. The fatigue protocol included sprints, steps, and jumps. To identify group differences, we used four mixed-design two-way (fatigue-by-group) analysis of variances.

RESULTS: We observed the main effect of fatigue during the side hop test and found that the postfatigue time was longer than the prefatigue time (prefatigue: 7.98 ± 0.84 s vs. postfatigue: 8.37 ± 0.81 s, $p < 0.001$). Group × fatigue interactions were determined for the PL ($F = 6.93$, $p < 0.05$). The PL demonstrated higher muscle activation in the CAI than in the con-

trol following fatigue (CAI: 132.2 ± 70.4 %maximum voluntary contraction [MVC] vs. control: 80.2 ± 35.8 %MVC, $p<0.05$). A significant difference was not detected for the TA, MG, or LG.

CONCLUSION: The fatigue protocol extended the time of the side hop test. Although there was no significant difference in the side hop test time between CAI and control, the activity of the PL in the CAI increased in lateral contact. The different muscle activities are to maintain performance during the side hop test and to control inversion due to ankle instability. Therefore, the side hop test of postfatigue may be an index of returning to sports following ankle sprains.

DOES ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTED INDIVIDUALS HOLD THE SAME ABILITY OF TIME TO STABILIZATION AS HEALTHY INDIVIDUALS DURING SINGLE-LEG LANDING TASKS AFTER RETURNING TO PLAY? - A PILOT STUDY

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INTRODUCTION: Anterior cruciate ligament (ACL) injury is one of the most common non-contact injuries in sports. It often happens to athletes in high-demand sports, such as football, rugby, and baseball. With ACL injuries, they might suffer from short-term mobility problems and long-term functional deficits. Even after anterior cruciate ligament reconstruction (ACLR) and returning to sports, athletes are found to have altered landing strategies in the reconstructed leg and a higher risk of re-injury due to the deficiency of dynamic postural stability. Dynamic postural control is the ability to transition from a moving action to a static state while maintaining stability. Landing tasks and the derivative index— time to stabilization (TTS) are often used as a screening method of dynamic postural control, which provides more stimulation of feedforward components in sensorimotor control and higher ground reaction force than static balancing. Thus, this study would like to discuss dynamic postural control between ACLR athletes and healthy athletes through time to stabilization (TTS) during landing tasks.

METHODS: There were eight ACLR athletes and six healthy athletes recruited in the current study. They were asked to perform two single-leg landing tasks (single-leg forward hop (SLFH) and single-leg vertical jump (SLVJ)) with a force plate (Kistler 9287, Switzerland). Each task would be conducted successfully three times. TTS was defined as the time needed from landing to static state and was collected and calculated from ground reaction force (GRF) in 3 directions (anteroposterior (AP), mediolateral (ML), and vertical (VL))

RESULTS: There was a significant difference between the two groups in MLTTS ($p=.04$) of SLVJ. There were no significant differences in other directions and SLFH. The APTTS, MLTTS, and VTTS of SLVJ in the ACLR group were 1.95±0.62, 2.05±0.62, and 1.40±0.80 seconds, respectively; and in healthy group were 1.81±0.52, 2.02±0.17, and 1.02±0.65 seconds respectively. The APTTS, MLTTS, and VTTS of SLFH in the ACLR group were 6.33±0.21, 2.10±0.59, and1.12±0.57 seconds; and in the healthy group, were 6.31±0.25, 2.24±0.80, and 1.01±0.22 seconds, respectively.

CONCLUSION: Past studies showed that ACLR athletes still had biomechanical knee deficits during vertical jumps, even when they reached horizontal functional symmetry after returning to play. This finding matches our results: the significant difference occurs only while performing SLVJ. Our results also demonstrate the same results as past studies that ML directional control is more challenging. ACLR athletes returning to sports may still have dynamic postural control deficits in ML sides during vertical performances.

THE ESTIMATION OF LEAP PERFORMANCE WITH MAINTAINING OPEN LEGS IN GRAND JETÉ FOR PROFESSIONAL BALLET DANCERS

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INTRODUCTION: Ballet dancers are required to perform the same beautiful movements on both sides of the body for choreographic purposes. However, the evaluation of beautiful movement is ambiguous because there is no specific index for ballet. Therefore, we interviewed ballet instructors about the grand jeté, a dynamic and frequently used movement. The respondents answered that the most beautiful moment was during the leap and it was important to keep the legs open during the leap. Therefore, maintaining the open legs and leaping is considered to be the high performance of the grand jeté. It is considered difficult to maintain more than 50% of the leg-open posture for a short period of time during leaping. But few studies have focused on ballet movement and leg-opening posture.

In this study, we defined the performance of the leg-opening during the grand jeté as whether or not the legs were open for at least 50% of the leap time. The purpose of the study is to examine the relationship between the indexes and the differences in leg opening posture and movement.

METHODS: Fifteen professional ballet dancers (age: 26.5±3.2 years, height: 160.5±3.8 cm, weight: 47.1±3.4 kg) were subjects. The subjects were given an explanation of the study, a consent form, and a brief questionnaire. Kinematic data were obtained from three grand jeté trials on each side. The trial with the highest leaping height was selected for analysis. The mean value of the maximum leg opening angle at the time of leaping was calculated for the trials under analysis. The threshold angles for the three conditions ((1)mean+1SD, (2)mean, (3)mean-1SD) were wet based on the average values. The leg-opening maintenance rate was defined as the percentage of leg-opening retention time divided by the leaping time. In this study, leaping movements with a leg-opening maintenance rate of 50% or higher were evaluated as high performance.

RESULTS: The average leg-opening angle during leaping was 137.2±28.3°. The dancers who maintained 50% or more leg openings in the three conditions during leaping were (1)0, (2)1 dancer on the right, (3)4 dancers on the right, 1 dancer on

the left, and 6 dancers on both conditions. There was no correlation between leaping time and leg-opening maintenance rate.

CONCLUSION: The correlation results suggest that even if the leaping time is longer, it does not necessarily mean that the leg-open posture is maintained. The result of the leg-open maintenance rate suggests that the right grand jeté maintained the leg-open posture for a long period of time than the left-leaping grand jeté. The suggests that there is a left-right difference in leg-open posture performance.

RELATIONSHIPS BETWEEN SPRINT PERFORMANCE AT DIFFERENT PHASES AND SIZE AND DYNAMIC STRENGTH OF THE HIP EXTENSORS

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INTRODUCTION: Sprint performance is known to be strongly related to the size of the hip extensors in both males and females (Miller et al., 2021; 2022). However, less is known about how hip extensor size is related to different phases of a sprint race. Furthermore, although isometric hip extensor strength was reported to be unrelated to sprint performance (Miller et al., 2021), this could be due to a lack of specificity between a static strength measure and the dynamic nature of sprint running. Therefore, this study examined the relationships between sprint race performance, including different phases, with size and dynamic strength of the hip extensors.

METHODS: Forty-six healthy young adults (25 males and 21 females, non-obese [BMI: 18-26] or low-moderate recreational physical activity) participated. T1-weighted axial 3-T MRI scans (FOV: 200*200 mm, slice thickness & gap: 5 mm) of the hip and thigh regions were obtained for each leg to assess muscle volume of the hip extensors (the sum of the gluteus maximus and three biarticular hamstrings). Participants then performed 60-m sprint running, from which the total time (0–60 m) as well as the time of the start (0–10 m), acceleration (10–20 m) and maximum velocity (45–60 m) phases were measured using optical timing gates. One-repetition maximum (1RM) of unilateral hip extension was assessed using a hip extension machine in a standing position (from the hip 90°-flexed to 0° position with the knee kept straight). Each leg was tested for the MRI and 1RM measurements, and averaged values across legs were used for analysis. Partial correlations of sprint performance variables with hip extensor muscle volume or strength were calculated for the whole cohort controlling for sex. Coefficients were compared among the phases by William's t test.

RESULTS: Absolute and relative (to body mass) hip extensor muscle volumes were both moderately correlated with 60-m sprint time ($r = -0.525$ and -0.677). This was also true for the start ($r = -0.447$ and -0.618), acceleration ($r = -0.482$ and -0.653) and maximum velocity ($r = -0.569$ and -0.672) phases. Although the correlations tended to become stronger from the start towards maximum velocity phase for both absolute and relative muscle volume, there were no significant differences in the r values between the phases ($P \geq 0.151$). Absolute and relative hip extension 1RM were also moderately correlated with 60-m sprint time ($r = -0.479$ and -0.599), and weak–moderately correlated with the start ($r = -0.276$ and -0.407), acceleration ($r = -0.449$ and -0.579) and maximum velocity ($r = -0.527$ and -0.610) phases. The correlations of the maximum velocity phase were significantly stronger than those of the start phase for both absolute and relative 1RM ($P < 0.014$).

CONCLUSION: Both muscle size and dynamic strength of the hip extensors correlate with sprint performance, particularly for the maximum velocity phase of sprinting.

Conventional Print Poster

CP-PN04 Nutrition I

LOW CARBOHYDRATE AVAILABILITY IN ENERGY BALANCE FOR FOUR DAYS HAS NO EFFECT ON MARKERS OF BONE FORMATION BUT INCREASES MARKERS OF BONE RESORPTION IN HEALTHY EXERCISING MALES

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INTRODUCTION: Low energy availability and low carbohydrate high-fat (LCHF) diets have both been implicated in the impairment of markers of bone metabolism. However, no study has yet evaluated the effect of LCHF-only in bone turnover markers in controlled laboratory conditions with a multi-day intervention. The aim of this study was to evaluate the effect of 4 days of LCHF compared to a protein and energy-matched, normal carbohydrate diet, in energy balance, while exercising daily. Based on current evidence, we hypothesised that blood markers of bone formation would be suppressed while markers of bone resorption would be increased by LCHF.

METHODS: Healthy trained males (n=8, 27±4 yrs, body mass 79±12 kg, VO2max 54 ± 6 ml/kg/min, body fat 16±4%) completed 4 consecutive days of a LCHF (1.5, 2.4, 3.8 g/kg/day, 12, 19, 69% total energy, from carbohydrates, fat & protein, respectively) and a normal-carbohydrate energy balance (NCEB; 7.7, 2.4 & 1.1 g/kg/day, 62, 19 & 19% total energy, from carbohydrates, fat & protein, respectively) diets in a randomised cross-over design, separated by at least 7 days wash-out

period. Diets were pre-packaged, custom-made, and provided 60 kcal/kg FFM/day energy intake. Exercise was performed daily in the laboratory on a cyclo-ergometer to expend 15 kcal/kg FFM/day, resulting in an energy availability of 45 kcal/kg FFM/day. Venous blood samples were obtained from the antecubital vein every morning in fasted conditions, including the 5th morning after 4 days dietary intervention. Body mass and body composition were measured daily by an 8-electrode phase-sensitive multifrequency BIA (SECA mBCA 515). Plasma samples were analysed for P1NP as a marker of bone formation, and β-CTX, as a marker of bone resorption. Two-way repeated measures ANOVA was performed to detect differences in means, using $p<0.05$ as a threshold of statistical significance. All data are expressed as mean ± SD.

RESULTS: Body mass did not change within groups, but it was reduced on day 5 in LCHF vs NCEB (delta 1.16 ± 0.6 kg, P=0.03), however fat free mass, fat mass, fat mass percentage and total body water remained unchanged, suggesting individuals likely remained in energy balance throughout. P1NP showed no changes (main effects: time, P=0.19; treatment, P=0.755), while β-CTX showed time (P=0.016), treatment (P=0.003) effects and an interaction (P=0.017), increasing on day 5 in LCHF (0.71 ± 0.27 µg/L) vs NCEB (0.57 ± 0.25 µg/L; P=0.017).

CONCLUSION: The main findings are that reducing carbohydrate availability during a 4-day period has no effect on markers of bone formation —which was contrary to our hypothesis— but increases markers of bone resorption. Our findings provide causal evidence that LCHF may be implicated in impairing bone metabolism or accelerating bone remodelling by increasing bone resorption relative to bone formation in the rested, fasted state.

SELF-REPORTED SYMPTOMS OF LOW ENERGY AVAILABILITY AMONG FEMALE ELITE ATHLETES AND CONTROLS

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SPORT SCIENCE

INTRODUCTION: Severe and/or long-term low energy availability (LEA) with and without eating disorders (EDs) is the underlying cause of the syndrome Relative Energy Deficiency in Sports (REDs) with multiple health (e.g., osteoporosis) and performance consequences (e.g., increased injury risk). We aimed to investigate symptoms of LEA among athletes and recreational active people, and the associations with EDs, excessive exercise, and motivation for training and dietary behavioral changes.

METHODS: Swedish female national team athletes [Tier 4, (n=150)] from 26 sports, and recreational active women [Tier 1-2, (n=108)] 18-39 years were recruited via sport organizations and social media. Participants filled out an anonymous on-line survey comprising the LEA in Females Questionnaire (LEAF-Q) [variables; menstrual dysfunction (only scored in non-hormonal contraceptive users), gastrointestinal problems and sport injuries]. A total score > 8 was used as indicative of LEA symptoms. The Eating Disorder Examination Questionnaire (EDE-Q) (a Global score > 2.3 was used as indicative of symptoms of EDs), the Exercise Addiction Inventory (EAI), and the Motivation to Change Questionnaire (MCQ) were also included.

RESULTS: Of all participants, 47.3% had symptoms of LEA [athletes 46.7% (LEAF-Q total score 11.5 ± 3.6), and recreational active women 48.2% (LEAF-Q total score 12.1 ± 3.8)]. Participants with LEA symptoms had a lower body mass (62.9 ± 9.4 vs. 66.3 ± 10.7 kg, p=0.007) and BMI (22.3 ± 2.9 vs. 23.4 ± 3.2, p=0.003), while no differences were found in age (24.8 ± 5.3 vs. 25.3 ± 5.8 years, p=0.389) or training load (13.1 ± 5.5 vs. 13.5 ± 7.3 h/week, p=0.676) compared to those with no symptoms. Most of the participants with LEA symptoms (68.9%) did not have symptoms of EDs. However, when excluding those with symptoms of EDs, participants with LEA symptoms had higher scores of EDE-Q global (1.1 ± 0.6 vs. 0.8 ± 0.6, p=0.001), dietary restraint (1.0 ± 0.9 vs. 0.6 ± 0.8, p=0.010), shape- (1.8 ± 1.1 vs. 1.3 ± 0.9, p<0.001), and weight concern (1.2 ± 0.9 vs. 0.8 ± 0.8, p=0.006) compared to participants without LEA symptoms, as well as a higher EAI score (20.5 ± 3.6 vs. 18.7 ± 4.6, p=0.003), and a perceived reduced ability to increase energy intake (p=0.019) and lower the training load (p=0.006).

CONCLUSION: In the present study symptoms of LEA was equally frequent among elite athletes and recreational active women. Our findings confirm earlier indications that most LEA cases do not have EDs. However, our findings suggest that symptoms of LEA may still be associated with restricted eating and excessive training behaviors as well as focus on body shape and weight. Reversing LEA by increased energy intake or reduced training load or a combination is the only treatment to prevent REDs health and performance implications. Our findings therefore emphasize the need for multidisciplinary prevention and treatment strategies to ensure necessary dietary and training behavioral changes.

THE EFFECT OF A DIGITAL INTERVENTION ON EATING AND WEIGHT CONCERNS AMONG FEMALE ENDURANCE ATHLETES WITH HIGH VERSUS LOW RISK OF EATING DISORDERS

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INTRODUCTION: There is a need to test the effectiveness of digital sports nutrition interventions to increase awareness of adequate energy intake to maintain optimal health and performance among female endurance athletes at risk of long-term low energy availability (LEA) and eating disorders (EDs). Current evidence suggests that female endurance athletes with symptoms of LEA, although with low risk of EDs, may have more eating and weight concerns compared to athletes without LEA symptoms. Additionally, athletes with EDs symptoms may show more resistance to improve their sport nutrition behaviour and reduce eating and weight concerns compared to athletes with no EDs symptoms. Thus, the aim of the present study was to investigate whether a 16-week digital sports nutrition intervention could reduce LEA and EDs symptoms among female endurance athletes with high versus low risk of EDs, respectively.

METHODS: In this multicentre study, female endurance athletes from Norway, Sweden, Germany, and Ireland (n=18) completed a 16-week digital sports nutrition intervention and an online survey pre- and post-intervention comprising the Eating Disorder Examination-Questionnaire (EDE-Q) and the Low Energy Availability in Females Questionnaire (LEAF-Q). Athletes 18-35 years of age with a LEAF-Q score ≥8, without chronic disease and not using hormonal contraceptives were offered the FUEL (Food and nUtrition for Endurance athletes – a Learning program) intervention with weekly sports nutrition videos. Based on a global EDE-Q cut-off score of 2.5, the participants were classified with either low (n=12) or high (n=6) risk of EDs. Group comparisons of the different questionnaire scores using a pre-post format were conducted using a Bayesian mixed factor analysis of variance with default priors and compared to the null model. To calculate the Bayes Factor (BF) for the interaction effect only inclusion probabilities for matched models were considered.

RESULTS: Changes in EDE-Q global score, EDE-Q restraint, EDE-Q eating concern, EDE-Q shape concern, and EDE-Q weight concern from pre- to post-testing did not differ between groups, as indicated by the lack of an interaction effect (BFincl < 1). Nor did changes in LEAF-Q injury, gastro-intestinal, menstrual, or total score from pre- to post-testing differ between groups (BFincl < 1).

CONCLUSION: Findings showed that participation in the FUEL intervention did not create any credible differences in LEA or EDs symptoms among female endurance athletes with high versus low risk of EDs, respectively. However, it is worth noting that the two groups showed a tendency to develop contradictory trajectories from pre- to post-intervention in relation to all LEAF-Q subscales and the EDE-Q eating concern subscale. Future research should therefore continue to further develop digital sports nutrition interventions to promote dietary behavior change in female endurance athletes who have both high and low risk of EDs.

THE EFFECT OF CREATINE MONOHYDRATE ON DUAL-ENERGY X-RAY ABSORPTIOMETRY MEASUREMENTS OF LEAN BODY MASS

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INTRODUCTION: Creatine supplementation (CS) is claimed to be the most safe and efficacious method to augment resistance training (RT)-based gains in lean body mass (LBM). Dual-Energy X-ray Absorptiometry (DXA) is recommended to measure changes in LBM because of its ability to differentiate between bone mineral density, fat mass, and LBM. A limitation of DXA is that LBM measures are affected by hydration status, and CS is proposed to induce water retention in muscle cells. Therefore, changes in hydration status need to be accounted for when using DXA to measure changes in LBM. Studies that have investigated the effect of CS and RT on LBM using DXA have not accounted for potential changes in hydration status due to CS. Based on the current evidence, it is not possible to discern whether changes in LBM measured via DXA result from CS-based fluid retention or muscle growth from CS and RT. We therefore investigated if DXA measurements of LBM measures were affected by potential increases in water retention from CS in healthy, untrained adults.

METHODS: Healthy, untrained adults were randomly assigned to a CS (n=17, 8 female/9 male, 28.5±8.0 years) or control (CO) (n=17, 12 female/5 male, 28.9±10.9 years) group. Both groups underwent DXA scans following an 8-hour fast with no strenuous exercise for 12 hours prior at Day 1 and Day 8. After the first scan, subjects in the CS group ingested 5 g of creatine monohydrate (CM) (True Protein; New South Wales, Australia) once a day for 7 days. Subjects in the CO group received no supplement. All subjects were instructed to maintain habitual dietary habits and physical activity levels. A two-way analysis of covariance (ANCOVA) with one between (CS and CO) and one within (time) factor was used to detect differences in means between time points. Mean change scores of each group were adjusted using participant baseline LBM as the covariate. Significance was set at $p \leq 0.05$. All data are expressed at mean ± SD.

RESULTS: There was no significant difference between groups in LBM change between Days 1 and 8. The mean difference between groups was 0.398 ± 1.953 (95% confidence interval -0.285 – 1.080, $p = 0.243$).

CONCLUSION: Ingesting 5 g of creatine daily for 7 days did not change DXA-measured lean body mass more than the control group. The lack of difference, and similar range of lean body mass change between groups, are likely due to innate lean body mass fluctuations in DXA measures that would occur regardless of creatine supplementation. In studies investigating DXA-measured lean body mass following creatine supplementation and resistance training, it is therefore likely that increases in lean body mass are due to muscular hypertrophy and not creatine supplementation-based fluid retention.

THE BONE-DERIVED COMPONENTS FROM ADULT CHICKENS PROVIDE A PROTECTIVE ACTION AGAINST IMPAIRED BONE METABOLISM IN VDRKO MICE.

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INTRODUCTION: Post-laying hens called adult chickens are characterized by the presence of medullary bone forming a reticular structure in the endocortical domain to store calcium (Ca), which is resorbed during the formation of the eggshell to supply Ca as a major component. The remarkable bone metabolism in which frequent changes in bone formation and bone resorption occur in the laying hens body during the egg-laying cycle, it is considered that therefore medullary bone contributes to Ca homeostasis. Normal Ca homeostasis and bone metabolism are primary requirements to maintain healthy bones in all generations, and the development of higher bone mass by early adulthood ensures lifelong athletic

function. In this study, we tested whether the oral administration of bone-derived components from adult chickens to animals could improve Ca and bone metabolism.

METHODS: The effects of bone-derived components from adult chickens on bone metabolism were investigated in systemic vitamin D (VD) receptor knockout mice (VDRKO), in which VD-dependent Ca absorption and homeostasis are disrupted. Meat samples were prepared from adult chickens or young chickens with no egg-laying experience by pressing meat parts including bones, heat-sterilizing, and freeze-drying. The test diets (adult chicken bone-containing diet and young chicken bone-containing diet) were prepared by replacing 25% of the diet weight with each meat sample. A control diet was used in which the Ca content was matched to that of the adult chicken bone-containing diet. Wild-type mice (WT) and VDRKO were fed one of each diet for 4 weeks from 5 weeks of age.

RESULTS: Hypocalcemia, characteristic of VDRKO, was observed only in the young chicken bone-containing group (young chicken group) and the control diet group and improved to the same level as WT in the adult chicken bone-containing diet group (adult chicken group). This result contributed to the improvement in blood parathyroid hormone levels in the VDRKO, blood PTH levels are decreased within normal range in the adult chicken group whereas severe hyperparathyroidism appeared in the young chicken and control diet groups. The bone phenotype was affected by calcium homeostasis, bone strength was decreased in the VDRKO young chicken and control diet groups, but those values of the adult chicken group recovered to the same level as WT. In addition, micro-CT analysis of the femurs showed a significant increase in cortical bone mineral density in VDRKO adult chicken group compared to the control diet group. The impaired apparent Ca absorption in VDRKO was partly recovered by the dietary treatment, the adult chicken group significantly increased only in female mice.

CONCLUSION: These results suggest that bone-derived components from adult chickens contain two types of VD-independent factors that contribute to bone health, one that improves Ca absorption in the intestinal tract and the other that has a direct improving effect on bone.

THE EFFECTS OF ENERGY, NUTRITIONAL INTAKE AND AGE AT MENARCHE ON BONE MINERAL DENSITY IN RHYTHMIC GYMNASTS

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INTRODUCTION: Rhythmic gymnasts manage their diet and daily training to maintain their body shape. As a result, they are prone to eating disorders, inadequate energy intake, and menstrual dysfunction. Intense training from an early age also increases the likelihood of delayed menstruation and primary amenorrhea. Chronic inadequate energy intake and menstrual dysfunction negatively affect bone mineral density (BMD). This study aimed to examine the associations between energy, nutritional intake and age at menarche and BMD.

METHODS: Thirty-eight female rhythmic gymnasts (mean age = 19.3 ± 1.1 yrs) who have been practicing rhythmic gymnastics since before the age of 10 years participated in this study. We used a questionnaire to obtain responses on the history of rhythmic gymnastics competitions and chronological age. Nutritional intake was assessed using a food frequency questionnaire (FFQ). All participants underwent dual-energy X-ray absorptiometry (DXA) to assess their total body and lumbar spine bone mineral content (BMC), BMD and Z-score. Independent t-tests were used to evaluate the difference between delayed menstruation and BMC as well as BMD. Pearsons correlation analysis, Spearman's rank correlation coefficient and multiple regression analysis were performed to examine the relationship between nutritional intake and BMD as well as BMC. P-value < 0.05 was considered statistically significant.

RESULTS: The average energy intake among the rhythmic gymnasts (1,673 ± 34 kcal/day) was less than activity level III (2,300 kcal/day) of the Japanese Dietary Reference Intakes. The BMD of each gymnast was acceptable and did not present as a Z-score of below -1. After adjusting for energy intake using the residual methods, dietary fibre correlated with lumbar spine BMD ($r = 0.365$, $p = 0.024$) and lumbar spine BMC ($r = 0.409$, $p = 0.011$), while vitamin C correlated with lumbar spine BMC ($r = 0.327$, $p = 0.045$). The mean age at menarche was 15.4 ± 1.4 years. There were no differences in the total body and lumbar spine BMD or BMC of athletes with menarche before or after age 15 years of age. Regression analysis showed that none of the predictors of BMD were significant. Only adjusting for energy intake dietary fibre ($p = 0.035$) was predictive of lumbar spine BMC.

CONCLUSION: Delayed onset of the first menstruation was observed in approximately 70% of all rhythmic gymnasts but there were no significant differences in the BMD or BMC. BMD was high despite deficient energy intake. The results suggest that competition-specific movements and training before the adolescent performed by rhythmic gymnastics may contribute to a high BMD. Further research studies with a larger number of participants and detailed investigations into menstrual function, diets and bone quality are warranted.

EFFECTS OF INTERMITTENT FASTING AND EXERCISE ON UCP1 SIGNALING PATHWAY IN HIGH FAT DIET-INDUCED OBESE MICE

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INTRODUCTION: Obesity has been a worldwide health problem over the past decades. In order to prevent and reduce obesity, it is necessary to reduce caloric intake while increasing energy expenditure. Previous studies have reported that uncoupling protein 1 (UCP1) activation promotes energy expenditure through browning of white adipose tissue (WAT).

Increased energy consumption through the promotion of UCP1 expression in brown adipose tissue (BAT) and browning of WAT, can be potential therapeutic targets to overcome obesity and metabolic diseases. Therefore, it is important to investigate interventions that can stimulate UCP1 and UCP1-related signaling mechanisms. The purpose of this study was to investigate whether intermittent fasting and swimming exercise activate UCP1-related signaling pathways and which intervention is more effective on metabolic parameters.

METHODS: Six-week-old male wild-type C57 BL/6 J mice were used and randomly assigned to the following 4 groups: the control group (CON, n=10), the high-fat diet group (HFD, n=10), the high-fat diet + intermittent fasting group (HFD+IF, n=8), and the high-fat diet + swimming exercise group (HFD+SEG, n=8). Intermittent fasting was treated 24 h fasting and 48 h feeding cycle, and swimming exercise was treated for 90 minutes a day, 5 times a week for 8 weeks.

RESULTS: After 8 weeks of treatment, the intermittent fasting and swimming exercise significantly improved body weight, triglycerides, insulin, and HOMA-IR. In the soleus muscle, AMPKα, PGC-1α, and FNDC5 protein levels were no significant difference between groups. However, in the gastrocnemius muscle, PGC1a and AMPKa protein levels were increased by swimming exercise. In contrast, intermittent fasting did not alter the levels of AMPKα, PGC-1α, and FNDC5 protein in skeletal muscles. In the BAT, the UCP1 protein level was increased by intermittent fasting and swimming exercise. In the subcutaneous fat, only intermittent fasting increased UCP1, but there was no significant difference between groups in UCP1 protein level in epididymal fat.

CONCLUSION: Intermittent fasting and swimming exercise ameliorated HFD-induced metabolic dysfunction. In addition, both intermittent fasting and swimming exercise-induced browning through increased UCP1 expression. However, intermittent fasting increases UCP1 expression independently of signaling mechanisms expressed in skeletal muscle.

INTERACTIVE EFFECTS OF FEEDING STATUS AND EXERCISE INTENSITY ON POSTPRANDIAL GLYCAEMIC CONTROL AND EATING BEHAVIOUR IN INDIVIDUALS WITH CENTRAL OVERWEIGHT/OBESITY

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INTRODUCTION: Pre-exercise feeding and exercise intensity have been shown to independently affect postprandial glycaemic control and energy intake. However, it is unclear whether there is an interactive effect of these two elements on post-exercise postprandial glycaemic control and eating behaviour in adults with overweight and obesity.

METHODS: Twelve (10 men and 2 postmenopausal women) centrally overweight/obese participants (mean ± SD: Age: 40 ± 7 years; waist circumference: 92 ± 9 cm) exercised on a treadmill for 4 km under either fasted or fed (5.5 kcal energy per kilogram body mass; 77% carbohydrate, 16% fat & 8% protein) conditions at either low- (50% V̇O2max) or high-intensity (70% V̇O2max) (FED-LOW, FED-HIGH, FAST-LOW & FAST-HIGH) in a randomised crossover design. After the completion of exercise, a 2-h 75-g oral glucose tolerance test (OGTT) was conducted immediately, followed by a 30-min lunch meal to assess ad libitum energy intake. Venous blood samples were collected at regular intervals throughout each trial to determine differences in glucose and insulin concentrations.

RESULTS: Exercise intensity (% of V̇O2max) during the 4 trials was 48 ± 4% during FAST-LOW, 51 ± 5% during FED-LOW, 71 ± 6% during FAST-HIGH and 71 ± 5% during FED-HIGH. There were differences in the total glucose area under curves (tAUC) during the OGTTs ($p = 0.003$), with both FAST-LOW (21612, 95% CI [19688, 23537] mg/150 min/dL) and FAST-HIGH (21940, 95% CI [20875, 23005] mg/150 min/dL) being higher than FED-LOW (19311, 95% CI [18337, 20285] mg/150 min/dL; both, $p < 0.05$) and FAST-HIGH was greater than FED-HIGH (21940, 95% CI [20875, 23005] versus 19598, 95% CI [18603, 20594] mg/150 min/dL, $p = 0.037$). No differences were found for insulin tAUCs between trials ($p = 0.663$). There was also no difference in ad libitum energy intake during lunch between 4 trials following OGTT (713 ± 441 kcal in FAST-LOW, 708 ± 449 kcal in FED-LOW, 746 ± 454 kcal in FAST-HIGH and 726 ± 450 kcal in FED-HIGH, $p = 0.996$).

CONCLUSION: Exercise in the fed state reduces subsequent postprandial glucose concentrations compared to exercise in the fasted state, irrespective of exercise intensity. Neither feeding status nor exercise intensity altered ad libitum energy intake during a post-exercise lunchtime meal.

THE EFFECTS OF DIET AND SELENIUM-ZINC CO-SUPPLEMENTATION ON BODY COMPOSITION AND EXERCISE PERFORMANCE IN OVERWEIGHT-OBESE INDIVIDUALS

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INTRODUCTION: Zinc and selenium are trace elements that play a major role in many biological processes in the human body (2, 5). Obese people appear to have lower zinc and selenium plasma levels than people with normal weight (3). However, the effect of zinc and selenium on body composition is still controversial (6). Allthough it has been demonstrated that low zinc levels negatively affect physical performance (4), it is still unknown whether zinc supplementation could positively affect exercise performance in this population. This randomized, double-blind, placebo-controlled trial aimed to examine the effects of a hypocaloric diet and selenium-zinc co-supplementation on body composition and exercise performance in overweight-obese individuals.

METHODS: Twenty-eight overweight-obese participants (mean BMI: 29.4 ± 4.7) were randomly 1:1 allocated to the supplementation group (n= 14, 9 females, 31.1± 5.5 yrs) and the placebo group (n= 14, 6 females, 32.1 ± 4.8 yrs). The partici-

pants received supplements of zinc and selenium or placebo tablets for eight weeks. The participants of both groups followed a hypocaloric diet during the intervention. Body composition, cardiorespiratory fitness (VO2max), and functional capacity (sit-to-stand tests, timed-up and go-TUG test, handgrip strength) were assessed before and after the intervention period.

RESULTS: Body fat was reduced, but cardiorespiratory fitness did not change over the intervention. However, some functional capacity tests improved similarly in both groups over the eight-week intervention period ($p < 0.05$). In contrast, a time x group interaction was found in the performance of the TUG test ($p = 0.010$), with the supplementation group improving more.

CONCLUSION: An eight-week zinc and selenium co-supplementation did not affect body composition and exercise performance in overweight-obese individuals. On the other hand, the supplements were effective in terms of improving performance in the TUG test.

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Conventional Print Poster

CP-MH11 Metabolic fitness

INFLUENCE OF TYPE 2 DIABETES MELLITUS DURATION ON THE EFFECTIVENESS OF A LIFESTYLE INTERVENTION: RESULTS FROM THE INTENSITY STUDY

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INTRODUCTION: It is well-established that type 2 diabetes mellitus (T2DM) duration has an impact on the management of the disease. In fact, studies on T2DM reversal suggest that a shorter duration of T2DM presence increases the likelihood of achieving remission. However, it is unclear whether the duration of time an individual has lived with T2DM impacts the response to an exercise intervention. Therefore, the purpose of this study was twofold: 1) to compare the changes in body composition between individuals with shorter and longer durations of T2DM who participated in 28 weeks of aerobic exercise, and 2) to determine whether these changes in body composition are associated with improved glycemia according to T2DM duration.

METHODS: This secondary analysis included thirty-four adults (>19 years old) with T2DM who took part in 28 weeks of aerobic exercise training. Participants were categorized into two groups using pre-established cut-points: 1) short duration T2DM (<5 years) or 2) long duration T2DM (≥5 years). Each group exercised according to the national recommendation of 150 minutes per week of moderate-to-vigorous aerobic exercise (4.5 to 6.0 metabolic equivalents (METs)). Glycemia was measured by glycated hemoglobin (HbA1c), body composition by BodPod, and cardiorespiratory fitness by peak oxygen consumption (VO2peak). All measurements were performed at baseline, 16 weeks and 28 weeks.

RESULTS: Following the completion of the trial, participants in the short duration T2DM group experienced a significant reduction in waist circumference ($F(2) = 8.206$, $p = 0.01$) and an increase in relative VO2peak ($F(2) = 4.094$, $p = 0.05$), while those with a longer duration of T2DM decreased fat mass (kg) ($F(2) = 5.571$, $p = 0.01$) and body fat percentage ($F(2) = 9.243$, $p < 0.01$), and increased fat-free mass ($F(2) = 3.641$, $p < 0.05$). A significant change was observed in HbA1c throughout the 28 weeks of exercise in the short duration T2DM group ($F(2) = 4.643$, $p = 0.04$), but not in the long duration T2DM group. Interestingly, no significant correlations were found between changes in HbA1c and changes in body composition in the short duration T2DM group, but the changes in weight ($r = 0.50$, $p = 0.02$), body mass index ($r = 0.49$, $p = 0.02$), waist circumference ($r = 0.50$, $p = 0.02$), fat mass ($r = 0.54$, $p = 0.02$) and body fat percentage ($r = 0.50$, $p = 0.02$) were significantly associated with the change in HbA1c in those with a longer duration of T2DM.

CONCLUSION: Our data demonstrate that those who have lived with T2DM for a longer duration experienced a greater improvement in body composition, which was significantly associated with the change in glycemia in this group. The results of this study suggest that the duration of T2DM presence affects the response to aerobic exercise.

THE EFFECT OF 10-DAYS OF HOT WATER IMMERSION ON CENTRAL HAEMODYNAMICS, BLOOD PRESSURE AND VASCULAR FUNCTION IN INDIVIDUALS WITH TYPE 2 DIABETES MELLITUS

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INTRODUCTION: Type 2 diabetes mellitus (T2DM) is characterised by progressive insulin resistance, hyperglycaemia and endothelial dysfunction, leading to increased risk of cardiovascular disease. Previous research in healthy adults has suggested that passive heat therapy may provide an alternative to exercise ('exercise mimetic') that can improve vascular health [1], but data are lacking from individuals with T2DM.

METHODS: Fourteen individuals completed a pre-post experimental study whereby central haemodynamics, blood pressure and vascular function were assessed pre- and post- 8-10 x 1 h hot water immersions (HWIs) (40 °C water) undertaken within a 14 day period. During HWIs, body position was adjusted to clamp rectal temperature at 38.5-39.0 °C. Central haemodynamics were assessed via stroke volume index (SVi), cardiac index (Qi), and resting heart rate (RHR) using thoracic impedance cardiography. Resting systolic blood pressure (SBP) and diastolic blood pressure (DBP) were recorded, and brachial flow mediated dilation (FMD) was assessed via ultrasound. Microvascular endothelial function was assessed via transdermal delivery of acetylcholine (Ach) and insulin using iontophoresis. Resting metabolic rate (RMR) was measured using a metabolic cart. Results (mean [SD]) were analysed using a paired t-test or Wilcoxon Signed Rank test for non-parametric data (significance $p < 0.05$) with effect sizes by Cohen's d or Rosenthal's r (non-parametric data).

RESULTS: SVi (pre: 54.6 (13.3) mL·m2, post: 49.4 (11.3) mL·m2, $p<0.02$, d=0.73), RHR (pre: 67 (12) beats.min-1, post: 64 (11) beats.min-1, $p<0.01$, d=0.83) and Qi (pre: 3.6 (0.7) L·min-1·m2, post: 3.0 (0.5) L·min-1·m2, $p<0.01$, d=0.88) were all significantly reduced following 10-days HWI intervention. SBP was also significantly reduced (pre: 136 (19) mmHg, post: 127 (15) mmHg, p=0.03, d=0.63), whereas DBP was unchanged (pre: 81 (11) mmHg, post: 80 (10) mmHg, p=0.56, d=0.15). Neither brachial FMD measures of macrovascular endothelial function (pre: 2.88 (1.81) %, post: 2.45 (1.56) %, p=0.43, d=0.22) nor microvascular function on the forearm were changed (Ach max, pre: 0.40 (0.25) CVC (flux.mmHg-1), post: 0.49 (0.50) CVC (flux.mmHg-1), p=0.63, r=-.09; Ach AUC, pre: 1.52 (1.60) CVC (flux.mmHg-1), post: 2.06 (2.77) CVC (flux.mmHg-1), p=0.63, r=-.09; insulin (insulin max, pre: 0.36 (0.56) CVC (flux.mmHg-1), post: 0.25 (0.33) CVC (flux.mmHg-1), p=0.51, r=-.13; insulin AUC, pre: 1.11 (2.10) CVC (flux.mmHg-1), post: 0.81 (0.99) CVC (flux.mmHg-1), p=0.86, r=-.03). RMR was significantly reduced (pre: 1987 (512) kcal·day-1, post: 1855 (379) kcal·day-1, p=0.045, d=0.59).

CONCLUSION: The present study demonstrates that 10 days HWI can improve SBP and cardiac efficiency in individuals with T2DM but does not improve endothelial function.

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THE INDEPENDENT AND COMBINED ASSOCIATIONS OF CARDIORESPIRATORY FITNESS AND BODY MASS INDEX WITH METABOLIC SYNDROME IN MIDDLE-AGED JAPANESE ADULTS: KZS STUDY

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INTRODUCTION: Despite previous studies suggesting independent associations of poor cardiorespiratory fitness (CRF) and high body mass index (BMI) with the development of metabolic Syndrome (MetS), the combined impact of CRF and BMI on MetS taking into account health-related behaviors has not been thoroughly examined in middle-aged Japanese adults. This study aims to investigate the independent and combined association of CRF and BMI with MetS in middle-aged Japanese adults.

METHODS: A cross-sectional study was conducted using observational data from the KZS study, a 6-month randomized controlled trial in Japan that investigated the effects of structured exercise training on Japanese adults. A total of 417 participants aged 39–64 (mean age: 50.3±6.4) were included in this study. CRF was estimated at baseline using a cycle ergometer, and participants were divided into three categories: high (upper 40%), moderate (next upper 40%), and low CRF (lower 20%). Height and weight, used to calculate BMI, were measured using a stadiometer and a standard scale. Participants were grouped into two categories: obese (BMI ≥ 30) and non-obese (BMI < 30). According to the IDF and AHA/NHLBI criteria, MetS was diagnosed by evaluating the presence of three of the following five risk factors: waist circumference ≥ 85 cm in men or ≥ 90 cm in women, elevated triglycerides ≥ 150 mg/dL, reduced HDL-C < 40 mg/dL in men or < 50 mg/dL in women, elevated systolic blood pressure ≥ 130 mm Hg and/or diastolic blood pressure ≥ 85 mm Hg, and elevated fasting glucose ≥ 100 mg/dL. Binary logistic regression models were used to estimate the odds ratios (ORs) and 95% confidence intervals (95% CIs) with MetS as the dependent variable and CRF, BMI, or the combination of CRF and BMI categories (3*2 groups) as the independent variables. The models were adjusted for age, gender, smoking, drinking, physical activity, sedentary behavior, sleeping, and educational levels.

RESULTS: Results showed that 221(53.0%) of participants had MetS. Compared to those with high CRF, those with moderate and low CRF had adjusted ORs (95%CI) for MetS of 1.62 (1.01–2.59) and 2.27 (1.27–4.06), respectively. The adjusted OR (95%CI) for MetS in obese participants was 2.12 (1.25–3.58) compared to non-obese participants. Furthermore, using non-obese participants with high CRF as the reference, the ORs (95%CI) for MetS in non-obese participants with moderate CRF,

non-obese participants with low CRF, obese participants with high CRF, obese participants with moderate CRF, obese participants with low CRF were 1.53 (0.90-2.59), 2.12 (1.1-4.09), 2.45 (0.77-7.75), 2.63 (1.28-5.39), and 3.86 (1.45-10.29), respectively.

CONCLUSION: Significant independent and combined associations of CRF and BMI with MetS were observed in this study. Therefore, it is important to prioritize targeted and tailored intervention programs to lower BMI and promote CRF in order to prevent adverse short and long-term health outcomes.

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EXERCISE METABOLISM IN INCREASED PROLACTINEMIA: A CASE STUDY

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INTRODUCTION: Prolactin (PRL) is a peptide hormone that is best known for its role in lactation in mammals. PRL has many other functions in regulating the reproductive system, nervous system and metabolism. In humans, normal circulating PRL is <25 ng/mL, whereas hyperprolactinemia is characterised by levels >100 ng/mL and has been linked to insulin resistance, glucose intolerance, and a predisposition to the development of metabolic syndrome. However, nonpregnant premenopausal women with PRL levels between 25-100 ng/mL are rarely studied. This range has recently been proposed to be a homeostatic functionally increased transient prolactinemia (HomeoFIT-PRL) [1]. We identified a HomeoFIT-PRL patient as a case study to perform metabolic testing during rest and exercise in fasted and fed states. We hypothesised that compared to women with normal PRL levels, the HomeoFIT-PRL patient would exhibit high blood lactate, an intermediate metabolite that is strongly associated with diabetes risk in adults [2].

METHODS: We measured blood lactate and glucose concentrations in one nonpregnant 22 year-old female HomeoFIT-PRL patient (PRL of 42-90 ng/mL in the past six months) during an incremental exercise test on a cycle ergometer at 9:00 in the morning in overnight fasted (12 h) and fed states. The fed state involved the patient consuming a mixed meal of 450 kcal (60% CHO, 28% fat, 12% protein) following an overnight fast. Exercise testing began 1 h following completion of the meal. The patient also completed after an overnight fast an oral glucose tolerance test (OGTT), during which glucose and lactate were measured every 15 minutes for 2 h after ingesting a 75 g CHO beverage. A control group of age- and fitness-matched women with PRL <25 ng/mL underwent the same testing to compare with the patient.

RESULTS: During incremental exercise, blood lactate in the HomeoFIT-PRL patient remained low in the fasted state (<2.0 mM) up to ~65% VO2max, after which lactate rapidly increased to >4.0mM. Postprandial lactate decreased from 3.0 mM at pre-exercise to 1.7 mM at ~55% of VO2max, after which lactate increased and remained higher than the fasted state exercise test. During the OGTT, glucose peaked (188 mg/dL) at 30 min and returned to near basal levels (100 mg/dL) by 75 min, while lactate peaked (3.9 mM) at 60 min and remained slightly elevated (1.5 mM) by 120 min.

CONCLUSION: The HomeoFIT-PRL patient in this case study exhibited metabolic responses at rest and during exercise in fasted and fed states that may suggest altered lactate metabolism. Further studies investigating the metabolic profile of HomeoFIT-PRL are warranted in this patient population.

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DEVELOPMENT OF THE KOREAN FIREFIGHTER PERFORMANCE BATTERY: JOB-RELATED PHYSICAL FITNESS ASSESSMENT

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INTRODUCTION: The Candidate Physical Ability Test (CPAT) is used in North America to assess firefighters fitness, but it is difficult to implement in Korean fire stations due to space and cost constraints. This study aims to develop and validate an alternative evaluation method called the Korean Firefighters Physical Ability Test (KFPB). The study found that the KFPB is a valid and reliable tool for assessing cardiorespiratory endurance, muscular strength, and muscular endurance in firefighters. The KFPBs evaluation criteria were classified into quartiles to increase its utilization, and it is an appropriate fitness evaluation tool suitable for Korean firefighters who require a high level of physical fitness.

METHODS: This study was conducted in three parts to verify the validity and reliability of the Korean Firefighters Physical Ability Test (KFPB) and to determine its evaluation criteria. Part 1 involved 20 male firefighters performing both the KFPB and CPAT, with oxygen consumption, heart rate, completion time, and perceived test intensity measured. Part 2 involved 90 novice firefighters (85 male and 5 female) performing the KFPB test-retest with a wash-out period, and completion time was recorded. Part 3 involved 94 novice firefighters (89 male and 5 female) performing the KFPB, and completion time was recorded to determine evaluation criteria.

RESULTS: In Part 1, positive correlations were observed between completion time, heart rate, oxygen consumption, and RPE indicators ($p < .05$). In addition, all eight sections of the CPAT and KFPB had significantly positive correlations (completion time, $r = .322–.664$, $p < .05$; heart rate, $r = .766–.880$, $p < .05$; oxygen consumption, $r = .373–.799$, $p < .05$). In part 2, intra-class correlation indicates an excellent level of 0.91, which satisfies the required level for reliability verification. In Part

3, the completion time, which was classified into quartiles of the KFPB was 441 – 497 seconds for the first grade, 498 – 521 seconds for the second grade, 522 – 599 seconds for the third grade, and 560 –751 seconds for the fourth grade.

CONCLUSION: This study found that the KFPB is a valid and reliable tool for evaluating the physical fitness of firefighters, with strong correlations to the CPAT and an excellent level of test-retest reliability. Evaluation criteria were presented in quartiles. Overall, the KFPB is a suitable fitness assessment tool for firefighters, addressing the limitations of the CPAT, and may help Korean firefighters maintain high fitness levels and perform firefighting activities safely and efficiently.

CHARACTERISTICS OF VISCERAL FAT AREA AND BLOOD PROPERTIES OF JAPANESE OVERWEIGHT MALE UNIVERSITY ATHLETES

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INTRODUCTION: Athletes whose weight affects their performance, eat and train to gain weight. In this case, because the body mass index (BMI) is calculated based on height and weight, many athletes with a BMI ≥25 kg/m2 are classified as overweight. Previous studies have stated that large-sized athletes are associated with body fat percentage (BF%) and risk factors for developing cardiovascular disease. Additionally, we have reported that athletes in various sports with higher BMI also have higher visceral fat area (VFA). However, VFA and blood characteristics of male university athletes with a BMI ≥25 kg/m2 have not been characterized.

The purpose of this study was to clarify the characteristics of VFA and blood properties of Japanese overweight male university athletes.

METHODS: The participants were 39 male university athletes with BMI ≥25.0 kg/m2 (Overweight-Athletes group). The control groups consisted 141 male university athletes with BMI between 18.5 kg/m2 and 25.0 kg/m2 (Normal-Athletes group) and 16 healthy male university students (Non-athletes group).

Anthropometry and blood sampling were performed in the early morning after an overnight fast. The VFA and waist circumference were measured using abdominal bioelectrical impedance analysis (Panasonic, EW-FA90).

Blood parameters were total protein, albumin, aspartate aminotransferase, alanine aminotransferase (ALT), γ-Glutamyl Transpeptidase (γ-GTP), Total-cholesterol (T-cho), low-density lipoprotein cholesterol (LDL-cho), high-density lipoprotein cholesterol (HDL-cho), triglycerides (TG), blood urea nitrogen, creatinine, urinary acid, glucose, and hemoglobin A1c.

RESULTS: VFA was 79.5 cm2 (65.8–111.3 cm2) in the Overweight- Athletes group, which was more than twice as high as that in the Normal-Athletes group ($p < 0.0001$). The percentage of participants with VFA ≥ 100 cm2 in the Overweight-Athletes group was 17/39 (43.6%).

In the Overweight- Athletes group, positive correlations were found between VFA and ALT ($r = 0.408$, $p < 0.01$), γ-GTP ($r = 0.544$, $p < 0.0001$), LDL-cho ($r = 0.330$, $p < 0.05$), and TG ($r = 0.436$, $p < 0.01$).

Within the Overweight-Athletes group, ALT, γ-GTP, and HDL-cho between the Overweight- Athletes group with VFA ≥ 100cm2 and those with VFA < 100cm2. The Overweight- Athletes group with VFA ≥ 100cm2 had higher AST ($p < 0.0001$) and γ-GTP ($p < 0.01$) and lower HDL-cho ($p < 0.05$) than those with VFA < 100 cm2.

CONCLUSION: It is suggested that Japanese overweight male university athletes had a VFA more than twice as high as than that of the normal athletes, and athletes with higher VFA also had higher markers of liver function and lipid metabolism.

ACTOVEGIN IN A NEW PERSPECTIVE – THE EFFECTS ON AEROBIC PERFORMANCE

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INTRODUCTION: Actovegin (Act) is a deproteinized hemodialysate from calf-blood containing more than 200 low-weight molecules. The potential ergogenic effects of Act have previously been investigated, with studies concluding Act has no effects regarding aerobic performance [1]. However, these findings were all found in relation to acute injections with Act. Evidence exists that Act shows enhancing effects on mitochondrial respiration [2] and may alter erythrocyte function as well [3]. Therefore, the aim of this on-going study is to investigate whether Act shows performance enhancing effects with chronic treatment, and whether this effect is additive with aerobic exercise training.

METHODS: A total of 40 healthy adult male mice were included in this study. The mice were divided into 4 groups; Act treated (A), saline treated (C), trained Act treated (AT) and trained saline treated (CT). All mice were treated for 14 days, with injections of either 0.1 ml Act (10mg/ml) or saline every other day. The training intervention consisted of a HIIT protocol, performed every other day by the trained groups (5 bouts of 1 min. at 85-95% of maximal running speed and 2 min. active recovery at 60-65% of maximal running speed between intervals). All mice completed a maximal aerobic performance test before and after the intervention period. High resolution respirometry (Oroboros, O2K) was used to assess skeletal muscle (V. Lateralis) mitochondrial respiration after the 14 day intervention. One-way ANOVA, Two-way ANOVA and Tukey's Multiple comparisons test were used for the statistical analysis, with an alpha-level of 0.05.

RESULTS: The most important novel finding in this study is that chronic treatment with Act has a performance enhancing effect. Both the CT and the AT group improved their aerobic exercise capacity after the 14 day intervention ($p < 0.01$ for

both groups). However, the percentage increase in performance was significantly higher in the AT group (32 %) compared to the CT group (17 %) ($p < 0.01$), showing an additive ergogenic effect of Act with training. Mitochondrial complex I + II linked respiration was significantly increased in the AT group compared to C ($p < 0.05$), showing additive effects of Act treatment with training on mitochondrial function. Neither Act treatment nor training alone showed significant improvements of mitochondrial function.

CONCLUSION: This is the first study showing that Act has a performance enhancing effect. Hence these findings are in rodents it would be highly relevant to investigate in human. Act remains permitted by WADA and other antidoping agencies, but we advocate these institutions to once again consider the status of Act.

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PHYSIOLOGICAL AND METABOLIC ADAPTATIONS TO AN INTENSIVE, MULTI-DAY MOUNTAINEERING EXPERIENCE FOR ACTIVE POSTMENOPAUSAL WOMEN: THE SARDINIA SELVAGGIO BLU WILD TREK

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INTRODUCTION: Outdoor activities are increasingly being recommended as ideal strategies for preventing and contrasting age-related losses in physical capacities, which in postmenopausal women are worsened by the decline in estrogen levels. In this framework, we proposed to evaluate in this population the effects of wild trekking by examining the functional and metabolic adaptations to an intensive, physically, and technically demanding 5-day trek.

METHODS: Six healthy, active postmenopausal women in their sixth decade of life (range 51-60 years old; median body mass index 25) participated in the study. Six men of comparable age, training status and mountaineering skills were also enrolled for gender-based comparisons. The participants traversed the Selvaggio Blu wild trek (Sardinia, Italy) completing a total of 56 kilometers, for an overall height differential of 14301 meters. During all five-days trek, subjects were supervised by two alpine guides. Changes in body composition, cardiorespiratory fitness, and metabolic patterns of energy expenditure were evaluated before and after the intervention.

RESULTS: Total energy expenditure during the trek was significantly higher ($p=0.03$) in women (12.88±3.37 kcal/hour/kg) than men (9.27±0.89 kcal/hour/kg). Extracellular (ECW) and intracellular water (ICW) increased significantly following the trek only in women (ECW: -3.5%; $p=0.02$; ICW: +3.3%; $p=0.002$). The same applied to fat-free mass (+4.3%; $p=0.012$), fat mass (-15.1%; $p=0.012$), skeletal muscle mass (+7.3%; $p=0.013$), and appendicular muscle mass (+5.7%; $p=0.005$. VO2/kg (+12%; $p=0.013$) and fat oxidation (at 100 W: +14.35%; $p=0.024$; at 120 W: +26.26%; $p=0.002$) were found increased in a significant manner only in women.

CONCLUSION: In post-menopausal women, a 5-day, intensive and physically/technically demanding outdoor trekking activity led to significant and potentially relevant changes in cardiorespiratory fitness, body-composition, energy balance and metabolism that are generally attained following quite longer periods of training. The significant changes in cellular hydration indicate that short but intense workouts specifically targeting the musculoskeletal system, such as the trekking experience here administered, have the potential to act as anabolic primers. However, due to the lack of effect among the male participants, who exercised at a lower relative intensity, attention should be put in adequately engaging participants according to their technical skills and physical fitness to achieve meaningful improvements in performance.

CAN PHYSICAL ACTIVITY, SEDENTARY BEHAVIOUR, AND FITNESS MODIFY THE ASSOCIATION BETWEEN SOCIOECONOMIC STATUS AND CORONARY ARTERY CALCIFICATION? A POPULATION-BASED CROSS-SECTIONAL STUDY

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INTRODUCTION: Preclinical markers of coronary artery disease, such as high coronary artery calcification (CAC), have been shown to be associated with socioeconomic status (SES) by residential area in a large Swedish population. However, the prevalence of CAC by other SES measures, such as education, financial strain, and working situation, remains unknown. Furthermore, physical activity's (PA) preventative effects on CAC may differ by SES, sex, domain of physical activity, and fitness level. Thus, in this study we investigated whether the associations between different individual SES factors and CAC, vary by accelerometer-derived physical activity and sedentary behaviour, and fitness.

METHODS: Data were taken from the Swedish CArdioPulmonary bioImage Study (SCAPIS), consisting of 5207 adults (age 50-65 years; 51% women). The SES factors (i.e., education, financial strain, and working situation) were self-reported. CAC was measured using Agaston method of computed tomography, and defined as no CAC (CAC = 0) and any (CAC > 0). Fitness was estimated VO2max derived from a submaximal cycle ergometer test and PA and sedentary behaviours were estimated based on accelerometers worn over 7 days.

RESULTS: Financial strain was associated with CAC in the whole population. However, the association between working situation and financial strain on CAC varied by sedentary behaviour, but only in women. Specifically, sedentary women who were retired or with high financial strain had a greater odds of CAC compared with those who were working/≥50% part-time (Odds Ratio 2.79, 95% confidence interval [1.19-6.52]) or with low financial strain (2.10 [1.14-3.88]). Also, women

who had both poor fitness and SES (either low education, high financial strain, or poor working situation) had a higher odds of CAC than those with both high fitness and good SES, even after adjusting for age, psychosocial factors (i.e., perceived stress, perceived sleep, depressive symptoms), self-reported general health, number of chronic conditions, and lifestyle factors (i.e., current smoking, alcohol abuse, physical activity and sedentary behaviours). This association was also seen in men with poor fitness, but only with the SES factor of low education. In the whole population, having a low moderate-to-vigorous PA level and high financial strain was significantly associated with higher odds of CAC (1.62 [1.05-2.49]).

CONCLUSION: Physical activity and fitness may modify the association between SES and CAC, especially among women. Women who are sedentary and in a poor working or economic situation may be at higher risk of CAC. Fitness levels may help to offset the negative effects of a poor SES on risk of CAC in both men and women.

A NETWORK META-ANALYSIS OF STRATEGIES FOR IMPROVING HORMONAL IMBALANCE IN REPRODUCTIVE-AGED WOMEN WITH OVERWEIGHT OR OBESITY.

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INTRODUCTION: The increasing prevalence of obesity worldwide is threatening reproductive function via, among other factors, hormonal disturbances caused by negative feedback between excess adiposity and the hypothalamic-pituitary-ovarian axis. Therefore, this study aimed to evaluate the comparative efficacy of exercise, diet and pharmacological interventions on the hormonal profile of reproductive-aged women with overweight or obesity.

METHODS: A systematic review was performed by searching PubMed, Scopus, Web of Science, PsycINFO, and Cochrane Library from inception to March 23, 2022, for randomized trials assessing the effects of exercise, diet and/or pharmacological interventions on the hormonal profile in reproductive-aged women with overweight or obesity. We performed frequentist random-effect network meta-analyses and rated the certainty of the evidence. The primary outcomes were serum levels of sex hormonal variations (gonadotrophins, androgens, or estrogens). We further conducted sensitivity network meta-analysis of the primary outcomes by differentiating the effects of different pharmacological interventions.

RESULTS: Among 2572 records screened, 78 full texts were assessed for eligibility resulting in 51 trials (4476 women) included, of which 35% presented a high or unclear risk of bias. Compared with control, i) Exercise combined with pharmacological interventions [mean difference (MD) -0.27, 95%CI -0.40 to -0.15 nmol/L] and adding diet interventions [MD -0.23, 95%CI -0.28 to -0.19 nmol/L] significantly reduced total testosterone levels; ii) Exercise combined with diet and pharmacological interventions [MD 3.11, 95%CI 0.79 to 5.44 nmol/L] and exercise plus diet [MD 2.72, 95%CI 1.14 to 4.30 nmol/L] increased sex hormone-binding globulin levels; iii) Exercise combined with pharmacological interventions produced a large decrease in luteinizing hormone (LH) levels [MD -6.03, 95%CI -10.29 to -1.78 IU/L]. Except pharmacological interventions alone, all the interventions improved weight status compared to controls, with diet as the most effective strategy for reducing body mass index (MD -1.82 kg/m2, [95% CI -2.27 to -1.37]) and waist circumference (MD -4.91 cm, [95% CI -7.07, -2.74])

CONCLUSION: Overall, approaches combining exercise and diet modifications with pharmacological interventions were associated with the best improvement in the hormonal profile in women with overweight or obesity. Compared to controls, exercise combined with pharmacological interventions was more effective than other strategies in reducing LH and total testosterone levels, while diet interventions alone or combined with pharmacological interventions produced larger improvements in weight status. In conclusion, strategies to restore an altered hormonal profile for improving fertility might strongly benefit from incorporating lifestyle changes, possibly leading to more promising reproductive outcomes in obese women wishing to conceive.

Conventional Print Poster

CP-MH12 Physiotherapy I

CHANGES IN MUSCLE STIFFNESS AND THORACIC POSTURE AND ITS ASSOCIATION AFTER COMPUTER TYPING.

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INTRODUCTION: During shoulder stiffness, the trapezius muscle is frequently perceived as uncomfortable and painful. Although some aspects have been partially clarified, the exact mechanisms of a shoulder stiffness have not been elucidated. Recent research suggested that one risk factor of shoulder stiffness is working for a prolonged time (1). However, the relationship between upper trapezius stiffness and posture during work is unclear. The purpose of this study was to clarify the relationship between upper trapezius stiffness and posture while typing on a computer.

METHODS: Twenty-seven healthy young men performed a 30-min computer typing task while sitting. The shear moduli of the upper trapezius were measured in the sitting position using ultrasonic shear elastography before and immediately after the typing tasks. Additionally, the kyphosis angles of the thoracic spine were measured in the sitting position using the Spinal Mouse before and immediately after the tasks. Wilcoxons signed rank tests were used to compare these

measurements before and after the tasks. Kendalls rank correlation (r) was used to assess the correlation between 1) the change in shear moduli of the upper trapezius before and after typing and 2) the change in thoracic kyphosis angle before and after typing.

RESULTS: Wilcoxons signed rank tests showed that the shear moduli of the upper trapezius were significantly higher after the task than before the task. The thoracic kyphosis angle after the task was significantly higher than before the task. Interestingly, we found a negative correlation between the amount of change in shear moduli of the upper trapezius and the amount of change in thoracic kyphosis angle ($r = -0.265$, $p < 0.01$).

CONCLUSION: The results of this study suggest that 1) computer typing causes stiffness in the upper trapezius, 2) an increase in the thoracic kyphosis angle leads to a rounded shoulder posture after typing, and 3) continuous computer typing in the same posture causes the upper trapezius muscle to become more rigid.

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HIP ABDUCTION IS EFFECTIVE FOR STRETCHING THE INDIVIDUAL HAMSTRING MUSCLES

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INTRODUCTION: Stretching in the sagittal plane (hip flexion and knee extension) is generally used for hamstring muscles in rehabilitation. Hamstrings have moment arms at the hip joint in three directions: extension, adduction, and rotation. Since the individual hamstring muscles have different moment arms (1), different stretching positions are predicted to be effective for each muscle. However, it is not clear which direction of stretching is effective for each hamstring. Few studies have examined the effects of stretching positions in the frontal or transverse planes and their combination. The purpose of this study was to clarify the most effective stretching position of the hip joint in the frontal and transverse planes for each hamstring using ultrasonic shear wave elastography.

METHODS: The participants comprised 20 healthy young men (20.9 ± 1.5years, 172.7 ± 5.8 cm, 63.5 ± 7.3 kg). They were randomly placed in nine different positions at 30° of hip flexion and 0° of knee flexion. These positions were combined by three hip adduction/abduction angles (20° adduction, 0° [neutral position], 20° abduction) and three hip rotation angles (30° internal rotation, 0° [neutral position], 30° external rotation): 1) adduction + internal rotation, 2) neutral position + internal rotation, 3) abduction + internal rotation, 4) adduction + neutral position, 5) neutral position and neutral position, 6) abduction + neutral position, 7) adduction + external rotation, 8) neutral position + external rotation, 9) abduction + external rotation. Shear elastic moduli of the right hamstrings (semimembranosus [SM], semitendinosus [ST] and biceps femoris long head [BFlh]) were measured at rest using ultrasonic shear wave elastography in these positions. A two-way repeated measures analysis of variance (ANOVA) and Bonferroni's post hoc test were used to determine the effects of position (adduction/abduction and internal/external rotation) on the shear elastic modulus of each muscle.

RESULTS: The ANOVAs showed the main effects of adduction/abduction in all muscles, and internal/external rotation in the SM and ST with no significant interactions. Post hoc tests showed that the shear elastic moduli of all muscles were significantly higher in the abducted position than in the neutral and adducted positions. In the SM, the shear elastic modulus was significantly higher in the externally rotated position than in the internally rotated position. In the ST, the shear elastic modulus in the externally rotated and neutral positions was significantly higher than in the internally rotated position.

CONCLUSION: The results of this study suggest that 1) the stretching position with a combination of hip abduction and external rotation may be effective for elongating the SM and ST and 2) hip abduction may cause stretching of the BFlh regardless of rotation.

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EFFECTS OF 4-WEEK FOAM ROLLING INTERVENTION ON RANGE OF MOTION, MUSCLE STRENGTH AND KNEE PAIN IN PATIENTS WITH KNEE OSTEOARTHRITIS

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INTRODUCTION: Foam rolling is a self-applied massage using a foam roller and is often used in rehabilitation. Previous studies reported that foam rolling intervention increases range of motion (1) and muscle strength (2). Recently, chronic foam rolling intervention showed to significantly reduce hip pain in patients with hip osteoarthritis (3). Therefore, foam roller intervention may be effective for knee osteoarthritis as well. However, there are no studies investigating improvement in knee function and pain in patients with knee osteoarthritis after foam rolling intervention. The purpose of this study

was to clarify the effectiveness of 4-week foam rolling intervention for improving range of motion, muscle strength and knee pain in patients with knee osteoarthritis.

METHODS: Twenty-three female patients with knee osteoarthritis (age: 74.1±5.1 years, height: 154.2±6.1cm, mass: 60.0±10.0kg) were randomly classified into two groups, a foam rolling group (FR group) and a control group (CON group). The FR group completed foam rolling and strength exercises every day for four weeks, while the CON group performed a sham foam rolling using towel and strength exercises. The participants were evaluated at baseline and after intervention based on the following measurements: knee flexion range of motion (KF ROM), knee extension range of motion (KE ROM), knee flexion maximal voluntary isometric contraction (KF MVIC), knee extension maximal voluntary isometric contraction (KE MVIC), visual analog scale (VAS) of knee pain, and knee pain extent. All measurements were statistically assessed using split-plot 2×2 (group×time) analysis of variance (ANOVA).

RESULTS: ANOVAs showed no significant interaction in all measurements. Time main effects were observed for KF ROM and knee pain extent ($p < 0.05$). The KF ROM was significantly higher at baseline than after intervention, and the knee pain extent was significantly narrower at baseline than after intervention. No changes occurred in KE ROM, KF MVIC, KE MVIC and VAS of knee pain.

CONCLUSION: This study demonstrated that 4-week foam rolling intervention may not be effective for range of motion, muscle strength and knee pain in patients with knee osteoarthritis.

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EIGHT WEEKS OF LOW-VOLUME COPENHAGEN ADDUCTOR EXERCISE CAN IMPROVE ADDUCTOR STRENGTH AMONG YOUNG ATHLETES: A CLUSTER RANDOMIZED THREE-ARM CONTROLLED TRIAL

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INTRODUCTION: Groin injuries are a major problem in multidirectional sports. In order to reduce the risk of sustaining this injury, modifiable risk factors must be tackled. Some programs have been tested using the Copenhagen Adduction (CA) exercise, an adductor exercise proven to improve hip strength. However, in a real environment these programs are modified and substituted for others with lower volumes. Whether these modified programs are effective in improving adductor strength is yet to be elucidated. The primary aim of this study was to assess the effectiveness of two different-volume CA exercise programs on adductor strength throughout 8 weeks. Additionally, secondary aim was to evaluate whether the expected adaptations were maintained for 3 weeks after the cessation of the adductor exercise programs.

METHODS: This cluster randomized control trial involved 3 U-16 rink hockey teams (n= 40) which acted as low-volume group, high-volume group, or controls. Throughout 8 weeks the intervention groups performed an adductor strengthening programme based on the CA exercise. Meanwhile, control group maintained their usual routine. Adduction strength was tested with the five-second squeeze test at baseline, 2, 8 and 11 weeks. Session adherence and adverse events were recorded daily. Repeated measures ANOVA was used to compare for intra and inter group differences.

RESULTS: Both low-volume and high-volume groups exhibited improvements in adductor strength from baseline to 8 weeks compared to control group ($p< 0.001$). No significant differences were observed between intervention groups, despite the slight advantage of performing a higher volume of adductor exercise (low-volume: 12%; high-volume: 17% improvement; $p= 0.32$). Adherence was 95% and 93% in the low-volume and high-volume groups, respectively.

CONCLUSION: In adolescent rink hockey athletes, it seems reasonable to perform low-volume weekly sessions of CA exercise to enhance adductor strength.

AEROBIC+STRENGTH VS. STRENGTH+AEROBIC: WHICH ONE IS THE MORE EFFECTIVENESS TRAINING PROTOCOL ON COGNITIVE FUNCTION IN HEALTHY-SEDENTARY INDIVIDUALS?

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INTRODUCTION: An active lifestyle is important in preventing decreases in functional capacity with age There are several studies that point out the positive effect of exercises programmes on life quality in matters of health. Besides the specified factors related to health, it is reported effects of exercises on the brain positively. In the study, it is aimed to determine whether changing the order of the types of exercises applied to the participants have an effect on cognitive functions.

METHODS: Forty-four young sedentary individuals (32 females; 12 males; age: 42.2 ± 9.6 years; the body height: 162.3 ± 7.8 cm, the body mass: 71.3 ± 14.6 kg, BMI: 26.9 ± 5.1 kg/m2) participated in the study. The Go/No-Go test and the d2 test of attention were used to determine cognitive functions. Participants were divided into two homogeneous groups according to their pre-test scores using hypothesis tests. One group of the participants was defined as aerobic+strength group

and the other as strength+aerobic group. Participants joined to exercise programs prepared in accordance with their age levels for 13 weeks. After the exercise program, the tests were applied to the participants once again.

RESULTS: When the parameters representing the attention and inhibition characteristics of the participants were compared in terms of groups, no significant difference was detected in any parameter. Total number of matters processed (Representing participants psychomotor speed) TN: (U= 128.500; p= 0.787). Nonmarked letters (Representing the selective attention of the participants) E1: (U= 125,500; p= 0.705). Number of correct responses in the Go task. GCR: (U= 128,000; p= 0.768). Number of wrong reactions in the Go task. GWR: (U= 128.000; p= 0.769). Correct response latency in the Go task. CRL: (U= 136.000; p= 1.00). Number of correct responses in the No-Go task. NGCR: (U= 103.500; p= 0.221). Number of wrong reactions in the No-Go task. NGWR: (U= 116.500; p= 0.463). Wrong response latency in the No-Go task. WRL: (U= 117.000; p= 0.494).

CONCLUSION: In the literature, no research has been found that examines the change in cognitive functions when aerobic and strength-based exercise protocols are changed during the intervention. Therefore, these research results will form an important reference in the literature on the subject. In the study, changing the order of intervention of aerobic and strength-based approaches in the exercise program does not make a significant difference on the change of cognitive characteristics of individuals.

505 CHANGE OF DIRECTION ASYMMETRY MAGNITUDE DECREASES ACCORDING TO CHRONOLOGICAL AGE IN MALE AND FEMALE ELITE YOUTH TENNIS PLAYERS: RESULTS FROM AN 11-YEAR LONGITUDINAL STUDY.

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INTRODUCTION: Functional interlimb asymmetry is inherent and can be exacerbated by practicing sports. Predominantly unilateral sports, such as tennis, can potentially increase the magnitude of functional asymmetry. For example, tennis strokes are more often executed on one side of the court, as players tend to use their forehand more than their backhand, resulting in side-to-side differences in COD (i.e., change of direction) tasks. Given that asymmetry in COD already occurs at an early age, and that functional asymmetry has been reported to affect athletic performance, this study aimed to examine the development of 505 COD asymmetry longitudinally in youth elite tennis players.

METHODS: The development of COD asymmetry was assessed yearly (up to six years of monitoring) in 323 male and 235 female youth elite tennis players (aged 6-13 years) using an 11-year longitudinal cohort study design (i.e., 2012-2022). For the 505 COD test, the time to cover a 5 m sprint, perform a 180° turn (i.e., either to the left or to the right) and a 5 m sprint back was recorded for both directions of rotation. All players conducted three trials per direction and were given at least one minute of rest between trials to ensure sufficient recovery. At all test occasions, the dominant (i.e., overall best result) and non-dominant performance (i.e., best test result of the opposite rotation direction) values were determined. The magnitude of asymmetry was calculated as follows: ([dominant performance value–non-dominant performance value] / dominant performance value)*100. Linear mixed effects regression models were used to examine the development of performance and asymmetry in the 505 COD according to players' chronological age and sex. To examine the direction of asymmetry as to which 505 COD performance was dominant across the test occasions within players, kappa coefficients were calculated.

RESULTS: Regardless of sex, both dominant and non-dominant performance values significantly improved ($p < 0.001$) with increasing chronological age. In both the male and female players, an increase in chronological age was related to a significant decrease in 505 COD asymmetry magnitude (i.e., -0.17 ± 2.83% per year). Regardless of age, the male players showed a significantly lower 505 COD asymmetry magnitude (i.e., -0.30 ± 1.00 %) compared to the female players. The kappa coefficients were slight for the male (i.e., k-value = 0.02) and poor for the female (i.e., k-value = 0.00) youth elite tennis players.

CONCLUSION: While the yearly 505 COD performances improved over time, the magnitude of 505 COD asymmetry significantly decreased among both male and female youth elite tennis players according to their chronological age. The large standard deviation as well as the poor to slight kappa values emphasize the individual and direction-specific character of the 505 COD asymmetry metric. Therefore, an individual and time-bounded approach seems warranted if practitioners deem to examine the (development of) functional asymmetry.

SPATIAL GENE EXPRESSION IN RAT TENDINOPATHY FOLLOWING ISOMETRIC LOADING

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INTRODUCTION: Tendinopathy is a significant problem in sport because tendon pain associated with movement impairs performance. Approximately 70% of injuries in high level sport are musculoskeletal sprains, strains, and tears. Despite the huge personal and economic cost of tendon injuries, no new treatments have been proposed for more than 25 years. The lack of novel treatments stems from our poor molecular understanding of the tissue. Isometric rehabilitation exercises have can reduce tendon pain (Rio et al., 2015, 2017; van Ark et al., 2016) and improve tendon structure (Baar, 2019). However, the molecular mechanisms behind those improvements and how to optimize rehabilitation remains unknown. It is our hypothesis that shifting the molecular signature of the injured region of the tendon to that of a developing tendon will result in tendon regeneration.

METHODS: To test this hypothesis, we injured the central core of the right patellar tendon. Fourteen days later, the rats performed a single isometric loading session (4 * 30 s) and tendons were collected six, twelve, twenty-four, and forty-eight hours after isometric loading. Tendons were sectioned longitudinally, stained with Hemotoxylin and Eosin, imaged and then solubilized to release mRNA onto 10X Visium Spatial Gene Expression slides. Image and sequencing files were processed in SpaceRanger (version 1.3.1). Spatial variability was assessed using Moran's I and visualized in the Loupe browser.

RESULTS: AABR07000398 was identified as a spatially expressed gene within the rat patellar tendon. Prior to injury, AABR07000398 is expressed exclusively in the paratenon and the connective tissue surrounding the patellar tendon. Following injury, AABR07000398 becomes the most spatially variable gene, with expression highest in the scar tissue.

CONCLUSION: Cells originating from the paratenon contribute to tendon repair (Dyment et al., 2013). AABR07000398 is a LCCL domain contain protein without a known function that in healthy tendon is expressed in the paratenon. Following injury, AABR07000398 expression is upregulated in the scar and may indicate movement of paratenon cells into the scar or that this gene contributes to tendon repair. We are currently determining the effect of isometric loading on AABR07000398 expression levels.

IMMUNE MONITORING ALONGSIDE FACTORS ASSOCIATED WITH UPPER RESPIRATORY ILLNESS IN ELITE SWIMMERS, OVER AN 8-MONTH TRAINING PERIOD LEADING INTO COMPETITION

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INTRODUCTION: Upper respiratory illness (URI) is the most frequently reported illness in athletes, resulting in lost training time and reduced success at competition. Due to the high physical demands on elite swimmers, individual athletic monitoring of mucosal immunity and identifying risk factors of URI is paramount. Therefore, the current study investigated the effect of training load (TL), sleep and Epstein Barr Virus (EBV) status on salivary immunoglobulin A (sIgA) and self-reported upper respiratory symptoms (URS).

METHODS: Fourteen elite national and international swimmers (age ± SD= 19.9 ± 0.8 years) were observed for 8-months leading into the Commonwealth Games 2018 and Swim Cup Eindhoven. Self-reported URS, sleep quality and saliva samples were collected weekly. The periodised plan of TL for each week was classified by coaches as low, moderate, and high. When this was compared against swimmer's perceived weekly TL intensity, it was significantly correlated (p=0.003) and thus used for analysis. Blood samples were taken at study commencement to determine EBV status and quantitative sleep parameters were measured use wrist-worn actigraphy for 2-week bouts at different time points during the study.

RESULTS: Over the 8-month observation, 70 URS episodes were recorded, leading to 34 days of missed training. Incidence (p=0.011) and severity (p = 0.001) of URS was significantly higher during high TL. Moreover, duration of URS was significantly longer during moderate (p=0.021) and high (p=0.001) TL, compared to low. Eight swimmers (61%) had evidence of past infection with EBV. However, EBV seropositivity had no relationship with incidence, severity, or duration of URS. When sIgA values were normalised to each individual's mean, relative sIgA concentration was 25% lower during URS than when no symptoms were present (p=0.033). Overall, swimmers spent 58% of the season below their individual 'healthy' sIgA average. Finally, average sleep duration was 6.5 hours and total sleep time was significantly lower during high (p=0.008) and moderate (p=0.002) TL, plus average sleep efficiency was 75% throughout the study.

CONCLUSION: The importance of individual athlete monitoring for coaches and physiologists, to identify those at increased illness risk was highlighted. Identification of risk factors associated with URS, such as increased TL, lowered sIgA and inadequate sleep, may allow for modifications in training or other illness preventative strategies. Overall, elite swimmers showed inadequate sleep, therefore promoting the use of sleep hygiene strategies and napping. There was high prevalence of EBV seropositivity for the elite swimmers; however, it was not a predictor of URS. Low participant numbers could be considered for the lack of significant findings with EBV serostatus; there is ongoing debate that individual data and trends may be more useful in elite athletic research, compared to group statistical analysis.

KINEMATIC ALTERATIONS DURING SINGLE-LEG DROP JUMP DUE TO A SUBJECT-ADAPTED FATIGUING PROTOCOL SUGGESTS INCREASED ACL STRAIN

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INTRODUCTION: Whether neuromuscular fatigue is a risk factor for anterior cruciate ligament (ACL) injury is still unclear [1]. This may be due to the lack of control over the fitness level of the study participants in previous studies. Here we characterize how a fatiguing exercise session adapted to the fitness level of each participant alters movement kinematics, evaluating whether these alterations may be associated with an increased risk of ACL lesion.

METHODS: Seven healthy male volunteers (height=1.8±0.07 m, weight=73.5±0.07 kg, age=31±5 years) performed four repetitions of a single leg drop jump (SLDJ) task, before and after a fatiguing session on a cycle ergometer (until exhaustion). The power intensity of this exercise was 10% above the anaerobic threshold of each participant, previously identified by means of cardiopulmonary exercise tests. The SLDJ consists of dropping from a step with one leg (first jump) and, upon touching the ground, jumping as high and as fast as possible (second jump), and finally keeping balance on the landing foot. Leg kinematics was monitored using a motion capture system. Repetition-averaged functional outcomes, as well as

joint angles at foot-strikes, toe-offs and at the end of landings (when the knee is maximally flexed), before and after cycling were compared for the dominant (D) and the non-dominant (ND) legs using two-ways repeated measure ANOVA.

RESULTS: The cycling session caused minimal changes in the height of the second jump (D: Δ=0.4±1.6 cm; ND: Δ=-1.2±1.7 cm) and in the time of contact with the ground between jumps (D: Δ=-0.08±0.1 s; ND: Δ=0.04±0.1 s). During the first jump, post-cycling the non-dominant knee tended to be more extended than pre-cycling at foot-strike (Δ=-4.8±6.3°). At the end of the first landing, there was a tendency to reduce ankle dorsiflexion compared to pre-cycling in both legs (Δ=-1.8±2.3°). During the second jump, the knee was more extended than pre-cycling at foot-strike for both legs (Δ=-2.8±3.0°, $p<0.05$). The knee of the dominant leg tended to be more flexed (Δ=4.6±3.8°) and the ankle of the dominant leg tended to be more dorsiflexed (Δ=1.7±1.8°) at the end of the second landing.

CONCLUSION: The increased knee extension at foot-strike indicates a quadriceps-dominant landing strategy, which is known to cause significant ACL strain [2]. The reduced ankle dorsiflexion at the end of the first jump may originate from increased activity of the ankle extensors muscles. Since these muscles are antagonist to the ACL, such a strategy may increase ACL strain too [3]. Therefore, our subject-adapted fatiguing protocol caused kinematic alterations that may be associated with an increased risk of ACL injury. Additional experiments and analyses will be performed to confirm these results.

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REST-ACTIVITY CIRCADIAN RHYTHM AND DAYTIME ACTIVITY DURING A WEEK OF SPA STAY

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INTRODUCTION: The Rest-Activity circadian Rhythm (RAR) is the marker of the 24h activity. Three main parameters describe it: Midline Estimating Statistic of Rhythm (MESOR), Amplitude and Acrophase. It could be altered in several pathological conditions; thus, maintaining a synchronized RAR is usually considered a good mark for the health status. Its natural decline also occurs with aging, accompanied by decreased physical activity levels [1]. Spas are increasingly popular among the elderly and subjects with chronic pathologies for their beneficial effects on health and for promoting active lifestyles [2,3]. The current study aims to assess RAR and daytime activity levels during a week of a Spa stay.

METHODS: 55 participants (mean age 64±11yrs), 19 males (34.5%) and 36 women (65.5%), staying one week at GB-Hotels (Abano Terme, Italy) and undergoing thermal therapies, wore the Actigraph Motion Watch 8 (CamNtech) to gather RAR and daytime activity data and filled a daily diary. Data from Days 2, 3 and 4 and of Days 5, 6, and 7 were mediated to compare changes between the first and the second period of the stay. Comparisons were adjusted for age, BMI, and sex. FORST funded this study.

RESULTS: The female sample reported a significantly higher weekly MESOR (172.9±41.7 vs 146.7±30.7 a.c., p=0.02), MESOR (173.5±41.3 vs 151.2±35.5 a.c., p=0.02) during the first part of the stay, and MESOR (172.3±48.6 vs 120.6±32.6 a.c., p=0.03) and amplitude (148.5±44.3 vs 120.6±32.6 a.c., p=0.03) during the second part of the stay than the male sample. No statistically significant differences were evident in the total sample between the first and second periods of the stay. Daytime moderate activity was significantly higher in the female than the male sample, considering the weekly (3:43±1:07 vs 2:51±0:47 h:mm, p=0.007), the first (3:51±1:06 vs 2:58±0:48 h:mm, p=0.004) and the second part (3:48±1:16 vs 2:48±0:54 h:mm, p=0.006) of the stay. During the stay, the participants spent, on average, 3:25±1:05 h:mm in moderate activity and 1:14±0:10 h:mm in continuous moderate activity per day. No differences were significant between the first and the second part of the stay in the total sample. From the daily diary, the most reported physical activities were walking, swimming, gym use, and thermal-water gymnastics.

CONCLUSION: Considering the 7-day Spa stay, participants reached 300 minutes per week of physical activity. Thus, the thermal centres and Spa stay, in addition to the beneficial effects on health, seem to be favourable in maintaining an active lifestyle.

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Conventional Print Poster

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INTRA-CRANIAL BLOOD VELOCITIES AND NEUROVASCULAR COUPLING ARE MODIFIED BY MATURITY AND EXERCISE TRAINING STATUS DURING YOUTH

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INTRODUCTION: Neurovascular coupling (NVC) describes the matching of cerebral blood flow to neural activity. Age-related declines in NVC may contribute to neurocognitive disease during adulthood(1). However, elevated cardiorespiratory fitness at 18 years of age reduces the incidence of neurocognitive disease later in adulthood(2). Yet it is not known if cardiorespiratory fitness influences NVC during adolescence. Therefore, we investigated the effect of exercise training-status on NVC at different stages of youth.

METHODS: Sixty-four endurance-trained (males: n=32, females: n=32) and 57 untrained (males: n=28, females: n=29) youths were characterised as pre- (males: n=33, females: n=29) or post- (males: n=27, females: n=32) peak height velocity (PHV). Middle and posterior cerebral artery blood velocities (MCAv and PCAv) and pulsatility index (MCAPI and PCAPI) were assessed via trans-cranial Doppler ultrasound. Resting cerebrovascular data were collected in 121 youths following 15 minutes of supine rest. Percentage change in intra-cranial velocities (ΔMCAv and ΔPCAv) and pulsatility index (ΔMCAPI and ΔPCAPI) were collected during five repetitions of a 30 second visual stimulus in 98 youths. Main effects of maturity status, biological sex and training status were determined via ANOVA. Between-group differences were determined by independent t-tests. Data are reported as group means (±SD).

RESULTS: Post-PHV youth exhibited lower resting MCAv (P≤0.001) and PCAV (P=0.009) than pre-PHV counterparts. Resting MCAv (P≤0.001) and PCAv (P=0.039) were lower in males when compared to females. Resting MCAv was higher in trained youths when compared to untrained counterparts (P=0.010), but there were no training effects during post-hoc comparisons (all; P≥0.05). The ΔPCAv and ΔMCAv during the NVC stimulus were similar in pre- and post-PHV youth (P=0.135 and P=0.671), males and females (P=0.120 and P=0.490) and trained and untrained youth (P=0.204 and P=0.549). Pre-PHV untrained males (16 [12] vs 7 [5] %; P=0.007) and females (18 [11] vs 6 [6] %; P=0.002) had a higher ΔPCAPI than their post-PHV untrained counterparts. However, the ΔPCAPI was similar in pre- and post-PHV trained males (P=0.840) and females (P=0.497). Furthermore, pre-PHV untrained males had a larger ΔPCAPI than trained counterparts (16 [12] vs 8 [6] %; P=0.023).

CONCLUSION: Endurance exercise training elevates MCAv during youth and dampens changes in cerebrovascular pulsatility during visual cognitive tasks in children. Therefore, exercise training during youth modifies cerebrovascular haemodynamics which may protect long-term neurovascular function.

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CYCLING CRITICAL POWER IS RELATED TO HEMOGLOBIN MASS BUT IS INDEPENDENT OF SEX AFTER ACCOUNTING FOR BODY SIZE AND COMPOSITION

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INTRODUCTION: Critical power (CP) is a submaximal aerobic exercise threshold that represents the highest workload sustained entirely through oxidative metabolism. While convective oxygen delivery, which is largely based on hemoglobin mass (Hbmass), may be an important determinant of submaximal aerobic exercise thresholds, to our knowledge, the relationship between Hbmass and CP has not been explored. The primary objectives of this study were to investigate (i) relationships between Hbmass and CP using absolute values and after normalizing data to body mass (BM) and fat-free mass (FFM); and (ii) sex differences in relative Hbmass and relative CP normalized to FFM. We hypothesized that (i) due to the confounding effect of body size, the strength of the relationship between absolute Hbmass and CP would be weakened by normalizing data to BM and FFM; and (ii) normalizing data to FFM would eliminate any sex difference in relative Hbmass and CP.

METHODS: 19 participants (n= 10 females, n= 9 males) performed a 25W/min incremental exercise test to determine maximal oxygen uptake (VO2max). On a separate day, participants performed a modified carbon monoxide rebreathe technique to measure Hbmass and underwent a DXA scan to obtain FFM. Finally, participants completed 3-4 constant load cycling trials to determine CP. Data were analyzed using simple linear regression to investigate the relationships between total Hbmass (g) and absolute CP (W) and between relative Hbmass (g/kg BM and g/kg FFM) and relative CP (W/kg BM and W/kg FFM). Independent t-tests were used to investigate sex differences in relative CP and Hbmass (normalized to FFM).

RESULTS: There was a strong, positive (r=0.724) and statistically significant relationship between total Hbmass and absolute CP (p<0.001, R2= 0.524). Positive, moderate (r= 0.648 and r=0.575, respectively) and statistically significant relationships were also found between relative Hbmass (BM and FFM, respectively) and CP normalized to BM (p=0.003, R2=0.420) and FFM (p=0.01, R2=0.331). When comparing males and females matched for VO2max (mean±SD: 58.5±6.8 vs. 59.0±8.4 mL/kg FFM/min; p=0.88), differences in relative Hbmass (15.2±1.7 vs. 14.1±1.4 g/kg FFM; p=0.13) and relative CP (3.5±0.6 vs. 3.7±0.9 W/kg FFM; p=0.52) were not statistically significant.

CONCLUSION: Hbmass explained approximately one-third to one-half of the variation in CP, depending on how data were expressed: Normalizing data to BM or FFM reduced the strengths of the correlations between Hbmass and CP compared to the relationship between absolute values. Additionally, this study supports a lack of sex differences in relative Hbmass and CP when data are normalized to FFM and the sexes are matched for fitness. To complement this cross-sectional study, future studies should examine if increasing Hbmass through an intervention (i.e., blood transfusion) also increases CP.

DOES CHRONOTYPE AFFECT VO2MAX IN HEALTHY ADULTS?

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INTRODUCTION: Recently a relationship was found between athletic performance and chronotype: an individual's alertness levels during the day. It has been discovered that morning types report to be less fatigued and perform better in the morning compared to evening types and that evening types are more susceptible to decreased performance when performing on a time of day that is not optimal according to their chronotype activity level. However, it has not yet been investigated whether VO2max, an objective marker of aerobic performance, is affected by chronotype.

METHODS: Sixty-five healthy adults, (32 males and 33 females) aged 31 +- 9 years old were included in the analysis. The subject sample had a VO2max of 47,05 +- 8,50 ml/kg^-1/min^-1, BMI of 22,5 +- 2,45 kg/m^2, and fat percentage of 20,13 +- 7,07 %. Subjects performed a maximal incremental exercise test on a cycling ergometer, starting at a power output of 80W and increasing by 30W every three minutes. Post-exercise, self-reported data of the Single Item Chronotyping scale (SIC) was collected to determine the chronotype of participants. The SIC consists of six options for identifying chronotype: 1. Morning type, 2. Evening type, 3. Daytime sleepy type, 4. Daytime type, 5. Highly active type, 6. Moderately active type. Time of day and season were added in the analyses as covariates.

RESULTS: No significant differences in VO2max were observed when comparing groups of different chronotypes (p = 0,089) when correcting for the time of day (p = 0,141). However, correcting for the season showed a trend to significance (p = 0,097). Mean VO2max values were observed to be highest for subjects of chronotype 3 (50,10 +- 9,03 ml/kg^-1/min^-1) and lowest for subjects of chronotype 4 (42,67 +- 8,29 ml/kg^-1/min^-1).

CONCLUSION: These findings contribute to the understanding of the effect of chronotype on physical performance and suggest that VO2max in healthy adults is less affected by chronotype compared to other factors determining athletic performance. However, a trend to significance was found in the data, suggesting that chronotype remains a factor to be studied in relation to physical performance. Coaches should take into account athlete's individual chronotypes and the time of day that training sessions are scheduled. Further research should explore whether other variables affect the relationship between chronotype and VO2max and how chronotype affects the factors that determine VO2max.

ACUTE EFFECTS OF LONG-DISTANCE RUNNING ON HEMATOLOGIC MARKERS (ANEMIA PHENOMENON) IN HEALTHY YOUNG MALE

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INTRODUCTION: Anemia caused by physical exercise is known as pseudo-anemia and it is a positive adaptation to aerobic exercise. Hemoglobin level is decreased because aerobic exercise expands the baseline plasma volume; this reduces the concentration of red cells, which contain the hemoglobin. This increase in plasma volume dilutes the number of red blood cells per volume of blood leading to a pseudo-anemia. On the other hand, urban sports such as 10 Km running have become part of the lifestyle and a platform for social activity. However, there are only a few studies that investigate the acute effect of long-distance running on anemia-related variables, particularly before, 24 h post-workout, and 48 h post-workout.

METHODS: This is quasi-repeated measures study. Ten healthy males were voluntarily in this study (19±1.00yrs, BMI 23.0±2.50). Subjects did not do any workouts for 7 days prior to the experiment. The running intensity was 70%–80% of MHR, and subjects must finish 10 Km. Venous blood collection performed at pre-running, 24 h post-running, and 48 h post-running to measure Hemoglobin (Hb) by cyanide-free hemoglobin spectrophotometry, Erythrocyte, Mean Corpuscular Hemoglobin (MCH), Mean Corpuscular Hemoglobin Concentration (MCHC), Mean Corpuscular Volume (MCV), and Red Blood Cell Distribution Width (RDW) by electrical impedance (hematologic analyzer). All the hematologic measurements were performed at the CITO laboratory in Setiabudi, Semarang. All of the study's procedures have been approved by the institutional health research ethics committee, UNNES (120/KEPK/EC/2020). One-way repeated measures ANOVA was performed to elucidate the differences in means on endpoints. A statistical level of p< 0.05 was accepted. All data are expressed as mean ± SEM.

RESULTS: Hb (gr/dl) were declined at 24h post-running (15.93±0.35), and significant at 48h post-running (15.64±0.51, p< 0.05) from pre-running (16.30±0.38). Erythrocytes (10^6/uL) were declined at 24h (5.54±0.34), and remarkable at 48h (5.42±0.39) from pre-running (5.67±0.37) as p< 0.05. In addition, neither at 24h (28.86±1.87) nor at 48h (28.96±1.87) of MCH (pg) were not different from pre-running (28.85±1.86) as p> 0.05. Furthermore, MCHC (gr/dl) decreases were not significant, at 24h (35.11±0.38), and at 48h (34.98±0.29) compared to pre-running (35.13±0.44) as p> 0.05. Moreover, there were no significant differences in changes of MCV (fl), pre-running (82.21±5.42), 24h (82.14±5.40), and 48h (82.77±5.39) as p> 0.05. At last, RDW (%) were significantly increased both at 24h (13.17±0.80), and at 48h (13.13±0.67) compared to pre-running (13.07±0.77) as p< 0.05.

CONCLUSION: Long-distance running as aerobic physical exercise is able to induce pseudo-anemia, and it is confirmed in the previous studies as the normal physiological adaptation of exercise.

REDUCING METABOLIC INSTABILITY ON TRANSITION TO CONSTANT WORK RATE EXERCISE DECREASES STEADY-STATE OXYGEN UPTAKE.

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INTRODUCTION: Metabolic instability represents the integrative physiological mechanisms underpinning the higher oxygen cost that develops above the moderate intensity domains (1). Although the early metabolic disruption at the onset of exercise might be largely responsible for this metabolic instability, no study has manipulated the exercise protocol to mitigate the early reliance on anaerobic substrate sources prior to attaining VO2 steady state. The aim of this study was to investigate whether approaching a target intensity within the heavy intensity domain through a ramp-to-steady state transition as compared to a square-wave transition would decrease the metabolic cost of steady state exercise.

METHODS: Ten active males and four females participated in this study. VO2max and the power output (PO) demarcating the moderate, heavy, and severe intensity domains were determined through the step-ramp-step protocol (2). On subsequent visits, participants randomly performed: i) a 21-min square-wave transition from 20 W to a constant work rate (CWR) PO corresponding to 75% of the difference between the PO at the gas exchange threshold and the maximal metabolic steady state; ii) a ramp (20 W·min-1) to the same CWR (rCWR) intensity. VO2, lactate concentration ([Lac]; collected every 3-min) and muscle oxygen saturation (SmO2) from the vastus lateralis were measured. The VO2 and VO2 gain (VO2-G) responses during the first 10-min of steady state were smoothed with a 1-min moving average and analysed using the Statistical non-Parametric Mapping method (3). SmO2 during the same 10-min were analysed using a 2-way ANOVA. The average steady state [Lac] collected within the steady state VO2 window, was analysed using paired student t-test. Significance was set at $P < 0.05$.

RESULTS: VO2max was 48.6 ± 8.1 mL/min/kg. VO2 and VO2-G profiles during the rCWR condition (2486 ± 22 mL/min and 10.7 ± 0.2 mL/min/W, respectively) were lower ($P < 0.05$) compared to the CWR condition (2570 ± 24 mL/min and 11.3 ± 0.2 mL/min/W, respectively) during the entire 10-min of steady state. The averaged [Lac] during the rCWR condition (3.39 ± 1.09 mM) was lower ($P < 0.05$) than the CWR condition (4.09 ± 1.25 mM). Whereas SmO2 was stable within the entire 10-min of VO2 steady state during the rCWR condition ($P > 0.05$), the CWR condition elicited unstable responses for the first 8-min at VO2 steady state ($P < 0.05$).

CONCLUSION: This study showed that mitigating the early metabolic perturbation from the square-wave CWR transition (represented by the oxygen deficit), through a rCWR transition to the same PO within the heavy intensity domain, leads to a lower metabolic instability as indicated by a decreased steady state [Lac], which resulted in a reduced VO2 and VO2-G. An improved muscle oxygenation dynamic during the rCWR compared to the CWR might play a primary role for metabolic stability and thus for the decreased metabolic cost of steady state exercise.

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DIFFERENT METHODS FOR DETERMINING THE BOUNDARY DEMARCATING THE MODERATE- FROM THE HEAVY-INTENSITY DOMAIN: REASSEMBLING THE IMPORTANCE OF THE LACTATE THRESHOLD

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INTRODUCTION: Aerobic capacity is one of the most powerful independent predictors of death risk among middle-aged and older men adults [1]. For many years, the Lactate Threshold (LT) was considered the boundary demarcating the moderate- from the heavy-intensity domain according to the well-established, but underutilized, domain schema of exercise intensity [2]. However, percentages of maximal anchors, such as percentages of maximal heart rate (%HRmax) or maximal oxygen uptake (VO2MAX), is the most common method utilized to prescribe training intensities. In healthy middle-aged and older men, the Six-minute Walk Test (6MWT) is also a widely used test for those same purposes. To our knowledge, the comparison of these methods for determining the boundary demarcating the moderate- from the heavy-intensity domain in middle to aged adults has been little investigated. Therefore, the aim of the study was to investigate the applicability of the LT to predict and demarcate the boundary from the moderate- to the heavy-intensity domain (HRm-h) in comparison with the 6MWT.

METHODS: Twelve participants performed 0) a familiarization procedure, 1) a cardiopulmonary treadmill test (CPX) [3], 2) the 6MWT [4], and 3) a discontinuous incremental field test for LT determination [5]. HRm-h was determined using 1)

HRmax obtained in the CPX, 2) peak HR obtained in the 6MWT, and 3) HR at the LT, and stratified by exercise intensity domains [1].

RESULTS: The HRm-h determined by the CPX and the 6MWT was overestimated by 10-20% (P<0.05; ES: 0.5-1.0) compared against the gold-standard LT. HRm-h stratification indicated participants fall into the very light to the vigorous intensity domains. Concerning the HR-6MWT m-h, 8, 8, 75, and 8% of the participants fall into the very light, light, moderate, and vigorous zones, respectively. These percentages for the HR-LT m-h were 25, 33, 33, and 8%, respectively.

CONCLUSION: The wide range of %HRmax at which LT occurs suggests that physical activity programs using exercise intensity prescriptions based on percentages of VO2MAX or HRmax would lack uniformity in the metabolic stress responses among individuals. Implementation of LT testing in physical activity programs might help to improve the quality of the aerobic capacity exercise training in middle-aged and older men.

NO POST-EXERCISE HYPOTENSION RESPONSE AFTER RESISTANCE EXERCISE SESSION REGARDLESS OF THE SET CONFIGURATION IN PHYSICALLY ACTIVE YOUNG PARTICIPANTS

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INTRODUCTION: Post-exercise hypotension (PEH) response after resistance exercise (RE) can be influenced by multiple factors such as the calculation approach (1), the participants characteristics or the exercise protocols (1,2). Set configuration has been shown to be a modulating factor for PEH following a single resistance exercise (3), however this has not been demonstrated for routines composed of several RE involving major muscle groups. The aim of this study was to compare the effect of two different whole-body RT set configuration protocols on PEH response and vascular tone.

METHODS: 32 apparently healthy young participants performed in a random order one control session (CON) and two RT sessions (leg extension, leg curl, lat pull, bench press and parallel squat) differing in the set configuration but with the same intensity (15RM load), volume (200 repetitions) and total resting time (360 s between sets for each exercise and 3 min between exercises): a long set configuration (LSC: 4 sets of 10 repetitions with 2 min rest between sets) and a short set configuration session (SSC, 8 sets of 5 repetitions with 51 s rest between sets). Beat-to-beat blood pressure (BP) was assessed by photoplethysmography (Task Force Monitor, CNSystems, Graz, Austria). Data recordings were performed for 10 min before and for the intervals 20–30 and 30–40 min after each session. PEH was determined by different approaches: I = absolute values, II = [(post-exercise – pre-exercise)/pre-exercise], III = (post-exercise – pre-exercise), IV = (post-exercise – post-control), and V = [(post-exercise – pre-exercise) – (post-control – pre-control)] (2). Additionally, low frequency of systolic BP oscillations (LFsBP) was evaluated.

RESULTS: BP response (i.e., systolic, diastolic, and mean arterial pressure) showed no main effects or interactions among protocols ($p > 0.05$), regardless of the PEH approaches used. Similarly, no main effects or interactions were found for LFsBP ($p > 0.05$).

CONCLUSION: Our findings showed that neither session resulted in a PEH response or change in vascular tone. Both sessions reached far from muscle failure (3) and were performed by young, healthy, physically active individuals with low-normal pre-exercise values (4,5). Therefore, besides training protocol characteristics, the profile of our sample might not be suitable for induce an overall (i.e., at the sample level) hypotensive effect after an acute RE session. Nevertheless, individual responses showed that some participants did experience reductions in BP, according to previous studies that reported that only approximately 65% of people have HPE and sometimes even post-exercise values increase (4,5).

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GUT MICROBIOTA AND PERIPHERAL BLOOD MICRORNAS ARE DIFFERENTIALLY EXPRESSED IN ENDURANCE RUNNERS COMPARED WITH ENDURANCE CYCLISTS

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INTRODUCTION: To date, gut microbiota composition has not been fully investigated in endurance athletes, from different fields, nor the peripheral blood mononuclear cells (PBMC) microRNAs' expression levels. AIM: Determining gut microbiota composition and microRNAs' expression in runners and cyclists, female and male athletes.

METHODS: 31 subjects (13 males) with a mean age of 43.3±7.5 y participated in our study. They included 16 runners, 9 cyclists, and 6 control subjects (active but not competitive). Fecal specimens were collected and analyzed for taxonomic profiling using MetaPhlAn2 to compare the relative abundances of species between experimental conditions based on the results of 16S rRNA analysis. Each participant underwent a maximal oxygen consumption test and a time-to-

exhaustion test at 85% of the measured VO2max. Blood lactate was collected every 5 minutes during the tests as well as venous blood, before and after the tests, to assess microRNA blood levels.

RESULTS: Bacterial alpha-diversity showed a significant difference [P=0.02] between male runners [n=13] and male cyclists [n=6]. Bacterial beta-diversity showed a significant difference [P=0.04] between female [n=8] and male [n=21] athletes. Five bacteria showed higher expression in runners compared to cyclists. There was a significant correlation between some bacteria, including lactate-utilizing bacteria, and improved exercise performance and delayed fatigue in runners, but not in cyclists. Compared with the time-to-exhaustion test, the maximal oxygen consumption test led to higher expression of PBMC microRNAs in runners and cyclists. The runners expressed a higher number of PBMC microRNAs and more diverse ones than the cyclists.

CONCLUSION: Male runners show greater bacterial species richness compared with male cyclists, but not with female runners and cyclists. PBMC microRNAs expression appears to be sport-specific (over-expressed in runners vs. cyclists), and related to exercise intensity. These findings emphasize the differences between runners and cyclists, probably due to the difference in physiological and biomechanical strains related to the mode of activity during training.

Conventional Print Poster

CP-PN01 Nutrition I

THE POST-PRANDIAL PLASMA AMINO ACID RESPONSE DOES NOT DIFFER FOLLOWING THE INGESTION OF A SOLID VERSUS A LIQUID MILK PROTEIN PRODUCT IN HEALTHY ADULT FEMALES

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MAASTRICHT UNIVERSITY

INTRODUCTION: Dietary protein digestion and amino acid absorption kinetics are modulated by numerous factors that, together, define the food matrix. It has been speculated that protein ingested in liquid form is more rapidly digested and absorbed when compared to ingestion in a solid form. Here we assessed the post-prandial plasma amino acid availability following the ingestion of a single bolus of protein provided in either liquid or solid form.

METHODS: 12 healthy, young females were included in this randomized cross-over study. On two separate test days, participants ingested 20 g milk protein concentrate in solid form (protein bar) or in liquid form (protein drink). Products were composed of the same ingredients and, as such, also had the same macro- and micronutrient composition. On both test days, arterialized blood samples were collected frequently for up to 4 h following protein ingestion to assess the post-prandial rise in plasma amino acid concentrations. Plasma amino acid concentrations were compared between treatments by two-factor repeated-measures ANOVA with time and treatment as within-subject factors. Incremental area under the curve, peak concentration and time to peak for plasma amino acid concentrations were compared between treatments using a paired t-test.

RESULTS: Protein ingestion strongly elevated circulating plasma amino acid concentrations (time effect: P<0.001), with no significant differences between treatments (time*treatment effect: P=0.088). The incremental area under the curve of the post-prandial rise in total plasma amino acid concentrations did not differ following bar versus drink consumption (160±73 vs 160±71 mmol·L-1·4 h-1, respectively; P=0.992). Furthermore, no differences in peak amino acid concentrations (3872±481 vs 3833±867 µmol·L-1, respectively; P=0.891) or time to peak (56±20 vs 53±20 min, respectively; P=0.674) were observed between protein bar and drink consumption.

CONCLUSION: Ingestion of protein in liquid or solid form does not modulate post-prandial amino acid availability in healthy, female adults. Differences in protein digestion and amino acid absorption kinetics due to differences in food matrix are not merely attributed to the protein being consumed in solid or liquid form.

POSTPRANDIAL PLASMA AMINO ACID, APPETITE, AND ENERGY INTAKE RESPONSES TO PLANT-BLEND PROTEIN INGESTION IN HEALTHY YOUNG ADULTS

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INTRODUCTION: The muscle anabolic response to some plant-derived proteins is inferior to that of animal-derived proteins, due to a lower content and specific deficiencies of essential amino acids (EAA) (1). Blending different plant-derived proteins could compensate for these deficiencies and may augment postprandial aminoacidemia over single-source plant proteins (2), with possible implications for appetite regulation (3). Indeed, perceived appetite and orexigenic hormonal responses to different sources of dietary protein are yet to be fully elucidated. Therefore, this study assessed postprandial plasma amino acid and ghrelin concentrations, appetite sensations, and ad libitum energy intake following ingestion of a pea-rice protein blend, compared with pea-only and whey protein.

METHODS: In a randomised, double-blind, crossover design, 11 healthy adults (M n=5, F n=6; Mean±SD age: 22±3 years; BMI: 23±3 kg/m2) ingested 0.3 g·kg-1·mass-1 of pea-rice blend, pea protein or whey protein. Arterialised blood samples were collected in the fasted state and over 240-min postprandially. Plasma concentrations of amino acids and ghrelin

were assessed via ultra-performance liquid chromatography mass spectrometry (UPLC-MS) and ELISA, respectively. Appetite sensations over 240-min were measured via Visual Analogue Scales. An ad libitum buffet-style test meal was administered after each trial to assess energy intake. Time-dependent and -independent variables were analysed via repeated measures ANOVA or mixed-effects models, depending on missing data points.

RESULTS: Mean plasma EAA incremental area the under curve (iAUC) was higher in Whey, compared to Pea ($p < 0.01$; mean diff (95% CI): 44218 (15806 to 72631) µmol·240 min·L-1) and Blend ($p < 0.01$; 14358 (16031 to 101121) µmol·240 min·L-1), with no differences between Pea and Blend ($p = 0.67$). Plasma total amino acid iAUC was not different between treatments (all $p > 0.05$). Plasma ghrelin (total) concentrations and subjective ratings of hunger, fullness, and food preferences were transiently altered after protein ingestion (time effect: $p < 0.04$ for all), with no differences between treatments ($p > 0.05$ for all). Ad libitum intake of total energy, carbohydrate, fat, and protein during the test meal were not different between treatments (all $p > 0.05$).

CONCLUSION: In healthy adults, ingestion of the pea-rice protein blend did not augment postprandial aminoacidemia above pea protein, perhaps attributable to only marginal differences in the essential amino acid composition of these proteins. Despite greater plasma essential aminoacidemia following Whey compared to Blend and Pea, no between-trial differences in appetite or energy intake responses were apparent, potentially as the plasma bioavailability of total amino acids did not differ between treatments.

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HIGHER MUSCLE PROTEIN SYNTHESIS RATES FOLLOWING INGESTION OF A BEEF-CONTAINING OMNIVOROUS MEAL COMPARED WITH AN ISONITROGENOUS VEGAN MEAL

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INTRODUCTION: Plant-derived proteins are considered to have lower anabolic potential compared to animal-derived proteins. The anabolic properties of isolated proteins do not necessarily reflect the anabolic response to the ingestion of whole-foods. The presence or absence of the various components that constitute the whole-foods matrix can strongly impact protein digestion and amino acid absorption and, as such, modulate post-prandial muscle protein synthesis rates. So far, no study has compared the anabolic response following ingestion of an omnivorous versus a vegan meal. In this study, we compared post-prandial muscle protein synthesis rates following ingestion of a whole-foods meal (providing 36 g protein) containing 100 g lean ground beef, versus the ingestion of an isonitrogenous, isocaloric whole-foods meal containing only plant-based protein sources (providing 36 g protein) in vivo in healthy, older men and women.

METHODS: In a randomized, counter-balanced, cross-over design, 16 healthy older (65-85 y) men and women underwent 2 experimental test days. On one test day, participants consumed a whole-foods omnivorous meal containing beef as the primary source of protein (36 g protein; MEAT). On the other test day, participants consumed an isonitrogenous and isocaloric whole-foods vegan meal containing only plant-based whole foods as the main sources of protein (36 g protein; PLANT). Primed continuous L-[ring-13C6]-phenylalanine infusions were applied. Blood samples and muscle biopsies were collected frequently for 6 h to assess post-prandial plasma amino acid profiles and muscle protein synthesis rates. Data are presented as mean±SD and were analyzed using two way-repeated measures ANOVA and paired samples t-tests. Effect sizes were estimated by Cohen's d.

RESULTS: MEAT ingestion increased plasma essential amino acid availability more than PLANT ingestion over the 6 h post-prandial period (time x treatment interaction: $P<0.001$) resulting in a greater incremental area under curve (87±37 vs 38±54 mmol/6h/L respectively; paired t-test: $P<0.001$; $d=1.16$). The greater post-prandial plasma essential amino acid availability was accompanied by ~18% higher peak essential amino acid concentrations (1314±144 vs 1111±193 µmol/L respectively; paired t-test: $P<0.001$; $d=1.07$). Ingestion of MEAT resulted in ~49% higher muscle protein synthesis rates when compared to the ingestion of PLANT over the 6 h postprandial period (0.052±0.023 vs 0.035±0.021 %/h, respectively; paired samples t-test: $P=0.037$; $d=0.57$).

CONCLUSION: Ingestion of a whole-food meal containing beef results in greater post-prandial muscle protein synthesis rates when compared to the ingestion of an isonitrogenous and isocaloric whole-foods plant-based meal in healthy, older adults.

EFFECTS OF SHORT-TERM LOW ENERGY AVAILABILITY ON AEROBIC AND ANAEROBIC ENDURANCE CAPACITY IN PHYSICALLY ACTIVE ADULTS

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INTRODUCTION: Low energy availability (LEA) is the underlying cause of the "relative energy deficiency syndrome in sports" (RED-S). RED-S can have serious effects on many body systems, resulting in short- and long-term impairment of optimal health and performance (1). It might lead to decreased muscular glucose utilization, mobilization of fat stores, slowing of metabolism, and decreased endurance performance (2). The study aims to investigate the short-term adaptations of aerobic and anaerobic endurance capacity to determine the effects of different LEA gradients to gain a deeper understanding of its symptoms.

METHODS: 22 participants (f=11, m=11, age 24±1 y, weight 72±12 kg, height 178±8 cm) were included in the randomized controlled study. Over 5 days, 3 different gradients of EA, 45 (control), 30 (EA30) and 10 (EA10) kcal/kg FFM/day, respectively, were used. An incremental treadmill test to exhaustion was performed during pre- and postintervention testing. Submaximal respiratory exchange ratio (RER), absolute V'O2max (L/min) and relative V'O2max (ml/min/kg), maximal heart rate (bpm), submaximal rate of perceived exertion (RPE) and the courses of lactate and glucose concentration in capillary blood samples were measured at the end of each increment and after exhaustion. BIA was performed to determine body weight and composition (fat free mass, fat mass, total body water). All variables were analyzed with one-way ANOVA. All data is presented as means ± SD.

RESULTS: Body weight (Δ: -2.1±1.0 kg; p<0.001) and fat mass (Δ: -1.0±0.7 kg; p=0.04) were reduced in EA10 compared to control. After treatments, the performance parameters showed no significant differences between groups (control, EA30, EA10) in absolute V'O2max (Δ: 0.03±0.24; 0.10±0.16; -0.13±0.05 L/min; p=0.059) and relative V'O2max (Δ: 0.50±3.11; 1.43±2.07; -0.50±1.98 ml/min/kg; p=0.35), maximal heart rate (Δ: -4.50±4.12; -0.86±7.95; -9.40±9.45 bpm; p=0.211), submaximal RPE and the courses in lactate and glucose concentration, respectively (p>0.05). Without influencing maximal (4.3±0.5 m/s) performance, submaximal RER was reduced after increment 1 in EA10 compared to control (Δ: -0.05±0.02; p=0.037), and after increment 2 in EA10 compared to control (Δ: -0.08±0.01; p<0.001) and to EA30 (Δ: -0.05±0.01; p=0.001).

CONCLUSION: The short-term intervention of nutritional energy restriction did not compromise running performance, however caused a metabolic shift from utilization of glucose to increased utilization of fat. A short-term energy restriction might have no negative effect on endurance running performance because of the reduced body weight due to the negative energy balance. Detrimental long-term effects should be considered to protect the athlete's health and performance by avoiding a negative energy balance over a longer period.

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EVEN AT VERY LOW DOSE, CAFFEINE IMPROVES VERTICAL JUMP PERFORMANCE IN A DOSE-INDEPENDENT MANNER

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INTRODUCTION: As we have recently reported (1), moderate doses (i.e., 3–6 mg/kg) of caffeine enhance various athletic performances (1,2), including jumping (3) which is one of the critical components for many sports. Yet, low dosage (i.e., ≤3 mg/kg) caffeine's ergogenicities have also been discussed (4). Lower dose caffeine may become a safe and effective ergogenic strategy, but it is unclear whether the ergogenic effect of caffeine on jump performance is dose-response. Therefore, we examined the effect of very low (i.e., 1 mg/kg) to moderate doses of caffeine, including the upper and lower limits of commonly utilized ergogenic doses (i.e., 3 and 6 mg/kg [5]), on vertical jump performance.

METHODS: Thirty-two well-trained collegiate sprinters and jumpers performed three countermovement jumps (CMJs) and squat jumps (SJs) on a force platform in a double-blind, counterbalanced, randomized, crossover design. Participants ingested a placebo or 1, 3, or 6 mg/kg caffeine 60 min before jumps. Jump heights were calculated by the velocity at jump takeoff using impulse and body mass, given from ground reaction force. Comparisons of jump performance among conditions were performed with one-way repeated-measures ANOVA and a paired Student's t-test with a Bonferroni correction. Relationships between jump height changes in each caffeine dose and interindividual factors were analyzed by the Spearman correlation test.

RESULTS: Compared with the placebo, 6 mg/kg caffeine significantly enhanced CMJ ($P < 0.001$) and SJ ($P = 0.012$) heights; moreover, 1 and 3 mg/kg caffeine significantly increased CMJ height (both $P < 0.01$) but not SJ height (both $P > 0.05$). There were no significant differences among all caffeine doses in both jumps (all $P > 0.05$). Furthermore, ergogenic effects of any caffeine dose on jump heights did not relate to plasma caffeine concentration immediately after jumps and habitual caffeine intake significantly (all $P > 0.05$). However, the ergogenic effects of 1 and 3 mg·kg-1 caffeine were negatively associated with jump height at the placebo condition (i.e., baseline performance level) in both CMJ (1 mg/kg: $\rho = -0.46$, 3 mg/kg: $\rho = -0.44$, both $P < 0.05$) and SJ (1 mg/kg: $\rho = -0.55$, 3 mg/kg: $\rho = -0.53$, both $P < 0.01$), whereas 6 mg/kg caffeine was not (both $P > 0.05$).

CONCLUSION: Even at a dose as low as 1 mg/kg, caffeine improved vertical jump performance in a dose-independent manner. Additionally, these enhancements were independent of plasma caffeine concentration and habitual caffeine intake. However, the ergogenic effects of lower dose caffeine were dependent on athletes' baseline performance. This study is the first to show the ergogenicity of 1 mg/kg caffeine on jump performance and provides new insight into the safe and effective ergogenic strategy in sports science.

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ACUTE CAFFEINE AND SODIUM BICARBONATE CO-INGESTION DOES NOT CAUSE A SUMMATIVE EFFECT ON MUSCULAR ENDURANCE ACCORDING TO MUSCLE SIZE GROUP

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INTRODUCTION: There is a consensus that caffeine (CAF) and sodium bicarbonate (NaHCO3) are sports supplements that, ingested isolated, attenuate and delay fatigue appearance, by improving Ca2+ bioavailability and reducing acidosis, respectively. In muscular endurance performance, both supplements also seem to promote an increase in performance by extending muscle contraction in time and delaying the force production decrement observed in extenuating tasks. However, while the effect of NaHCO3 on muscular endurance is irrespective of muscle size group, CAF ergogenic effect seems to be higher in large compared to small muscle groups due to increased motor unit recruitment and firing rates. Therefore, this study aimed to examine the effect of the acute co-ingestion of CAF and NaHCO3 in upper- and lower-body on muscular endurance performance.

METHODS: Twenty-seven recreationally resistance-trained individuals (male/female: 14/13; age: 24±3 yr; body mass: 69.4±14.1 kg) participated in a double-blind, placebo-controlled, cross-over and randomized study. Participants were assigned to four conditions: a) NaHCO3+CAF; b) NaHCO3; c) CAF; d) placebo (PLA). Participants ingested 0.3 g/kg of body mass of either NaHCO3 or placebo on two occasions at 120 and 90 min before the trial, consuming 0.15 g/kg of body mass each time. Subsequently, 60 minutes before the trial, participants ingested 3 mg/kg body mass of either caffeine or placebo. Then, participants performed two muscle endurance tests of bench press and back squat exercises at 65% and 85% 1RM, performing as many repetitions as possible in one serie until task failure.

RESULTS: No differences in body composition or dietary intake were found among experimental conditions. Compared to PLA, CAF supplementation improved the number of repetitions (ANOVA effect, $P<0.001$), mean velocity (ANOVA effect, $P=0.043$) and mean power (ANOVA effect, $P=0.026$). CAF ingestion stimulates these effects mainly in the squat exercise, particularly at 85% 1RM for mean velocity (4.7%, $P = 0.033$), peak velocity (4.6%, $P=0.034$), mean power output (5.5%, $P=0.022$), peak power output (7.1%, $P=0.023$) and force peak (2%, $P=0.044$) compared to placebo. NaHCO3 and NaHCO3+CAF did not report any statistically significant difference compared to the placebo for any investigated variables.

CONCLUSION: In conclusion, co-ingestion of caffeine and sodium bicarbonate did not promote a synergic effect on muscle endurance performance. Only acute caffeine intake stimulated an improvement in back squat exercise performance, particularly at 85%1RM. This effect on caffeine larger but not in smaller muscle groups (quadriceps vs deltoids) reinforces the central hypothesis suggesting that this substance mechanism of action mainly occurs in the central nervous system. However, this effect can be attenuated when ingested together with NaHCO3, suggesting that this supplement may alter the pharmacokinetics and pharmacodynamics of caffeine.

EFFECT OF ACUTE SODIUM BICARBONATE AND CAFFEINE INGESTION ON HIGH-INTENSITY SPRINT PERFORMANCE

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INTRODUCTION: Caffeine (CAF) and sodium bicarbonate (NaHCO3) are two supplements that provide sports performance-enhancing effects. The acute and isolated ingestion of both supplements improves high-intensity tasks that last between 30 s to 10 min. CAF and NaHCO3 improve Ca2+ utilization in skeletal muscle by increasing its bioavailability and reducing acidosis, respectively. Thus, it can be argued that the co-ingestion of both supplements may produce a summative ergogenic effect on high-intensity exercise. However, this idea has been scarcely studied. Therefore, this study aimed to examine the effect of the acute co-ingestion of CAF and NaHCO3 on high-intensity sprint performance.

METHODS: Twenty-five recreationally-trained individuals (age: 23.3±4.0 years; sex (female/male): 12/13; body mass: 69.6±12.5 kg) participated in this randomized, double-blind, placebo-controlled and cross-over study design. Participants were assigned to four conditions: a) NaHCO3+CAF; b) NaHCO3; c) CAF; d) placebo (PLA). Participants ingested 0.3 g/kg of body mass of either NaHCO3 or placebo on two occasions at 120 and 90 min before the trial, consuming 0.15 g/kg of body mass each time. Subsequently, 60 min before the trial, participants ingested 3 mg/kg body mass of either caffeine or placebo. Then, participants performed four Wingate tests (Wt), interspersed by 1.5 min rest period among them, each one consisting of a 30-s all-out sprint against an individualized resisted-load (7.5% participants' body mass). Before and immediately after the Wt capillary blood samples were collected for lactate assessment.

RESULTS: Peak (Wpeak) and mean (Wmean) power output revealed a supplement (ANOVA, $P=0.029$ and 0.040) and supplement and sprint interaction effect (ANOVA, $P=0.009$ and 0.049). Compared to the placebo, NaHCO3+CAF and NaHCO3 increase Wpeak performance in Wt3 and Wt4 (3-7%, $P<0.05$). While NaHCO3 supplementation increased Wmean performance in Wt3 (4.2%, $P=0.001$). Time to Wpeak and fatigue index (FI) did not report statistically significant supplement or interaction effects. However, both variables, time to Wpeak (-6.7 to -10.3%) and FI (5.4 to 9.3%) reported partial differences in all supplement protocols compared to placebo ($P<0.05$). Finally, lactate showed a supplement plus sprint interaction (ANOVA, $P<0.001$). Differences were found immediately after the Wt4, when comparing CAF+NaHCO3 and NaHCO3 to caffeine (13-17%, $P<0.05$) and placebo (23-28%, $P<0.05$).

CONCLUSION: Although the isolated ingestion of caffeine and sodium bicarbonate improved high-intensity sprint performance, the co-ingestion of both supplements did not stimulate a summative ergogenic effect. Therefore, despite the

potential existence of any pharmacokinetic and pharmacodynamic interaction between caffeine and sodium bicarbonate, in skeletal muscle, the potential ergogenic effect of both supplements on Ca2+ bioavailability and utilization seem not to be synergic.

LOW- VS HIGH-CARBOHYDRATE DIET ON CONTINUOUS GLUCOSE MONITORING METRICS AND PERFORMANCE IN COMPETITIVE CYCLISTS: A RANDOMIZED CROSSOVER TRIAL

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INTRODUCTION: Continuous glucose monitors (CGM) recording minute-by-minute interstitial glucose levels have recently gained popularity among professional endurance athletes for their purported benefits of monitoring and optimizing fueling adequacy around training sessions and competitions, as carbohydrate intakes between and within days are usually arranged according to the goal and the fuel requirements of each training session (1). While GCM use is supported by evidence among active and non-active diabetes patients, data on healthy athletes is still very limited (2). This study aimed to examine the glycemic responses to a short-term low-carbohydrate or high-carbohydrate diet in healthy competitive cyclists while wearing a CGM.

METHODS: This randomized crossover-designed study recruited 13 competitive cyclists with more than 8 hours of training per week (29±10 years, 174±7 cm, 70±9 kg, 309±42 WCP). Participants were asked to follow a 3-day standard run-in diet, followed by 7 days of either a low-carbohydrate (<130 g/day) or high-carbohydrate diet (> 5 g/kg/day) in a randomized order, while a CGM (Abbott Libre Sense) measured their interstitial glucose for 14 consecutive days. On the last day of each diet period, participants underwent a 3-hour training session, including two 3-minute all-out intervals at the start and at the end of the session, and power data was recorded. Glucose data was divided into sleep and wake phases and analyzed using the iglu Shiny app. Mean glucose levels, coefficient of variation (CV), and mean amplitude of glycemic excursion (MAGE) metrics were considered as main outcome variables. A MANOVA for repeated measures was conducted to test differences between diet periods.

RESULTS: When analyzing the treatment (diet) effect, no significant variations were reported for any of the collected variables, neither during sleep nor wake time (all $p \geq 0.05$). A different glucose distribution over time in the zones (<70, 70120 mg/dL) was reported, with the high-CHO period showing a wider distribution in the three zones. When participants consumed the diet high in carbohydrates, average power was higher in both 3-minute intervals (+5.9±5.5%, $p<0.01$), and there was a smaller decrease in power output between the initial and final burst (-5.1±4.5%, $p=0.003$) compared to the low-carbohydrate week (-6.6±5.1%, $p=0.002$).

CONCLUSION: While CGM may provide a fast and an easy snapshot of interstitial glucose levels, in this study glucose metrics seemed to not be influenced by diet in healthy competitive cyclists. However, performance during the 3-min bout was worse in the low-CHO period, as well as the within session power decrement. The usefulness of this technology for optimizing off- and on-the-bike fueling strategies to improve training adaptations and performance remains to be determined and requires further investigation.

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RELATIONSHIP BETWEEN BLOOD GLUCOSE CONCENTRATION AND RUNNING PERFORMANCE DURING HALF-MARATHON RACE IN WELL-TRAINED DISTANCE RUNNERS

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INTRODUCTION: Well-trained distance runners exercise at an intensity of >80% of maximal oxygen uptake during half-marathon running. Carbohydrates are the primary energy source during intense-intensity running. During the half-marathon race, runners almost not be stuck by a sudden feeling of exhaustion described as "hitting the wall", due to a lack of glycogen stores or absence of suitable energy source. Consuming more carbohydrates is considered to have a positive effect on half-marathon running performance. Blood glucose concentration (BGC) during high-intensity cycling exercise is shown to be higher in well-trained cyclists than in untrained cyclists (Coggan et al., 1995; Kjaer et al., 1986). Therefore, we aimed to clarify the relationship between BGC during half-marathon race and running performance by continually measuring BGC during the race.

METHODS: Fourteen well-trained male distance runners, with a mean seasonal best time of 29:40.0±37.5 for 10,000 m, competed in an official half-marathon race. In all runners, BGC was continuously monitored every 15 min from 24 hours before the race to the end of the race using a glucose monitor system (FreeStyle Libre, Abbott Japan, Japan). Analyses used BGC 5 h before the race (Gpre), peak BGC during the half-marathon race (Gpeak), and mean BGC during the race (Gmean). Additionally, mean running speed during the half-marathon (sHM) and difference in running speed between the first 5 km and the last 6 km of the half-marathon (Δspeed) were calculated as running performance variables. Pearson's

correlation coefficient was used to assess the relationship between BGC and running performance variables. The significance was set at a P value of <0.05.

RESULTS: Mean Gpre, Gpeak, and Gmean were 87.8 ± 13.5, 191.4 ± 53.2, and 167.8 ± 43.8 mg/dL, respectively. The half-marathon finish time and sHM were 66:03 ± 2:45 and 320 ± 13 m/min, respectively. The Δspeed was 22 ± 23 m/min. The Gpeak and Gmean were significantly associated with sHM (r = 0.69 and 0.75, respectively; P < 0.05) and Δspeed (r = −0.67 and −0.73, respectively; P < 0.05).

CONCLUSION: Runners maintaining a high BGC during the half-marathon race had a superior running performance. Furthermore, running speed in the second half of the race decreased more in runners with lower BGC than in those with higher BGC. These results suggest that continuous BGC monitoring and maintaining a high BGC might contribute to superior half-marathon performance.

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DYNAMICS OF GUT MICROBIOTA DURING A CYCLING GRAND TOUR IS RELATED TO EXERCISE PERFORMANCE AND MODULATED BY DIETARY INTAKE

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INTRODUCTION: Regular exercise has been described as a factor modifying both the diversity and the relative abundance of certain bacterial phyla or families, although the few studies that have been carried out on this show important methodological differences and divergent results. To our knowledge, the effect of a cycling stage race on the gut microbiota composition and metabolic activity of professional cyclists has not been analysed. Studying the composition of the intestinal microbiota in this context can help both to understand its potential modulatory role in the response to exercise and to optimize and personalize the use of supplements. The aim of this cohort study was to analyse the dynamics of faecal microbiota composition of professional cyclists over a Grand Tour, and their relationship with performance and dietary intake.

METHODS: 16 professional cyclists competing in La Vuelta 2019 were recruited. Faecal samples were collected at four time points: The day before the first stage (A); After 9 stages (B); After 15 stages (C); On the last stage (D). Faecal microbiota populations were analysed using 16S rRNA sequencing. Dietary intake before and during La Vuelta 2019 was recorded by means of semiquantitative food frequency questionnaires.

RESULTS: A principal component analysis (PCA) followed by Generalized Estimating Equation (GEE) models were carried out to explore the dynamics of microbiota and its relationship with performance. Bifidobacteriaceae, Coriobacteriaceae, Erysipelotrichaceae, and Sutterellaceae dynamics showed a strong final performance predictive value (R2=0.83, ranking and R2=0.81, accumulated time). The abundance of Erysipelotrichaceae at the beginning of La Vuelta was directly related to the previous intake of a complex-carbohydrate-rich foods, while during the competition the abundance of Bifidobacteriaceae was negatively affected by the intake of simple carbohydrates from supplements.

CONCLUSION: An ecological perspective represents more realistically the relationship between gut microbiota composition and performance, compared to single-taxon approaches. The composition and periodisation of diet and supplementation during a Grand Tour, particularly carbohydrates, could be designed to modulate gut microbiota composition that allow better performance.

Conventional Print Poster

CP-AP02 Training and Testing I

COMPARISON OF SLEEP HEART RATE VARIABILITY MEASURED WITH THE OURA® RING TO A CONVENTIONAL MORNING MEASUREMENT WITH A HEART RATE MONITOR

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INTRODUCTION: Resting heart rate variability (HRV) is a non-invasive measure of the autonomic regulation of the myocardium; it can be used to monitor the response to training. The most common practice is to measure HRV upon awakening. Devices measuring HRV throughout the night are now available. They may contribute to improving measurement assiduity, an important factor for valid tracking (1). The aims off this study were to: 1) Compare sleep HRV measured with the OURA® ring (Oura Health Oy, Finland) during the night to a morning measurement at rest with a conventional heart rate monitor. 2) Examine the relation between acute:chronic workload ratio (ACWR) and the HRV measured with both methods.

METHODS: During a 3-week training period, 14 female soccer players (15-16 years) wore the OURA® ring during sleep and were instructed to record their post-awakening morning HRV with a commercial heart rate monitor (polar H10, Polar Electro Oy, Finland) paired to a mobile app (Elite HRV, USA). In parallel, they recorded the duration and rating of perceived exertion (RPE) of every training session with an athlete monitoring system (XPS Network®, Sideline Sports, USA) to obtain a daily session-RPE (sRPE). The ring computes the root mean square of the differences between successive heartbeats (RMSSD) for every 5-min of continuous sleep throughout the entire night. The mobile app paired to the heart rate monitor was set to record heart rate for 3-min supine. The first minute was used as a stabilization period and only the last 2-min were used for analysis (2). The average of all 5-min recording at night was compared to the 2-min supine morning recording. For ACWR, a 7-day and a 28-day exponentially weighed moving average of sRPE was used to calculate acute and chronic fatigue (3). Relation between ACWR and each HRV methods were assessed using mixed effects models. Athletes with fewer than 3-weekly measurements for either method were excluded from the evaluation of the relationship with ACWR (1).

RESULTS: Throughout the 3-week period, compliance was greater for the ring with 81% vs 56% for the morning measurement ($P = 0.002$). No difference was observed between methods ($P = 0.886$) with an average RMSSD of 82.2 ± 43.4 ms and 78.5 ± 38.9 ms for the morning and the ring measurements respectively. The mean bias between measurement methods for RMSSD was 3.7 ms and the limits of agreements were -91.9 to 99.2 ms. A relationship was observed between nighttime RMSSD and ACWR ($P = 0.038$; $n = 152$) whereas it was not the case between morning RMSSD and ACWR ($P = 0.3$; $n = 137$).

CONCLUSION: As HRV measurement with the OURA® ring was related to the athletes' ACWR and a better adherence towards its use was observed, our results suggest that the monitoring of HRV with the ring may be a preferable alternative to the conventional method.

This project was supported by Soccer Québec. Authors have no conflict of interest to declare.

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AI-SMARTPHONE MARKERLESS MOTION CAPTURING OF COUNTER-MOVEMENT-JUMP KINEMATICS

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INTRODUCTION: A motion capture technology that comes at a low cost and requires no additional hardware could act as a game changer that allows assessing kinematic data in field studies (1). In the present study, we developed and validated a novel markerless, smartphone video-based artificial intelligence (AI) motion capture system that utilizes deep learning techniques to calculate and analyze body movements. The novel system estimates 3D kinematics from 2D video sequences and can thus detect and analyze e.g. movement in the sagittal plane from a frontal view. We validated the system by obtaining and comparing lower limb counter-movement-jump (CMJ) kinematics to those of a gold-standard method.

METHODS: Thirteen participants (1 female), age 28 (± 9) years performed six CMJs. We used 2D videos created by a smartphone (Apple iPhone X, 4K, 30 fps), mounted on a tripod, and placed in front of the participants to create 18 different key points which together build a full skeleton including joints and their connections. The key point locations are estimated in 2D pixel coordinates and create a 360° pose estimation and resulting joint angles (flexion and extension). Body parts and skeletal key points are recognized and localized by calculating confidence maps using a multi-level Convolutional Neural Network that integrates both spatial and temporal features and does not require any additional sensors or hardware (2). We evaluated and validated the angular response over the entire movement against a gold standard Vicon motion capture system using Pearson's r correlation coefficients as well as the Mean Average Error (MAE) and Mean Squared Error (MSE).

RESULTS: Pearson correlation coefficients (r) for shoulder, hip, and knee angular progressions in the sagittal plane during the entire movement were reported as .97, .99, and .99, respectively. MAE was calculated in degrees and reported as 3.18 for the shoulder, 2.24 for the hip, and 2.18 for the knee angle. MSE was 2.85 for the shoulder, 2.62 for the hip, and 2.85 for the knee angle respectively.

CONCLUSION: The results showed that the smartphone AI motion capture system achieved both high validity and high accuracy, indicating that it is a viable alternative to traditional motion capture systems which can accurately track human movement and provide valid joint angle data. Nevertheless, it still has to be determined whether the system can correctly measure more complex 3D movements, such as rotational movements, or if it can detect deformations like Varus or Valgus knee alignment.

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INDIVIDUALIZING HIGH-INTENSITY INTERVAL TRAINING INTENSITY IN DISTANCE RUNNERS: ARE PEAK TREADMILL SPEED AND 10000-M SPEED PERCENTAGES VALID ALTERNATIVES TO THE DELTA CONCEPT?

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INTRODUCTION: Cardiorespiratory adaptations to high-intensity interval training (HIIT) are optimized when athletes train longer at (or near) maximal oxygen uptake (1). Previous research showed that the speed (vΔ50) halfway between the second lactate threshold (vLT2) and the peak treadmill speed (Vpeak) identifies an optimal intensity for inducing cardiorespiratory adaptations to exercise in distance runners (2). Since most runners cannot access human physiology laboratory testing due to high costs and time restrictions, there is a need for valid, cheap and practical alternatives to the Delta concept for individualizing HIIT prescriptions. Previous studies showed that vΔ50 corresponds to about 90% of Vpeak with very low individual variability (2-4). Moreover, 10000-m races are run at intensities that are, on average, close to vΔ50 (5). Therefore, we investigated whether the respective percentages of Vpeak and 10000-m speed can be considered valuable candidates to prescribe HIIT to distance runners instead of vΔ50.

METHODS: Sample size planning was aimed at accuracy in parameter estimation (6). 75 distance runners (58 men and 17 women, age: 37 ± 8 years old) were recruited for the study. 57 (for Vpeak) and 61 (for 10000-m speed) runners underwent replicated measurements after 8 weeks. Blood lactate from the earlobe and cardiopulmonary variables were determined during a discontinuous incremental stepwise test on the treadmill (3-min step duration, 1.5 km/h speed increase, 1% gradient). vLT2 was determined using the modified Dmax method (7), and Vpeak was derived using linear interpolation (8). 10000-m performance was tested on a 400-m track. The percentage of Vpeak and 10000-m speed corresponding to vΔ50 was then determined. Moreover, we performed inferential analysis using mixed-effects models to isolate the net interindividual variability from the other sources of variability (9). We presented the results as mean ± standard deviation (SD) or point estimate and 95% confidence interval (CI).

RESULTS: vLT2, Vpeak and 10000-m speed in the 75 runners were 14.2 ± 1.1, 17.0 ± 1.3, and 14.2 ± 1.2 km/h, respectively. vΔ50 occurred at 91.7% (95% CI: 91.3 to 92.1) of the Vpeak with a SD of 1.5% (95% CI: 1.3 to 1.8) and 110.2% (95% CI: 109.0 to 111.5) of the 10000-m speed with a SD of 5.2% (95% CI: 4.5 to 6.3), respectively. The net interindividual variability for Vpeak and 10000-m speed percentage corresponding to vΔ50 was 1.0% (95% CI: 0.7 to 1.5) and 4.2% (95% CI: 3.2 to 6.2), respectively.

CONCLUSION: Vpeak but not 10000-m speed percentages can be a valid alternative to the Delta concept for individualizing HIIT intensity in distance runners and have the potential to make this HIIT approach more accessible to the largest part of the runner population.

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EFFECTS OF HEAVY RESISTANCE VS PLYOMETRIC TRAINING ON RUNNING ECONOMY AND RUNNING TIME TRIAL PERFORMANCE IN MIDDLE-AGED RECREATIONAL RUNNERS: A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Running economy has a critical role in long-distance running performance [1]. Heavy resistance training (HRT) and plyometric training (PT), as an adjunct to running training, could improve running economy and running time trial performance [2]. However, the comparative effectiveness is unknown, especially in middle-aged recreational runners despite their increasing number [3]. Elucidating effective training modalities for improving long-distance running performance will provide useful information in designing training programs for middle-aged recreational runners. Thus, the present study examined the effects of HRT versus PT, as an adjunct to running training, on long-distance running performance in middle-aged recreational runners.

METHODS: Twenty middle-aged recreational runners were randomly allocated into HRT or PT group (n = 10/group). Participants conducted prescribed training programs twice a week for 10 weeks as an adjunct to daily running training. HRT program consisted of leg press, leg curl, and calf raise with 50–90% of one repetition maximum (1RM), taking 2 seconds for each concentric and eccentric phase. PT program included counter-movement jump (CMJ), rebound jump, hurdle hop, and drop jump as quickly as possible. Before and after the intervention, the participants were tested for 1RM of the three lifting tasks (leg press, leg curl, and calf raise), jump performance (CMJ and drop jump performances), VO2 at 8–12 km/h (running economy), VO2max, velocity of VO2max (vVO2max), and 5-km running time.

RESULTS: HRT significantly increased 1RM of the three lifting tasks (19.1–21.1%, $p < 0.001$), while PT significantly enhanced the 1RM of leg curl only (8.3%, $p = 0.007$). Both HRT and PT significantly enhanced the scores of CMJ (6.4–8.3%, $p = 0.016$) and drop jump (9.3–26.2%, $p = 0.005$–0.009) without significant differences in the gains between the groups ($p \geq 0.248$). No significant main effects and group-by-time interactions were detected in running economy (-2.6–-1.1%; $p \geq 0.271$), VO2max (-0.11–0.64%; $p \geq 0.598$), and vVO2max (0.7–2.0%; $p \geq 0.233$). There were also no significant main effects and interactions in 5-km running time (-0.2–0.8%; $p \geq 0.491$). The individual variance of the improvement in running economy was negatively correlated with those of the baseline 1RM, jump performances, and VO2max ($r = -0.872$–-0.582, $p =$

0.001–0.078) in PT, suggesting that the effect of PT on running economy is influenced by muscle strength, jump abilities, and VO2max at baseline.

CONCLUSION: In middle-aged recreational runners, the addition of HRT or PT to running training can increase muscle strength and/or jump performance, but neither of these has a significant effect on long-distance running performance. Nevertheless, runners with higher 1RM, jump performances, and VO2max at baseline may better improve running performance by conducting PT.

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EFFECT OF ATTENTIONAL FOCUS STRATEGY ON DROP JUMP PERFORMANCE, KINETICS AND KINEMATICS : COMPARISON BY DJ EXPERIENCE LEVEL

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INTRODUCTION: Attentional focus strategy (AFS) can promote a neutral (NEU), internal (INT), or external focus of attention (EXT) and improves various sports performance. Drop jump (DJ) is a plyometric training that strengthens the stretch-shortening cycle in lower limb muscles and is commonly utilized by strength and conditioning coaches and athletes. Furuhashi et al. 1) reported that EXT improves DJ performance in inexperienced DJ. Another study suggested that modifying the instructions for AFS in inexperienced DJ can reduce contact time (CT) and increase jump height (JH) 2). Thus, it is clear that AFS can be effective coaching method in DJ. However, all of these have been limited to effects on DJ performance. Hence, this study aimed to investigate the effects of AFS on DJ, focusing on both performance and the kinetics and kinematics involved.

METHODS: 19 experienced DJ male athletes (E group) and 10 inexperienced DJ healthy male collegiate (I group) performed two trials of DJ each under three conditions (NEU, INT, and EXT). The instructions for each condition were as follows: Neutral: "Perform the jump to the best of your ability", Internal: "Step off the box, land on the balls of your feet, then fully and explosively extend your ankles, knees, and hips to jump as high as possible", External: "Step off the box, jump fast, imagine the ground is hot, get off the ground quickly, imagine you are a stiff spring, and focus on jumping to the roof." Three-dimensional coordinates of the 47 retroreflective markers fixed on each subject's body were obtained using a Vicon T20 system (Vicon Motion Systems Ltd.) with 10 cameras operating at 250 Hz. Ground reaction force was measured by a force platform at a rate of 1000 Hz. From the measured data, reactive strength index (RSI), contact time, jump height, kvert, joint torque, joint torque power, angular flexion, and extension displacements of the lower leg joints were calculated.

RESULTS: The E Group showed the highest DJ performance in NEUT. Additionally, there were significant differences between conditions in kinematics and kinematics in a few variables.

The I group showed the highest DJ performance in NEUT and EXT. In addition, there were significant differences between conditions in many variables in kinetics and kinematics.

CONCLUSION: The results suggest that the optimal AFS depends on the degree of DJ experience. The findings also suggest that AFS has a greater effect on kinetics and kinematics in DJ inexperienced individuals compared to DJ experienced.

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IMPACT OF PRE-SEASON TRAINING ON CORE STABILITY, PERFORMANCE AND INJURY RISK IN FOOTBALL

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INTRODUCTION: Core Stability is defined as the ability to control the position and motion of the trunk over the pelvis to allow optimum force transmission to the terminal segments [1]. Core training improves sprinting and shooting performance [2,3] and decreases ACL injury risk by stabilizing the trunk over lower limbs [3]. However, the link between the Core Stability, measured on the field, and the performance is not clear. Thus, the aim of this study was to determine the effect of pre-season training on Core Stability and its link with ACL injury risk and performance.

METHODS: Thirty-five soccer players from U17 and U19 teams performed two measure sessions, before (T0) and after (T1) typical soccer pre-season training. Core Stability was assessed by Close Kinetic Chain Lower Extremity Stability Test (CKCLEST) score (highest number of touches in 15 seconds) and by the composite score (sum of the best score of each axis, normalized against participants' leg length) for Lower Quarter Y Balance Test (LQ-YBT). To evaluate the ACL injury risk, they performed 6 non-anticipated cutting tasks filmed by two video cameras (Hero 7, GoPro, USA) placed in sagittal and frontal planes. The Cutting Movement Assessment Tool (CMAS) was used to estimate the ACL injury risk from 0 (no risk) to 11 (very high risk). Cutting was followed by a shot from the penalty point. Ball peak speed was measured with a radar (Stalker Pro II, Stalker Sport, USA). Paired sample Student's t-test was used to compare the two sessions and effect size was computed by Cohen's d. Significance was set at $p<0.05$.

RESULTS: Significant improvement was found for CKCLEST score ($p < 0.001$, $d = 1.73$) between T0 and T1 (24.2 ± 2.7 vs. 28.4 ± 2.8 touches) but LQ-YBT composite score showed no significant differences ($p = 0.307$, $d = 0.18$) with 108.5 ± 5.7 vs. 109.4 ± 5.3 cm for T0 and T1, respectively. CMAS means were 4.04 ± 0.77 (T0) vs. 3.72 ± 0.79 (T1) without significant differences ($p = 0.065$, $d = 0.333$). Shooting speed was not significantly different ($p = 0.146$, $d = 0.259$) between the two sessions (25.2 ± 2.3 (T0) vs. 25.8 ± 1.7 (T1) m.s-1).

CONCLUSION: The increase of CKCLEST score between sessions shows that pre-season training influence Core Stability by improving speed of lower limb combined to a better trunk and pelvis stability. However, shooting, which induces the same kind of movement (i.e. leg dynamic movement in sagittal plane with core stability) was not improved by pre-season training. In addition, football pre-season training, generally composed by prone plank exercises [5], in unlikely to improve motor control of the core, as evaluate by LQ-YBT. Beyond the importance to assess Core Stability with dynamic test, it will be interesting to integrate dynamic core exercises to pre-season training to increase performance and injury risk along with Core Stability.

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MODELLING OF LACTATE-TIME CURVES FOR ESTIMATING PERFORMANCE PARAMETERS IN CYCLING

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INTRODUCTION: Lactate power curves from graded exercise tests are commonly used to derive performance markers and intensity domains in endurance sports. These curves can differ between testing protocols because the time course is neglected. Mader (2003) described a metabolic model consisting of four differential equations which naturally describe the blood lactate response over time in response to exercise. In practice, this model is already used to infer performance markers such as maximal oxygen consumption (VO2max) and maximal lactate accumulation rate (ċLamax) from observed lactate testing data but an evaluation is still lacking. In this study, we evaluated the computational properties of this approach in silico. Further, we compare estimates from this approach against measured performance markers in a case study.

METHODS: The metabolic model from Mader was adopted as described by Heck et al. (2022) to estimate VO2max and ċLamax based on lactate-time curves of graded exercise tests. We simulated lactate responses to a graded exercise test (50 Watt increase every 5 minutes) with varying VO2max and ċLamax. Next, random noise with varying levels was applied to hypothetical measurements at the end of each stage to reflect measurement error. VO2max and ċLamax were obtained by nonlinear least-squares estimation using the Levenberg-Marquart algorithm. In a case study, VO2max and ċLamax were obtained from a ramp test and a sprint test, respectively. Lactate measurements from a graded exercise tests (increment 40W/5min) were used to estimate VO2max and ċLamax using least squares and Markov Chain Monte Carlo (MCMC) methods to obtain the posterior distribution using slightly informative priors.

RESULTS: The computer simulation showed larger estimation errors and worse parameter recovery within confidence intervals for ċLamax than for VO2max. With high error (SD = 0.4), the algorithm failed to estimate any parameter in less than 0.7 % and parameter coverage decreased for VO2max (91.8-99.9%) and ċLamax (87.5-99.9%) compared to low error (SD = 0.1, 100%). Moderate error (SD = 0.2) yielded estimates within ~5% of the original VO2max and ~35% of ċLamax in 95% of the simulation.

In the case study, measured VO2max and ċLamax were 61 ml/min/kg and 0.59 mmol/min/l, respectively. Least squares estimation yielded a VO2max of 60.3 CI95% [57.5; 63.1] and ċLamax of 0.63 CI95% [0.35; 0.91]. Estimation via MCMC yielded a VO2max of 59.5 CI95% [57.6; 61.3] and ċLamax of 0.56 CI95% [0.41; 0.73].

CONCLUSION: Non-linear least squares estimation yields robust estimates of VO2max but was more uncertain for ċLamax. The case study showed small differences between estimated and measured VO2max and ċLamax. Additional test data (e.g., sprint tests) could be used to possibly enhance parameter estimation. Thus, a principled method for learning performance parameters from observed testing data using a theoretical model is presented. The validity of this approach has still to be proven.

THE RELATIONSHIP BETWEEN BREATHS TAKEN AND SWIMMING PERFORMANCE IN A 50-METER FREESTYLE RACE

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INTRODUCTION: The 50m freestyle race is the event with the highest speed in the competitive swimming. To achieve a high swimming speed, the following are important, (1) increase propulsion and (2) minimize resistance (Toussaint & Beek, 1992). The front crawl stroke used in racing is considered to cause an increase in resistance and a reduction in propulsion, as the posture changes significantly due to respiratory movements (Pedersen et al., 2006). Further, it has been shown that it is necessary to reduce the number of breaths to as few as possible to avoid increasing the resistance in the 50m freestyle races (Pedersen et al., 2006). However, how many breaths should be taken during a 50m freestyle race was not indicated. The purpose of this study was to examine the relationship between the number of breaths during a race and the swimming performance results in a 50m freestyle event.

METHODS: 228 swimmers (121 males, 107 females) who participated in the 50m freestyle event at the Inter college swimming championship 2018 in Japan were analyzed. The competition was carried out at a long course (50m). Each race in the heats and B-final, and the final competition was video-recorded, and the number of breaths of the subjects was counted from the obtained movie. The swimming speed was calculated from the competition results and used as the swimming performance.

RESULTS: In the 50m freestyle races, the most frequently observed number of breaths was once (44.2%) in males and three times (32.0%) in females. The average number of breaths was 1.3 times for males and 3.0 times for females in the heat and was 0.3 times for males and 1.8 times for females in the finals. There was a significant difference between the heat and the finals in the number of breaths for both males and females ($P<0.05$). The swimming speed at each the number of breaths for males and females, respectively, was 2.147 m/s and 1.921 m/s in 0 time, 2.108 m/s and 1.882 m/s in 1 time, 2.085m/s and 1.878 m/s in 2 times, 2.058 m/s and 1.846 m/s, in 3 times, 2.046 m/s and 1.821 m/s in 4 times, and 2.177 m/s and 1.818 m/s in 5 times. In addition, for females, it was 1.818 m/s in 6 times and 1.778 m/s in 8 times. A significant difference was observed in the swimming speed at each the number of breaths ($P<0.05$). There was a significant correlation between the number of breaths and the swimming speed in male and female ($P<0.05$)

CONCLUSION: Previous studies have reported that eight male 50m freestyle finalists in the national championships breathed 1, 2 or 3 times (Pedersen et al., 2006). In this study, the results showed that the lower the number of breaths, the higher the swimming speed. Reducing the number of breaths was considered a prerequisite for success in the 50m freestyle races. Therefore, it was suggested that it is preferable for coaches to instruct swimmers to suppress breathing to 0 or 1 time for males and 2 times or less for females.

EARLY SUCCESS IS NOT A PREREQUISITE FOR SUCCESS AT THE ADULT AGE IN SPANISH SPRINTERS

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INTRODUCTION: An earlier onset of discipline-specific training and competition during their development years need not necessarily be associated with greater success in senior category (1). In fact, small performance transfer between junior and senior categories has been observed in track and field athletes (2-6). However, most studies have analysed the transition rate only from U18 to senior (2, 4, 7), or from U13 to U20 (6). Studies from U14 to senior category are scarce (3, 5). The main research objective was to quantify the transition rate from success in junior categories (from U14 to U23) to success in senior category, in sprint events in Spain.

METHODS: An observational and longitudinal analysis was carried out using the Royal Spanish Athletics Federation database rankings. We analysed 547 sprinters (238 women and 309 men) from their U14 to their senior stage who ranked in top-20 on at least one occasion during the period 2004 to 2021 in any age category. Contingency tables were used with McNemars statistic to analyse the status in each category, and the transition rate in subsequent categories.

RESULTS: The first entry in top-20 occurs mostly in U14 (42.8%, 234), and the frequency in following categories is progressively lower: 23.6% (129) in U16; 20.2% (111) in U18; 7.5% (41) in U20; 4.4% (24) in U23; and only 1.4% (8) of athletes make their first top-20 entry in the senior category.

The rate of athletes who, being in top-20 positions in any of the different junior categories, achieve the senior top-20 position is 3.8% (9) in the U14; 7.4% (15) in U16; 10.6% (24) in U18; 20.9% (32) in U20; and 31.4% (32) from U23 to senior ($p<0.05$ in all cases).

Transition rates from junior categories with their subsequent categories was statistically significant in all cases ($p<0.05$). From the total of top-20 U14 athletes (234), 31.2% (73) maintained top20 status in U16, 24.4% (57) in U18, 15.4% (36) in U20, and 9% (21) in U23 category. From the total of top-20 athletes in U16 (202), 53.5% (108) remained their top20 in U18, 27.5% (55) in U20 and 16.3% (33) in U23. From the total of top-20 in U18 athletes (228), 45.6% (104) remained their top-20 status in U20 and 26.8% (61) in U23. From the total of top-20 athletes in U20 (153), 43.1% (66) maintained their top-20 status in U23.

CONCLUSION: Data analysis from 547 Spanish sprint athletes showed that: 1) first entry in top-20 position occurs mainly at early ages; 2) the hardest steps to overcome are from U14 to U16, and from U23 to senior; and 3) success in junior categories is not a good predictor of success in the senior category (i.e., low transition rate).

Conventional Print Poster

CP-PN06 Thermoregulation I

COMPARISON OF HEAT PREPARATION STRATEGIES IN ELITE TRACK AND FIELD ATHLETES PRIOR TO THE DOHA 2019 WORLD ATHLETICS CHAMPIONSHIPS AND TOKYO OLYMPICS 2020NE

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INTRODUCTION: Increasing data regarding elite endurance athlete preparations for competition in hot conditions continues to emerge, reinforcing our understanding of heat acclimation (HeA), heat acclimatisation (HtA) and/or heat mitigation strategies in this population. However, exertional heat illnesses (EHI) have been reported in non-endurance athletes as well, suggesting this population would also benefit from said preparation strategies. This study explored how track and field athletes prepared for competition in the heat at the Doha World Athletics Championships 2019 (DOHA) and Tokyo Olympics 2020ne (TOKYO).

METHODS: 48 (28 male) DOHA and 36 (15 male) TOKYO athletes completed a paper (DOHA) or online (TOKYO) survey on heat preparation strategies for their stadium events. Athletes were grouped by sex (MALE vs. FEMALE) and climate they lived/trained in [hot (HOT) vs. temperate/cold (TEMPERATE)], with relationships assessed.

RESULTS: 40% (DOHA) and 39% (TOKYO) indicated 'no specific heat training' prior to competition. 58% (DOHA) and 33% (TOKYO) used HtA only, 0% (DOHA) and 17% (TOKYO) used HeA only and 2% (DOHA) and 11% (TOKYO) used both HtA and HeA. 80% of athletes from HOT (46% TEMPERATE) used HeA/HtA prior to DOHA. At TOKYO, MALE athletes predominately selected 'no specific heat training' (53%) or using HtA only (47%), whereas females selected no specific heat training (29%), HeA only (29%), HtA only (24%) and both HeA and HtA (19%). 14% [DOHA (0% TOKYO)] of athletes reported a previous EHI diagnosis while the most common symptoms of EHI reported by athletes during previous training/competition in the heat included cramping (27%), nausea (13%) and severe headache (13%) at DOHA and nausea (22%) and severe headache (19%) at TOKYO. Athletes reported having no pre-cooling (76%) or mid-cooling (73%) strategies for DOHA. At TOKYO pre-cooling strategies included ice slurry/cold water ingestion (53%), direct ice application (47%), cold towel (42%), ice vest (31%), and water/ice pouring/dousing (25%) and ice slurry/cold water ingestion (42%), no strategy (36%), direct ice application (33%) and cold towel (31%) for mid-cooling.

CONCLUSION: The use of HeA/HtA (~60%) by non-road race athletes did not differ between competitions albeit at lower reported adoption than road-race peers at DOHA (63%). Use of HeA/HtA was higher in HOT compared to TEMPERATE (DOHA) and use in FEMALE varied greater (i.e. HeA, HtA or combined HeA/HTA) than MALE prior to TOKYO. Pre- and mid-cooling strategies were more prevalent at TOKYO than DOHA, likely due to differences in stadium environment (air-conditioned DOHA and not at TOKYO). Future research would benefit from: i) a greater understanding of the prevalence/incidence of EHI/EHS among non-endurance athletes'; ii) how knowledge of evidence informed practice and the real/perceived barriers (e.g. access to facilities, impact on usual training) to implementing HeA/HtA impact its use in this population.

EFFECT OF ADDING HEAT STRESS BY LAYERED CLOTHING DURING 3 DAYS OF ENDURANCE TRAINING ON THERMOREGULATORY ABILITY IN A HOT ENVIRONMENT

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INTRODUCTION: INTRODUCTION: Heat acclimation (HA) prevents performance deterioration in a hot environment. Conventionally, HA can be acquired by repetitive exercise sessions in a hot environment. HA improves thermoregulatory ability and exercise performance in a hot environment (1). To acquire HA, daily prolonged exercise (60-90 min) in a hot environment for about 2 weeks is currently recommended (2). In this case, an environmental chamber and a period of 10-14 days are required (3). In the present study, we focused on adding heat stress by layered clothing to create a hot environment. Although layered clothing during 5 days of endurance training improved VO2max (from 52.41 mL/kg/min to 55.24 mL/kg/min; p=0.002), the impact of shorter duration of endurance training with layered clothing remains unclear. Therefore, the purpose of the present study is to clarify the effects of heat stress added by layered clothing during 3 days of endurance training on thermoregulatory during exercise in a hot environment among long-distance runners.

METHODS: METHODS: Nine male long-distance runners conducted three consecutive days of endurance (cycling) training at 50% VO2max for 90 min/day at 15°C with layered clothing (WEAR condition) or short-sleeve shirts and short (CON condition). Each condition was separated six weeks between conditions. During the training sessions, core temperature, heart rate, sweat rate, score of thermal sensation and rate of perceived exertion were evaluated. Before and after training period, heat stress test (HST) consisting of 40 min of endurance (cycling) exercise in a hot environment (35°C, 50%RH) were conducted. During HST, core temperature, plasm volume, heart rate, sweat rate, sweat sodium concentration, score of thermal sensation and rate of perceived exertion were evaluated.

RESULTS: RESULTS: Peak core temperature during training session was 38.39°C in WEAR and 38.31°C in CON, with no significant difference between conditions. The mean heart rate during training session was 126 bpm in WEAR and 120

bpm in CON (P>0.05 between conditions). The average sweat rate during training session was significantly higher in WEAR (2.45%) vs. CON (1.31%) (p<0.001 between conditions). The absolute changes in resting core temperature before and after training period were -0.97% (from 37.22°C to 36.85°C) in WEAR and -0.82% (from 37.19°C to 36.88°C) in CON, with no significant difference between conditions. The relative change in sweat rate after HST were 0.01% (from 1.01% to 1.03%) in WEAR and 8.87% (from 1.03% to 1.12%) in CON, with no significant difference between conditions.

CONCLUSION: CONCLUSION: Three consecutive days of endurance training adding heat stress by wearing layers didn't improve thermoregulatory ability in a hot environment.

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MENSTRUAL CYCLE MONITORING IN SPORTS - EVALUATION OF TEMPERATURE PROFILES THROUGHOUT THE CYCLE AND VALIDATION OF TWO DIFFERENT BASAL BODY TEMPERATURE MEASUREMENT METHODS IN FEMALE TRACK AND FIELD ATHL

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INTRODUCTION: In female athletes, training periodization should consider the different phases of the individual menstrual cycle (MC). During the follicular phase (FO) body temperature (BT) remains nearly constant. With the increase of the sex hormone progesterone after ovulation BT increases around 0.25-0.5°C and remains on this level throughout the luteal phase (LU) until progesterone declines again a few days before the next menstruation. The basal (lowest) BT values can be measured during the night. If the variations in BT should be used for the determination of the different phases of MC in sports, however, a practical and cost-efficient method needs to be evaluated. This study aims to compare BT in the external auditory canal right after waking up with the respective temperature of a 24 h intravaginal measurement.

METHODS: The study included competitive female track and field athletes (n=9, 27±6y) with 21 MC in total. During the observation period, the subjects wore a 24 h intravaginal temperature sensor (OvulaRing, VivoSenseMedical GmbH) that recorded BT every 5 min (gold standard). Both, the lowest temperature during the night (low-BT), and the temperature directly after waking up (wake-BT) with OvulaRing were determined from the data. In addition, BT was measured daily in the external auditory tract (ear-BT) with a conventional ear thermometer (SFT 53, Beurer GmbH) directly after waking up. Time of ovulation was determined if there was an increase of BT in the FO of 0.25°C and it lasted for at least three days. Variables were compared using Bland-Altman plots and concordance correlation coefficient analysis.

RESULTS: The mean deviation between wake-BT and ear-BT had a bias of 0.66°C (95%CI [0.34 0.96°C]) with limits of agreement (LoA) ranging from -0.60°C (90%CI [- 1.0 -0.30°C]) to 1.91°C (90%CI [1.61 2.41°C]). The correlation between the two methods was poor (pc=0.05). The mean difference between low-BT (at 2:26am±1:48h) and wake-BT had a bias of 0.60°C (95%CI [0.55 0.65°C]) with LoA ranging from 0.08°C (90%CI [0.02 0.13°C]) to 1.12°C (90%CI [1.06 1.18°C]). The correlation was poor (pc=0.15) between the two time points of BT. Ovulation could be detected with low-BT (ΔFP-LP 0.35°C) and wake-BT (ΔFP-LP 0.28°C), but not with ear-BT, which on average did not allow meaningful ovulation detection (ΔFP-LP 0.09°C).

CONCLUSION: As the correlation between ear-BT and the intravaginal wake-BT at the same time point was weak, the simple and easy-to-use method cannot be recommended for determining the different phases of an individual MC. Further, ovulation detection was impossible using ear-BT measurements. Wake-BT might not be used for information about the lowest BT during the night. Easy-to-use techniques, the optimal time of measurement, and good standardization should be evaluated as alternatives for the exact but cost-intensive intravaginal BT measurement. This project was funded with research funds from the Federal Institute for Sports Science based on a decision by the German Bundestag.

ATHLETE HEAT PREPARATION AT THE WORLD ATHLETICS RACE WALKING TEAM CHAMPIONSHIPS MUSCAT 2022: A SURVEY TO DETERMINE ELITE RACE WALKERS' PRACTICE AND KNOWLEDGE – WORTH A PRACTICAL APPLICATION?

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INTRODUCTION: Exercise in the heat can compromise athlete endurance performance and health with acclimation/acclimatisation (HA) providing the best protection against these. HA adoption remains far from universal, despite those athletes who used HA prior to the World Athletics Championships in Doha 2019 placing higher whilst showing lower medical events. Continued sport globalisation alongside global warming increase the likelihood of elite sporting events and championships in extreme heat. Therefore, surveying athlete knowledge and exercise in the heat related practice at the World Athletics Race-Walking Teams Championships Muscat 2022 (WRW) would seem prudent to provide further evidence for practice and stakeholder education. The purpose of this study was to assess elite racewalkers' heat preparation strategies and knowledge during the WRW and explore sex and athletes' climate differences.

METHODS: Male (n = 42) and female (n = 24) elite racewalkers completed an online survey prior to WRW. Responses were descriptively analysed by sex (male vs. female) and the climate they live/train in (hot vs. temperate/cold). Relationships within sex and climate were determined with logistic regressions for categorical data. Additionally, relationships between ranking (medallist/top 10 vs. non-medallist/non-top 10) and HA preparation were also assessed.

RESULTS: 43% of athletes did not complete specific HA training. Four surveyed athletes were medallists and had all implemented HA before Muscat (3 heat acclimated only, 1 heat acclimatised only). 15 surveyed athletes ranked within the top 10, being more likely to report preparing for the heat specifically prior to the event, compared to those who did not finish within the top 10 [80% vs. 50%; P = .049, OR = 0.25, 95% CI (0.06% - 1%)]. Climate differences existed for heat acclimatization preparation only [59% hot vs. 21% temperate/cold; P = .002, OR = 8.7, 95% CI (2% - 34%)]. Males [(88%) females (38%)] were more likely to acclimatize for >10 days (P = .020, OR = 0.1, 95% CI (1% - 67%). Females were more likely to not know expected conditions in Muscat [42% vs. 14%; P = .016, OR = 4.3, 95% CI (1% - 14%)] nor what wet bulb globe temperature is [83% vs. 55%; P = .024, OR = 4.1, 95% CI (1% - 14%)]. 83% of athletes were unaware of the World Athletics 'Beat the Heat' leaflet (a previous stakeholder education initiative).

CONCLUSION: Overall, HA use slightly declined prior to the WRW compared to the Doha 2019 Championships. Athletes who implemented HA before the championships tended to place better than those who did not, highlighting the importance and benefit of HA prior to competition. Previous germane educational resources from World Athletics had initial good impact elsewhere but appear to have waned here. Further efforts to provide continually impactful and penetrative educational resources, to bridge the gap between research and practice, particularly in female athletes, are needed in this (and likely many other) sports.

EFFECTS OF HEAT ACCLIMATION IN THOROUGHBRED SKELETAL MUSCLE

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INTRODUCTION: Heat acclimation improves exercise performance in hot conditions, and these adaptations involve improvement in skeletal muscle metabolism. However, few reports have described adaptations to hot environments at the cellular level in equine skeletal muscle. The purpose of this study was to determine whether heat acclimation in Thoroughbreds could improve exercise performance and induce skeletal muscle adaptations related to heat stress compared to training in a cool environment.

METHODS: Thirteen trained Thoroughbred horses (4.6 ± 0.4 [mean ± SE] years old; 498 ± 19 kg) were assigned to train 3 days/week for 3 weeks either in a cool condition (COOL; Wet Bulb Globe Temperature [WBGT] 12-13°C; n = 6) or a hot condition (HOT; WBGT 29-30°C; n = 7). The training protocols consisted of cantering at 7 m/s for 2 min and at the speed eliciting 90% of maximal oxygen consumption (VO2max) for 2 min 2 days/week, and cantering at 7 m/s for 3 min 1 day/week, followed by a 20-min walk in each session. Before and after the training period, standardized exercise tests consisting of cantering for 80 s in HOT at the speed sustaining 112%VO2max until fatigue were conducted. Biopsy samples were obtained from the middle gluteal muscle before exercise tests for western blotting and real-time RT-PCR. Data were analyzed with using paired t-tests ($P < 0.05$).

RESULTS: Time to exhaustion increased by 24% in HOT (79 ± 9 s to 98 ± 8 s, P = 0.02) after 3 weeks of heat acclimation, but did not change significantly in COOL (82 ± 7 s to 76 ± 5 s, P = 0.40). Heat shock protein (HSP)-70 protein increased significantly only in HOT (COOL, 1.02-fold, P = 0.82; HOT, 1.37-fold, P < 0.01), whereas HSP-70 mRNA was similar in both groups (COOL, 1.11-fold, P = 0.55; HOT, 1.07-fold, P = 0.64). In contrast, HSP-90 mRNA increased significantly only in HOT (COOL, 1.04-fold, P = 0.84; HOT, 1.50-fold, P = 0.01), and HSP-90 protein tended to increase in HOT (COOL, 1.07-fold, P = 0.48; HOT, 1.17-fold, P = 0.06). Gene expression of succinate dehydrogenase complex flavoprotein subunit A (SDHA; COOL, 1.15-fold, P = 0.33; HOT, 1.27-fold, P = 0.04), hypoxia inducible factor (HIF)-1α (COOL, 1.05-fold, P = 0.81; HOT, 1.67-fold, P < 0.01), and pyruvate dehydrogenase kinase isozyme 4 (PDK4; COOL, 1.89-fold, P = 0.29; HOT, 3.25-fold, P = 0.02) increased significantly only in HOT. Peroxisome proliferator-activated receptor γ coactivator (PGC)-1α did not change significantly in protein (COOL, 1.28-fold, P = 0.31; HOT, 1.11-fold, P = 0.65) or mRNA (COOL, 1.36-fold, P = 0.33; HOT, 1.46-fold, P = 0.10) expression.

CONCLUSION: Our results demonstrate that heat acclimation improves exercise performance and increases expression of various proteins and mRNAs, including HSPs, SDHA, HIF-1α, and PDK4. These results suggest that heat acclimation activates protective responses to heat stress and increases signaling pathways to induce mitochondrial adaptations in skeletal muscle.

DEVELOPMENT OF A NON-INVASIVE THERMOMETRY USING AN INFRARED THERMAL-IMAGING CAMERA WITH RATS RUNNING AT VARIOUS SPEEDS: A PILOT STUDY

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INTRODUCTION: Exercise-induced increase in body temperature is a crucial factor for determining exercise performance (Gonzalez et al. 1995). Typically, body temperature during exercise is measured using rectal and abdominal temperatures, which are known to reflect increased temperatures dependent upon exercise duration and intensity (Samuel et al., 2015). However, such temperature measurement methods can seem invasive and appear to be stressful for animals, which may interfere with a precise molecular and neurocircuitry analysis behind body temperature regulation with exer-

cise. This precludes us from measuring exercise-related body temperature using conventional methods and makes us to use a non-invasive thermal camera. We have been developing a treadmill running model for rats that compels different running speeds based on the lactate threshold, focusing on hormonal and metabolic changes (Soya et al., 2007). We thus aimed to establish an animal model for evaluating body temperature change dependent upon running speeds that will extend our current running model by allowing the measurement of the body surface temperature using a non-invasive thermal camera.

METHODS: F344 male rats (10-12 weeks old) were used in this study. Based on LT assessment (LT speed: 21.0±0.90 m/min), 3 groups (S: sedentary group resting on the treadmill, n = 7; L: light exercise group running at 10 m/min, n = 7; and V: vigorous exercise group running at 25 m/min, n = 8) were created, and the rats ran or rested on a treadmill for 30 minutes. Body surface temperature (BST) was measured using an infrared thermal-imaging camera (InfRec R550, Nippon Avionics, Japan) before and after running, and blood lactate and glucose levels were measured at the same time.

RESULTS: Thirty minutes of treadmill running was revealed to increase the BST depending on the running speed, whereas resting did not produce changes in temperature. Note that there was no difference in room temperature among groups. Blood lactate levels increased solely in the V group.

CONCLUSION: The findings described above are consistent with those of the previous study (Soya et al., 2007), which demonstrated the validity of an exercise model based on LT, even with the use of a thermal camera. We found that the rat BST increased during treadmill running in a manner dependent upon speed, which is consistent with previous studies using conventional means to measure core body temperature. This implies that we have successfully developed a running model that can non-invasively measure changes in exercise-related body temperature. Establishing such a model may help to explore brain molecular and neurocircuitry mechanisms for thermoregulation during exercise.

INFLUENCE OF (IN)CONGRUENT VISUAL INFORMATION ON THERMAL PERCEPTION DURING EXERCISE IN THE HEAT: A RANDOMISED CONTROLLED CROSSOVER TRIAL

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INTRODUCTION: Human thermoregulation is vital to human survival, and is regulated by behavioural and autonomic responses. Behavioural responses are the more powerful of the two mechanisms, and are driven by subjective perceptual awareness of the thermal environment. Perception itself is a holistic experience of all senses, however there is evidence to suggest visual information, is prioritised over other sensory information. We have recently demonstrated that this relationship is not well understood, particularly when humans are exposed to extreme environments, or during exercise. This study tested the hypothesis that a 'cold' visual virtual environment would change thermal perception when compared to a 'hot' visual virtual environment during exercise in a warm environment.

METHODS: Sixteen healthy, active participants (six females) who were not susceptible to motion sickness volunteered for the study [mean (SD), age: 23.4 (3.7) years;(" V") ̇O2max: 38.2 (5.8) mL·kg-1·min-1]. In a within participant, randomised, crossover design, volunteers completed three experimental sessions, involving a 30-minute bout of cycling in 35 °C (50 % r.h.), whilst exposed to three different visual environments [no virtual reality (NoVR), virtual reality displaying an arid landscape (HotVR), and virtual reality displaying a snow covered landscape (ColdVR)].

Thermal sensation, thermal comfort, rating of perceived exertion, heart rate, core temperature, four-site skin temperature were recorded. Mean skin temperature, mean body temperature, perceptual strain index, and physiological strain index were subsequently calculated. Plasma cortisol was also analysed before and after each trial. Data were analysed using a 3 (Condition: NoVR, VRHot, VRCold) x 4 (Time: Pre, 10-, 20-, 30- min post onset of exercise) repeated measures ANOVA. Cortisol was analysed with a 3 (Condition: NoVR, VRHot, VRCold) x 2 (Time: pre, post) repeated measures ANOVA. The main effects of condition, time, and their interaction were explored, with statistical significance accepted at $p < 0.05$.

RESULTS: Cycling in the heat resulted in a significant increase in all variables over time in all conditions (all $p < 0.05$). Manipulation of the visual environment did not alter perceptual, physiological, or biochemical variables (all $p > 0.05$). Similarly, no significant interactions were observed.

CONCLUSION: It is concluded that using VR to manipulate the virtual environment during cycling in the heat does not meaningfully alter perceptual, physiological, or biomarkers of hypothalamic-pituitary-adrenal axis activity.

PSYCHOLOGICAL AND PHYSIOLOGICAL CHANGES TO THE COLD PRESSOR TEST IN ADOLESCENT HANDBALL PLAYERS WITH NORMAL MENSTRUATION

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INTRODUCTION: The menstrual cycle involves significant changes in hormone levels, which cause physical and psychological changes in women, which are further affected by stress. The cold-pressor test (CPT) in which subjects immerse their forearms in ice water is among the most commonly used laboratory stressors.

METHODS: Twenty-seven adolescent female elite athletes (mean age 16.6 ± 1.69 years) from a rural Hungarian womens handball club were included in the study. Anthropometric measurements (anthropometer, BIA, Tanner-scale) were taken

2 days before the socially involved cold pressor test. According to the menstrual cycle, 2 groups (follicular, and luteal) were formed. The average day of the menstrual circle in the follicular phase (n=12) was 8.38 ± 3.33 and in the luteal (n=15) 21.3 ± 5.52 days. Before the simulation, immediately after, and 30 minutes later, a saliva cortisol sample, blood pressure, and heart rate were measured. During the 30-minute break, the participants completed a psychological test package (SWLS, PSS, CD-RISC, HA-7, ACSI-28, SAS-2, MHC-SF).

RESULTS: Among the physiological parameters, the diastolic blood pressure value after the simulation was measurably higher (p= 0.003), as well as the heart rate (p= 0.046). No significant difference (p>0.05) could be detected in the salivary cortisol values and in the other cardiovascular parameters. The score on the Perceived Stress Scale was significantly higher (p= .015) in the follicular group (29.8 ± 7.17 points) than in the luteal group (22.5 ± 7.29 points). Furthermore, ACSI-28 confidence was significantly higher (p= 0.045) in the luteal group (13.2 ± 1.76 points) than in the follicular group (11.9 ± 1.38 points). The tolerance time spent voluntarily in the simulation did not differ (p>0.05) between the two groups.

CONCLUSION: The data showed that neither the resting nor the salivary cortisol parameters following the stress simulation were different in the two stages of the menstrual cycle. Regardless, psychological differences were found. These results contribute to the wide range of stress simulation studies, supplementing them with adolescent subjects.

Conventional Print Poster

CP-MH13 Physical activity/Inactivity

HIGH-GROOVE MUSIC BOOSTS SELF-SELECTED JOGGING SPEED AND POSITIVE MOOD IN UNIVERSITY STUDENTS

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INTRODUCTION: Around 27.5% of adults worldwide do not meet the recommended requirement of 150 minutes a week of moderate-to-vigorous physical activity. Positive affective response to exercise promotes exercise adherence; however, pleasure mood is reduced along with an increase in the exercise intensity [1]. To address this dilemma, listening to music during exercise may helpful. Since music has positive impacts on endurance performance and perceived enjoyment in vigorous-to-maximal intensity [e.g. 2], it may enhance both exercise intensity and pleasure in health promotion situations (light-to-moderate intensity exercise). We tested this hypothesis using groove music, which induces a sensation of "wanting to move to the music" accompanied by positive affective responses [3].

METHODS: Fourteen Japanese university students (8 male) participated in the two experimental conditions, High-Groove (HG) and Low-Groove (LG), with a within-subject, crossover design. Participants performed two sessions of three minutes running exercise on a treadmill at least 15 minutes apart in randomized order. Before the experiment, they previewed tempo-matched 12 pairs of high/low-groove music lists and selected one of them to listen to during their exercise session. The participants were asked to run at a comfortable pace and were allowed to adjust the treadmill speed during the first minute. During exercise, heart rate (HR) and treadmill speed was recorded. After each exercise session, Borg's rating of perceived exertion (RPE), psychological mood (Two-Dimensional Mood State), and rating of groove [4] were measured. We compared each parameter using a paired t-test (two-tailed, $\alpha = 0.05$). Values are mean±SE.

RESULTS: Rating of groove was higher in HG (HG: 32.1±1.2; LG: 16.0±1.5). Self-paced speed of treadmill was faster in HG (HG: 5.9±0.2; LG:4.6±0.3 [km/h]). HR (HG: 134.2±5.5; LG: 115.5±4.8 [bpm]) and RPE (HG: 12.2±0.6; LG: 9.9±0.7) were higher in HG. Exercise intensity was within the range of moderate in HG whereas it was light in LG. Psychological arousal levels (HG: 1.4±0.5; LG: -0.9±0.5) and pleasure levels (HG: 3.1±0.8; LG: 0.7±0.6) post exercise were higher in HG.

CONCLUSION: Listening to high-groove music listening during running increased not only the self-selected speed, which increased the exercise intensity measured by HR and RPE, but also enhanced the positive affective response (arousal and pleasure) to lower intensity exercise. These findings are interesting because groove music was beneficial in elicit a positive mood beyond the potential negative impact of increasing the exercise intensity. Although the long-term effects are unclear from this short-time, acute intervention study, the results suggest that listening to high-groove music during exercise may be helpful to increase both exercise intensity and adherence in health promotion situation.

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RELATIONSHIP OF PHYSICAL ACTIVITY LEVEL, SEDENTARY BEHAVIOR AND PHASE ANGLE IN YOUNG ADULTS.

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INTRODUCTION: The phase angle (PAn) has been considered an indicator of the state of cell health, cell mass, and the integrity of the cell wall. Different authors have found a relationship between the levels of Physical Activity (PA) and PAn, however, this relationship has been little explored with sedentary behavior (SB) in young adults.

METHODS: Observational, analytical cross-sectional study. Young adults of legal age, physiotherapy students at the Universidad del Rosario (UR) in Bogotá-Colombia, without cardiometabolic disease or presenting an injury that prevented

them from performing PA were randomly selected. The approval of the ethics committee of the UR was obtained. After signing the informed consent, PA was evaluated with the IPAQ, SB with the SITQ-7D, and PAn through octagonal bioimpedance. Differences between sex and the relationship between PAn with AF and SB were determined, and statistical significance was assumed with a value of $p<0.05$.

RESULTS: 228 young people aged 20.8±2.9 years participated, who mainly have a moderate (50.4%) and high (43.4%) PA level, spending 11.9±0.66 and 10.2±4, 2 hours of SB during the week and weekend, respectively, and 5.5±0.66 degrees of PAn. A relationship was found between PAn and PA METs ($r=0.322$, $p<0.001$), but not with SB ($p>0.05$).

CONCLUSION: Significant differences were found in PAn and SB on the weekend between men and women, in addition to the direct relationship between PAn and SB in young adults, which is in line with what was reported by Mundstock E, et al. which shows the relevant role of PA in relation to health. More studies are required to analyze SB and its effects on population health, according to Ribeiro AS, et al. and Souza MF, et al., the phase angle is related to muscular resistance training and therefore with strength in older adults, so the relationship between SB, PA and some components of the condition should be explored. physical as muscular strength in the young adult population.

CHANGES IN PHYSICAL ACTIVITY AMONG 17-YEAR-OLD ICELANDIC ADOLESCENTS – OBJECTIVE AND SUBJECTIVE DATA FROM TWO COHORTS

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INTRODUCTION: During late adolescence changes in health occur and previous data has shown that physical activity declines as teenagers head into young adulthood (1). However, maintaining healthy lifestyle from adolescence to adulthood has been linked to numerous lifestyle benefits (2), thus teenagers aged 14–17 years are recommended to accumulate at least 60 minutes of moderate-to-vigorous intensity, mostly aerobic, physical activity, across the week (3). The aim of the currents study was to examine how physical activity, measured both objectively and subjectively had changed in two cohorts of 17-year-old Icelandic adolescents from 2017 to 2021.

METHODS: In spring 2017 we measured free-living physical activity with wrist actigraphy for one week in 160 adolescents (96 girls, born 1999) and asked participants to answer an online questionnaire to measure subjective physical activity. In spring 2021, 171 adolescents (107 girls) in a cohort born 2003 answered the questionnaire and a subset of 74 (45 girls) agreed to wear wrist actigraphy for one week.

RESULTS: Objectively measures of average weekly physical activity decreased 4.1% and dropped from 1786 counts/min of wear/day in 2017 to 1713 counts/min of wear/day in 2021. However, the difference was not statistically significant ($P=0.18$). When subjective activity was explored, with hours of weekly physical activity, in 2017 40% of adolescents did 6 hours or more of physical activity per week. However, in 2021 only 30% of 17-year-olds did 6 hours or more of weekly physical activity. As a result, 60% of the adolescents were exercising less than the recommended one hour a day in 2017, and that number had increased to 70% in 2021.

CONCLUSION: In a span of 4 years, Icelandic older adolescents reduced their general physical activity both measured objectively and subjectively. Further there was an increase in the number of adolescents that did not meet the recommendation of at least 60 mins (1 hour) or more of moderate-to-vigorous intensity physical activity daily. This data indicates that in only 4 years, or between 2017 to 2021, older Icelandic adolescents were moving less, for shorter amounts of time and even fewer are reaching the recommended physical activity guidelines per week.

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THE EFFECT OF EXERCISE HABITS ON BODY COMPOSITION OF FEMALE UNIVERSITY STUDENTS

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INTRODUCTION: Skeletal muscle mass (SMM) increases with development and reaches its peak around age 20. Thereafter, it is known to decrease SMM with age. Furthermore, SMM decreases with inactivity. On the other hand, body fat percentage (%Fat) increase relative to a decrease in SMM and is also increased by inactivity. Changes in body composition due to increases in body fat and decreases in SMM pose a risk for future disease. Recently, it has been reported that the number of young Japanese women with the exercise habit has been decreasing. Considering that women potentially have less SMM than men, the lack of exercise habit may have more impact on their future health. The purpose of this study was to examine the effects of past and present exercise habits on body composition among female university students.

METHODS: The subjects were 61 female university students aged 18-22 years (age: 20.2 +/- 1.0 years, height: 157.5 +/- 5.6 cm, weight: 51.8 +/- 6.6 kg). Exercise habits were defined as exercising for at least 1 hour per session, twice a week for at

least two years. The subjects were divided into three groups: the group with current exercise habits (CEH group, n = 21), the group with past exercise habits until one year ago (PEH group, n = 21), and the group with no exercise habits from the past to the present (NEH group, n = 19). The whole body and segmental SMM and %Fat values were measured by a body composition analyzer, and then SMM per body weight (%SMM) was calculated. A one-way ANOVA was performed to examine significant difference among the three groups.

RESULTS: The duration of exercise was significantly longer in the CEH group (6.9 +/- 3.4 years) than in the PEH group (5.2 +/- 1.8 years). The CHE group had larger total SMM, segmental SMM, total %SMM, and segmental %SMM than the NEH group. The CEH group also had a significantly lower %Fat than the NEH group. The CEH group had a significantly higher %SMM of the upper limb than the PEH group. In the PEH group, the %SMM of the lower limb was significantly larger than in the NEH group.

CONCLUSION: We found that the CEH group had larger SMM and a lower body fat percentage than the NEH group. The results suggest that continuing exercise habits at a young age may reduce in future health risks. Although the PEH group had a lower %SMM of the upper limb than the CEH group and a higher %SMM of the lower limb than the NEH group, there was no clear indication of the effect of past exercise habits or the loss of exercise habits. In the future, it will be necessary to increase the number of subjects and examine with a stricter classification of the type, frequency, and duration of exercise.

RATES OF COMPLIANCE AND ADHERENCE TO HIGH-INTENSITY INTERVAL TRAINING: A SYSTEMATIC REVIEW AND META-ANALYSES

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Introduction

The purposes of our systematic review and meta-analyses were to determine: 1) rates of compliance and adherence to supervised and unsupervised high-intensity interval training (HIIT) interventions for insufficiently active adults and adults presenting with a medical condition, and 2) whether compliance and adherence rates were different between HIIT and moderate-intensity continuous training (MICT) interventions.

Methods

Articles that reported on adults who were 1) insufficiently active or presenting with a medical condition, and 2) involved in a HIIT intervention which measured compliance or adherence were included. A search was employed in six databases. Screening of articles and data extraction were completed by two independent reviewers and consensus was reached through deliberation. Risk of bias was assessed using the RoB 2.0 or ROBINS-I. HIIT and MICT compliance and adherence rates were calculated via weighted averages. Meta-analyses were conducted to discern differences in compliance and adherence rates between supervised and unsupervised HIIT vs. MICT interventions. Sensitivity analyses, publication bias, and sub-group analyses were also conducted. Overall quality of the cumulative evidence was appraised using GRADE.

Results

188 studies were included (n=8928). Most studies were English, single-center, prospective randomized controlled trials. 29.3% of studies were identified as having high risk of bias, and 20.2% moderate risk. Compliance to supervised HIIT interventions averaged 89.4% (SD:11.8%), while adherence to unsupervised HIIT averaged 63% (SD:21.1%). Compliance and adherence to MICT averaged 92.5% (SD:10.6%) and 68.2% (SD:16.2%), respectively. Based on 65 studies, meta-analysis revealed that compliance rates were not different between supervised HIIT and MICT interventions [Hedge's g=0.026 (95%CI: -0.090–0.143), p=.66]. Results were robust and low risk of publication bias was detected. Sub-group analysis indicated compliance favoring HIIT for insufficiently active but otherwise healthy adults [Hedge's g=0.262 (95%CI: 0.048–0.476), p=.017]. Quality of the evidence was rated as moderate. Based on 10 studies, adherence rates were not statistically different between unsupervised HIIT and MICT interventions [Hedge's g=-0.313 (95%CI: -0.681–0.056), p=.096]. Sub-group analysis may point to differences in adherence rates dependent on the method of measurement used. Quality of the evidence was rated as very low.

Discussion

Compliance to supervised HIIT interventions is high and comparable to that of supervised MICT among insufficiently active adults and adults with a medical condition. Adherence to unsupervised HIIT interventions is moderate and comparable to MICT, although results should be interpreted with caution due to high heterogeneity and very low quality of evidence. Further research is needed, taking into consideration the exercise protocols employed, methods of outcome measurement, and timepoints of measurement.

A 4-YEAR FOLLOW UP STUDY FROM THE 40-WEEKS FOOTBALL AND ZUMBA WORKPLACE INTERVENTION STUDY AMONG FEMALE HOSPITAL EMPLOYEES IN NORWAY.

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INTRODUCTION: This 4-year follow-up study of a 40-week cluster-randomised workplace intervention, evaluates the long-term effects of Football and Zumba on aerobic capacity (VO2max), body composition, blood cholesterol, as well as self-reported muscle pain among female hospital employees.

METHODS: Initially, 107 female hospital employees were divided into the two exercise groups Football and Zumba, which were offered 1-2 exercise sessions over 40 weeks, and a control group. Measurements were carried out at baseline, 12 and 40 weeks. The current study was conducted 4 years after the end of the intervention, and included a total of 43 participants, divided into the Football group (n=14), the Zumba group (n=17) and the Control group (n=12). For reasons of statistical power, the intervention groups were combined in the statistical analyses.

RESULTS: Of the total of 31 participants in the intervention groups, 7 in the football group and 3 in the Zumba group maintained regular exercise in their respective activities 4 years after the end of the intervention. Otherwise, there were no significant differences between self-reported amount of exercise between the three groups in the period from the end of the intervention to the 4-year follow-up. Based on a linear model analyses, the intervention groups revealed a significant higher overall mean in VO2max (1.0 ml/kg/min, 95% CI 0.31 to 1.71, p = 0.005) and lower limb bone mineral density (BMD) (0.02 g/cm2, 0.00 to 0.04, p = 0.024) four years after the end of the intervention compared to the controls. Moreover, the intervention groups revealed a significant lower duration of pain during the past 3 months in the neck-shoulder region (-6.8 days, 95% CI, -10.9 to -2.6, p = 0.002), S-Cholesterol (-0.17 mmol/L, 95% CI -0.31 to -0.02, p = 0.023), LDL Cholesterol (-0.13 mmol/L, 95% CI -0.26 to -0.00, p = 0.049), as well as total body fat mass (-671 g, 95% CI, -1164 to -178, p = 0.008) compared to the controls.

CONCLUSION: This 4-year follow-up study among female hospital employees indicates that several of the beneficial health effects achieved through 40 weeks of football and Zumba organized by the workplace, are maintained after 4 years despite a relatively low degree of compliance.

THE COVID-19 PANDEMIC DECREASES CARDIORESPIRATORY FITNESS. A 3-YEAR FOLLOW-UP STUDY IN INDUSTRY

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INTRODUCTION: The COVID-19 pandemic was first noticed in China in December 2019 1. Already in mid-March 2020, the Norwegian society closed, with a gradual opening during spring 2020 through mid-July 2020. During autumn 2020 and winter/spring 2021, parts of Norway closed again; enterprises and, in particular, restaurants closed, and the public was again encouraged to work at home. During the spring and summer of 2021, the number of infected decreased in line with an increase in vaccination and ultimo September, Norway was back to normal. However, primo December 2021, the Omicron-mutation was detected in Norway, and new limitations of movements were enforced until February the12th, 2022. Throughout the pandemic, there were temporary regional differences in closure in Norway.

METHODS: The present study is a prospective follow-up study of early manifestation of cardiovascular disease in industry workers in which both shift workers and day workers (controls) participate. In the spring and summer of 2018, we invited 172 workers, at two insulation material plants in Eastern Norway, whereof 94 workers agreed to participate. We examined these workers in August 2018, and August 2021 and in a subset study in October 2018. We here report results obtained among all workers who attended at baseline (BL) and three years afterwards at follow-up (FU). According to the protocol, we excluded persons with serious medical conditions, leaving 86 eligible participants, of whom we examined 70 at FU. After five minutes of rest, while sitting, we measured resting heart rate (RHR). We used the mean of three measurements. Maximal oxygen uptake (VO2max) was assessed by a standardized graded ergometer cycle test and direct measurement of oxygen uptake with a Cosmed K5 metabolic analyser. Data were analysed with Stata 17, and p-values below 0.05 were considered significant. The Regional Ethics Committee in Oslo approved the study (2018/1258). We informed the participants about the study, and they gave their written consent to participate (ISRCTN42416837).

RESULTS: RHR increased from 61.3 to 64.4 beats per minute (95%CI, 0.8, 5.4). Self-reported PA decreased by 43.9 min/week, (95%CI, -73.5, -14.4), and VO2max decreased from 39.6 ml/kg/min at BL to 34.0 at FU, a reduction of 5.6 ml/kg/min (95%CI, -7.6, -3.7). Adjusted for actual age, the corresponding figure for VO2max was 5.4 ml/kg/min, (95%CI, -7.4, -3.4), an annual loss of 4.6%.

CONCLUSION: The PA decrease did not affect BMI and fat mass in this study over 3 years. This concomitant stability in BMI and fat mass does not, however, rule out a negative effect on fat metabolism, since decreasing energy expenditure is associated with an increase in intra-abdominal fat without necessarily increase of BMI at the same time. In line with the decrease in self-reported vigorous PA and an increase in RHR, we found a significant decrease in VO2max during a 3-year follow-up of industry workers, possibly a result of physical inactivity during the COVID-19 pandemic.

PHYSICAL CONDITION AND KLOTHO LEVELS IN ADULTS WITH CYSTIC FIBROSIS

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INTRODUCTION: It is now well established that physical condition level is one of the main predictors of the disease's prognosis in people with cystic fibrosis (CF). Besides, the α-Klotho protein (αKl) is an emerging biomarker of health and aging, which further seems to be related to the levels of physical fitness in healthy population. In CF patients, recent publications suggest αKl could act: (i) at cellular level, helping to improve mucus clearance from the lung epithelium trough potassium channels activation; and (ii) to regulate some inflammatory cytokines and therefore contribute to control the persistent inflammation characteristic of CF patients.

Our aim in this study was thus to determine the possible relations between αKl levels and physical condition in CF adult patients and healthy controls.

METHODS: 89 subjects were analyzed: 36 CF patients (18 women) and 53 controls (18 women) of the same age. The analyzed variables were: age, weight, height, BMI, maximum oxygen consumption (VO2max), blood levels of αKl and interleukin 10 (IL10).

RESULTS: Age and BMI were: 33.0±9.3 years and 20.7±2.1 kg/m2 in CF women; 33.1±9.4 years and 21.5±2.6 kg/m2 in healthy women; 31.78±7.6 years and 22.8±2.3 kg/m2 in CF men and 30.6±7.4 years and 23.3±2.1 kg/m2 in healthy men.

Significant differences were found comparing CF subject vs. controls for VO2max ($p<0.001$) in total sample, as well as dividing by sex: VO2max was 30.5±8.2 ml/kg/min in CF subjects (26.4±5.6 ml/kg/min women, 34.7±8.3 ml/kg/min men) and 51.6±7.1 ml/kg/min in healthy subjects (44.7±4.3 ml/kg/min women, 55.2±5.4 ml/kg/min men).

There were no significant differences comparing both groups for αKl levels: 968.8±713.2 pg/ml in CF subjects and 917.1±305.5 pg/ml in healthy subjects. Nevertheless, interesting opposite significant differences were observed separating by sex: CF women presented higher levels than controls (1283.4±891.6 pg/ml vs. 772.7±376.8 pg/ml, $p=0.032$, Cohen's $d=0.746$), while CF men presented lower levels than controls (654.2±206.9 pg/ml vs. 991.4±234.6 pg/ml, $p<0.001$, Cohen's $d=1.494$).

Correlations analysis showed significant relations between VO2max and αKl, in opposite direction between the two groups: healthy subjects with higher levels of αKl presented higher VO2max ($r=0.319$, $p=0.02$), while CF subjects with higher levels of αKl presented lower VO2max ($r=-0.451$, $p=0.006$). No significant relations were observed between IL10 and αKl or VO2max.

CONCLUSION: Opposing results found for αKl levels between men and women could be explain by possible relations between αKl and sex hormones previously described in literature.

αKl levels and VO2max are inversely correlated between patients with CF and healthy subjects. We hypothesize the higher αKl levels in CF patients with worse physical condition may be due to higher chronic inflammatory state that activates processes regulated by anti-inflammatory proteins, αKl being one of them.

CHANGES IN INSULIN RESISTANCE AND BODY COMPOSITION FOLLOWING 14 DAYS OF BED REST WITH OR WITHOUT AN EXERCISE COUNTERMEASURE.

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INTRODUCTION: Mechanical unloading during spaceflight (microgravity) and prolonged bed rest leads to loss of muscle mass and strength, as well as to the development of insulin resistance. Prolonged 6-degree head-down tilt bedrest (HDTBR) is an analogue to microgravity. In the present study we investigate whether or not exercise can mitigate changes in body composition and insulin sensitivity induced by 14-days of HDTBR.

METHODS: Twenty-two participants (59±3y; 24.9±3kg/m2) underwent 14 days of HDTBR with (n=11) or without (n=11) exercise as a countermeasure. Body composition was measured using iDXA and MRI before and after HDTBR. Oral glucose tolerance test (OGTT) was performed at baseline and during HDTBR (day 3, 9, 13) and recovery.

RESULTS: Both the exercise and control group experienced significant weight loss (-1.2[-1.9, -0.5]) vs. (-1.1[-1.6, -0.6]), which was driven by a significant muscle mass loss in the control group (-0.5[-1.1, 0.01]) vs. (-0.8[-1.3, -0.3]) and significant fat mass loss in the exercise group (-0.7[-0.9, -0.4]) vs. (-0.3[-0.5, -0.1]). Compared with baseline, the OGTT performed during HDTBR remained similar and showed significantly lower glucose excursion curves in the exercise compared to the control group ($p<0.05$). However, following a 6-day recovery period, the glucose response to OGTT returned to similar values as seen at baseline in the control group.

CONCLUSION: Loss of muscle mass and impaired glucose homeostasis can be mitigated with regular exercise during 14 days of HDTBR in healthy individuals. Additionally, the exercise protocol in this study may represent the basis of developing effective inflight exercise countermeasures helping astronauts to maintain their musculoskeletal health while in space. It may likewise assist patients requiring bed rest during hospitalization. These findings highlight the need to elucidate the mechanisms through which exercise exerts such benefits.

Conventional Print Poster

CP-MH14 Physical activity promotion

PITFALLS OF DATA MONITORING BY USE OF DIGITAL DEVICES OF AN ACTIVITY PACING STUDY PROTOCOL IN PEOPLE WITH HIV

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INTRODUCTION: Physical activity has been shown to improve cardiorespiratory fitness (CRF) in people living with HIV (PLWH). However, exercise adherence in this population is low. Smart technology has been suggested to improve adherence by providing motivational feedbacks and measuring activity and fitness parameters. The aim of this study was to investigate health and quality of life benefits to monitor activity pacing (AP), a strategy to manage fatigue during exercise, in PLWH by using an actigraph and a smartphone app showing exercise details directly to participants.

METHODS: This was a randomized-controlled study divided in two phases: 2-week Observational Phase (OP), in which subjects performed their daily routine and were monitored in a subject-blind configuration of devices; 16-week Training Phase (TP), with subjects either randomized into an Experimental Group (EG: no-blind configuration) or Control Group (CG: blind configuration). The actigraph (Philips Health Band) provided tracking from all participants of HR, daily steps, minutes per day with steps >100/min (moderate activity) or >130/min (vigorous activity), via Bluetooth to a mobile app installed on subjects' smartphone, which transmitted data to Philips Actigraphy Server System (PASS) website where were accessible to trainers. At baseline (BL) and end of study (W18) participants were tested for body composition (BMI, hip, waist circumference), CRF (6MWT), blood lipids (total-, HDL-, LDL-C).

RESULTS: Twenty-four participants were enrolled and randomized 12 in EG and 12 in CG. Five dropped-out during the follow-up. During the study we had several technical issues regarding band/app pairing and/or data transmission to the website, depending on different models, operating systems, and configurations of mobile phones. Therefore, we were not allowed to carry out the study following the experimental design (i.e., comparison of data between EG and CG), and could only analyze data from the whole group who completed W18 assessment (N=19). Considering a total of 2581 days of monitoring, we collected total complete data of 963 days (40%); this fraction was significantly higher during the OP than in the TP [219/266, (83%) vs. 744/2128, (35%); p<0.0001, Chi-Square Test]. There were no significant differences in distance [median: 504 (IQR: 453-588) m vs 522 (477-597) m, P=0.860)] and VO2 at steady state [15.5 (12.5-21.6) ml/kg/min vs 18.1 (14.2-22.4) ml/kg/min, P=0.104] during 6MWT at W18 (Wilcoxon test). However, we observed significant reduction of BMI [27.7 (24.7-31) kg/m2 vs 27.7 (24.5-30.1) kg/m2, P=0.036], hip circumference [106 (94-109) cm vs 104 (93-109) cm, P=0.014], total-C [188 (170-223) mg/dl vs 186 (160-201), P=0.049] and HDL-C [45 (38-54) mg/dl vs 41 (36-51), P=0.045] (Wilcoxon test).

CONCLUSION: The technical problems affected training prescription and monitoring, failing to assess an improvement of CRF. However, the AP was useful to improve body composition and blood lipid profile.

WEIGHT-CLASS SPORTS AND SUSCEPTIBILITY TO UPPER RESPIRATORY TRACT INFECTION: A CROSS-SECTIONAL STUDY

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INTRODUCTION: BACKGROUND: Limited data on the relationship between weight-class sports and health are available. In particular, no studies have investigated the relationship between weight-class sports and upper respiratory tract infection (URTI) susceptibility.

PURPOSE: We conducted a cross-sectional study investigating the relationship between weight-class sports and susceptibility to URTI among Japanese past and present sports people.

METHODS: This study was conducted with monitors registered with an Internet research firm in Japan. The study participants consisted of 2,500 past or present sports people living in Japan. An Internet survey began on July 30, 2021, and ended on August 3, 2021. Participants were asked about the frequency of URTI before the COVID-19 a pandemic, and were asked to select the most appropriate answer among the following options: a few times each year, about once every year, once every few years and, rarely. Participants were also asked if they had ever participated or are currently participating weight-class sports (have participated in the past and currently participating [WCS-G]; have participated in the past but not currently [Past-WCS-G]; have never participated [No-WCS-G]). In addition, potential confounding factors that may be associated with URTI were investigated. We defined "a few times each year" and "about once each year" as frequent URTI sufferers and "once every few years" and "rarely" as non-frequent URTI sufferers. Multivariable-adjusted odds ratios (OR) and 95% confidence intervals (95% CI) for the susceptibility to URTI were obtained using logistic regression models while adjusting for confounders age, sex, marital status, household income, and education.

RESULTS: There were a total of 869 (34.8%) frequent URTI sufferers. Using the No-WCS-G as a reference, the OR and 95% CI were 1.53 (0.99–2.37) for Past-WCS-G, and 2.93 (2.30–3.72) for WCS-G, respectively.

CONCLUSION: The results of this study show that a negative relationship was observed between weight-class sports and URTI. Although this is a cross-sectional study and the study design cannot determine causal relationships, sports people

who play weight-class sports may need to be more careful in preventing URTI than those who play other sports. Therefore, the future studies are necessary to clarify the relationship between weight-class sports and URTI using a study design that can better establish the causal relationship between weight class sports and susceptibility to URTI.

RELATIONSHIP BETWEEN ANTERIOR-POSTERIOR ACCELERATION AND THE T2 RELAXATION TIME OF LUMBAR INTERVERTEBRAL DISCS DURING RUNNING EXERCISES

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INTRODUCTION: There is limited knowledge about which loading protocols are beneficial to intervertebral discs (IVDs). The T2 relaxation time reflects the state of the IVD, and the length of the T2 relaxation time for lumbar IVDs is reportedly associated with loading patterns such as fast walking or slow running (1). These findings suggest that running exercise regimens affect IVDs; however, the detailed loading applied during running needs to be clarified. Reportedly, slow running is beneficial for IVDs, but the mechanism is unclear. Therefore, this study aimed to investigate the relationship between the load during slow running and changes in the T2 relaxation time of lumbar IVDs before and after running.

METHODS: Sixteen healthy male students were enrolled in this study (age, 20.8 ± 1.2 years; height, 172.2 ± 4.4 cm; weight, 72.3 ± 9.2 kg). The participants ran on a treadmill at a speed of 8 km/h for one minute. Running acceleration was recorded by a triaxial accelerometer with a belt fixed to the participant's L4/L5 lumbar intervertebral region. T2 values before and after the exercise were measured using MRI. For the measurement, the L4/L5 disc was divided into five regions of interest, designating the anterior annulus fibrosus (AF), anterior nucleus (AN), central nucleus (CN), posterior nucleus (PN), and posterior annulus fibrosus (PF). Pearsons correlation coefficient was used to examine the correlation between changes in the T2 relaxation time and acceleration.

RESULTS: The T2 relaxation time of the IVDs changed from their pre-running baseline values by +3.8% for AF, -2.6% for AN, -1.3% for CN, +0.2% for PN, and +7.5% for PF. The accelerations were 0.23 ± 0.06 rms in the X-axis (medial-lateral), 1.37 ± 0.08 rms in the Y-axis (vertical), and 0.30 ± 0.06 rms in the Z-axis (anterior-posterior). Analysis of the correlation between changes in the T2 relaxation time and acceleration showed a positive correlation between changes in the CN T2 relaxation time and acceleration in the Z axis ($r = 0.65$, $p = 0.006$).

CONCLUSION: In this study, a positive correlation was found between Z-axis acceleration and T2 relaxation time after running, suggesting that greater anterior-posterior acceleration increases the water content of the CN. This result supports the finding of previous studies that slow running results in the optimal range of loading for IVDs (1). However, as the running speed increases, the acceleration also increases (2), which may exceed the optimal loading range. Although high-speed running studies are necessary, the results suggest that anterior-posterior loading from slow-speed running may be related to changes in the water content of the CN.

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TEMPORAL RELATIONSHIP BETWEEN OBJECTIVELY MEASURED PHYSICAL ACTIVITY AND PAIN OCCURRENCE IN PATIENTS WITH SICKLE CELL ANEMIA: A PILOT STUDY

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INTRODUCTION: Sickle cell anemia is caused by a mutation on the beta-globin gene, which leads to the production of abnormal hemoglobin. Under deoxygenated conditions, this hemoglobin may polymerize, causing red blood cells to adopt a sickle-like shape. Acute painful vaso-occlusive crises observed in sickle cell anemia patients result from the obstruction of vessels by sickled red blood cells. Since hypoxemia is one of the main triggers of red blood cell sickling, patients are usually recommended to avoid vigorous exercising. However, the adoption of sedentary lifestyles may prevent the development of physical activity-mediated adaptations that could have improved the clinical outcome of the disease. To date, only 2 studies have proposed an objective measurement of sickle cell anemia patients and none of them has been interested in the temporal relationship between physical behaviors and pain. The present study aims at exploring the temporal relationship between objectively assessed physical activity and pain occurrence in sickle cell disease patients.

METHODS: Eighty sickle cell disease patients were recruited through the National Center for Blood Transfusion of Dakar, Senegal for the "drePAnon" study (UMIN000042826, UMIN-CTR Clinical Trial). The participants were given a wrist-worn activity tracker equipped with an accelerometer and providing access to minute-by-minute physical activity data. The monitoring period lasted for 5 to 15 weeks. The participants also complete a pain diary. The data of 6 patients (male only, 30 ± 5 years old) with the highest quality of pain and physical activity data were used to perform the temporal statistical analysis. For each day of the monitoring period, 24 data features informing on the timing, duration, and volume of 3 and 6 MET or more physical activity over periods of 24, 48, and 72 hours were extracted from the minute-by-minute activity tracker time series. The temporal relationship between the principal components of the 24 physical activity parameters and pain was tested using cross-correlation tests for each patient and for time lags of 0 to -5 days.

RESULTS: Significant positive correlations between the principal component parameter of 3 and 6 MET or more physical activity and pain intensity were found in 3 of the 6 patients (correlation coefficients between 0.22 and 0.77). Interestingly, the strongest correlations (i.e., correlation coefficient above 0.70) occur for a time lag of -3 days.

CONCLUSION: The present study tends to confirm the potential temporal relationship between relatively high intensities of physical activity completed within the course of the daily life and later painful vaso-occlusive events. The risk of experiencing acute painful episodes on one given day may be related to physical behaviors that were performed 3 days before. Further studies are necessary to confirm these preliminary observations and to develop activity tracker-based preventive strategies against vaso-occlusive events.

A COMPARISON OF TWO BEST-PRACTICE CLINICAL EXERCISE SERVICES IN THE UNITED KINGDOM: RECOMMENDATIONS FOR SERVICE AND EDUCATION PROVIDERS

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INTRODUCTION: In the United Kingdom (UK), the National Health Service long-term plan advocates clinical exercise services, yet we have shown previously, clinical exercise provision is inconsistent across conditions in terms of job titles, roles and qualifications (Crozier et al., 2022). The creation of UK Clinical Exercise Physiologists (CEPs), as a registered health professional in 2021, provided a solution to standardise the exercise workforce. Our aim was to compare common themes across two nationally recognised best-practice clinical exercise services in terms of staff knowledge and skills to generate common themes to translate into consistent, evidence-based, actionable recommendations.

METHODS: A multi-method qualitative (semi-structured interviews, focus groups, observations, field notes and researcher reflections) approach was employed with the researcher immersed for 12-weeks within each service (cancer service delivered from a community setting and cardiac service delivered in dedicated acute setting). The Consolidated Framework for Implementation Research (CFIR) was used as an overarching guide. Data from each service were thematically analysed individually before synthesis to compare generated themes from staff and service user perspectives. Clinical exercise service staff recruited (n=17) were comprised of registered Clinical Exercise Physiologists (CEPs) (n=5), unregulated advanced exercise instructors (n=7), clinical nurse specialists (n=2), dieticians (n=1) and service managers/leads (n=2). Service users recruited (n=16) attended either one of the exercise services following a clinical event or diagnosis.

RESULTS: There were five common themes identified across the two services: (i) registered CEPs (or those qualified to a level to apply for registration via equivalency) were employed, (ii) nationally recognised exercise referral pathways were followed from the initial point of care and referral for exercise was to a CEP (iii) workplace craft and peer observation were essential for the sharing of knowledge and experiences between different health professions (iv) flexible behaviour change approaches via impromptu conversations were more successful at engaging patients than structured education sessions, and (v) individualised and innovative evidence-based exercise prescription was optimal.

CONCLUSION: The themes outlined in this study suggest that clinical exercise services should employ registered CEPs. The knowledge and skills CEPs possess including innovative, evidence based-exercise prescription, flexible behaviour change approaches, referral pathways and communication with other health care professionals, ensure effective clinical exercise services. Education and continued professional development of CEPs should include workplace specific training and observations. The themes from this study align with the Clinical Exercise Physiology UK curriculum framework to ensure CEPs are trained to meet the standards for registration.

TRAINING EXERCISE AND SPORT PROFESSIONALS TO SUPERVISE EXERCISE PROGRAMS TAILORED TO PREGNANT AND POSTPARTUM WOMEN: THE ACTIVE PREGNANCY PROJECT WORKSHOPS AND EDUCATIONAL RESOURCES

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INTRODUCTION: Physical activity should be part of a healthy lifestyle during pregnancy and postpartum. Current literature supports the recommendation to initiate or continue physical exercise in pregnant and postpartum women without complications. Despite evidence of multiple health and fitness benefits to mother and foetus of being active during pregnancy and postpartum, most women reduce both frequency and intensity of exercise, and many are inactive throughout, failing to meet recommended physical activity levels. Therefore, promoting physical activity and exercise among women of childbearing age remains a priority in public health policy, and it is a challenging process. Women's health literacy is essential to improve healthcare behavior, empowerment, and self-management. Thus, educating exercise and health professionals effectively is of major importance.

The objective is to present one of the outcomes of the Active Pregnancy Project regarding the educational programs, resources, and professional standards for exercise and sports professionals dealing with pregnant and postpartum women.

METHODS: This session will present a qualitative analysis regarding the development, feasibility, and effectiveness of educational interventions and contents, as well as European professional standards for exercise and sports professionals, based on updated guidelines and evidence on the positive impact of exercise during pregnancy and postpartum.

The main methods were: conducting systematic reviews; validating the exercise program as a complex intervention in health; developing educational standards and training for the Pre/Post Natal Exercise Specialist; developing educational tools, such as webinars, workshops, guidelines, and textbook (e.g. Exercise and Physical Activity during Pregnancy and Postpartum, by Springer) and manuals (e.g., Active Pregnancy and Health Professionals' Guides) for women and professionals; developing the free access Active Pregnancy YouTube channel: https://www.youtube.com/channel/UC0Vyookwc0mcQ5T70imtoNA/playlists.

RESULTS: The educational program and materials developed within the Active Pregnancy Project effectively educate exercise and sports professionals to work with pregnant and postpartum clients. They will be professionally prepared to consider the multifaceted determinants and outcomes of prenatal physical activity and intervene to promote physical activity before, during, and after pregnancy, helping women to overcome any identified barriers.

CONCLUSION: Trustworthy and comprehensive guidelines created based on the Active Pregnancy Project and international and interdisciplinary initiatives should be disseminated among all interested in prenatal physical activity: pregnant women and their families, obstetric care providers, and exercise professionals to enable them effective cooperation and to globally promote exercise in pregnancy.

EVALUATION AND TREATMENT OF THORACIC HYPERKYPHOSIS IN YOUNG BASKETBALL PLAYERS: A PILOT STUDY

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INTRODUCTION: Thoracic hyperkyphosis is one of the most common postural disorders (Garoflid, 2000) identified with a rounded back and shoulders forward (Vaughn, 2007) that could be developed during adolescence (Kamaci, 2015). Young basketball players have a high level of endurance demand, often overloading the biological tissues and causing biomechanical compensations (Guedes, 2014). Due to the immaturity of their musculoskeletal structures, those consequences may influence the growth process and lead to the development of various postural patterns (Grabara, 2014). The following study aims to verify if the use of a corrective program could prevent postural disorders in young basketball athletes.

METHODS: Twenty-eight healthy male adolescents basketball players took part in the study: fourteen in the experimental (EXP) group (15.3±1.1yrs; 65.9±9.1 kg; 182.5±6.2 cm) and fourteen in the control (CTRL) group (15.4±1.3 yrs; 73.9±6 kg; 180.8±7.5 cm). Both groups were assessed with a postural screening test in order to find any postural issues and subjects were screened with manual inclinometers and plumb line (Kendall, 2005). At baseline (PRE) and post 8 weeks of training (POST), Dorsal Kyphosis grades (DK), Forward Head Posture grades (FHP), Forward Shoulder Position anteposition (FSP), and Push-Pull ratio (PPratio) have been evaluated. The training program was structured with three parts: the first with mobility exercises for the upper joints, the second with analytical exercises for the shoulder musculature, and a third with integrated exercises for the upper musculature.

RESULTS: In the EXP group, DK (PRE 45.8±5.3°; POST: 36.1±7°), FHP (PRE: 12.9±5.6°; POST: 3.3±3.4°), FSP (PRE: 12.9±1.5 cm; POST: 11.1±1.4 cm), and PPratio (PRE: 2.73±1.24; POST: 1.54±0.34) were significantly ($p<0.01$) influenced by training. In the CTRL group, there weren't any significant changes in the data except for the FSP (PRE: 12.3±1.3 cm; POST: 13.1±1.6 cm) ($p<0.05$).

CONCLUSION: Our data show that a corrective exercise program could improve dorsal kyphosis posture, lowering the entity of the dorsal and cervical curves, realigning the head and the shoulders in the correct position, and balancing the muscular strength differences between pushing and pulling muscles. The present corrective exercise program could be used as a pre-practice warm-up in those athletes who have a kyphosis posture or in those athletes with a kyphosis that needs to be corrected.

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ASSOCIATIONS BETWEEN PHYSICAL ACTIVITY, CARDIORESPIRATORY FITNESS, PERCEPTUAL-COGNITIVE FUNCTION, AND DEPRESSIVE SYMPTOMS IN YOUNG ADULTS

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INTRODUCTION: Depression is a global health pandemic, particularly affecting young adults, and can result in cognitive impairment, premature mortality, and various other physical and mental health issues. However, limited research exists on the relationship between objective habitual physical activity, cardiorespiratory fitness, perceptual-cognitive functioning and depression in young adults. This study aimed to examine the relationship between these variables in young South African adults aged 18-25 years.

METHODS: Forty young adults between 18-25 years (21.8 ± 1.76 years) were included in this study, with a majority female (90%). The Beck Depression Inventory (BDI) evaluated depressive symptoms, and a combination of heart rate and accelerometry (ActiHeart®) measured objective habitual physical activity levels over seven consecutive days. Cardiorespiratory fitness was calculated from an incremental step test. Multi-object tracking measurements (NeuroTracker®) represented perceptual-cognitive functioning and screen time was measured using a log sheet. . Partial correlation analyses, multiple regression analysis and Pearson's Chi-squares were utilized to determine the relationship between objective habitual physical activity, cardiorespiratory fitness, perceptual-cognitive functioning, and depressive symptoms.

RESULTS: The average BDI-score was 20.5 ± 8.0 points for the participants. Results showed no significant association between objectively measured habitual physical activity and symptoms of depression ($r = 0.002$; $p = 0.989$), nor between cardiorespiratory fitness and symptoms of depression ($r = -0.13$; $p = 0.43$). There was, however, a significant negative correlation between symptoms of depression and perceptual-cognitive functioning($r = -0.34$; $p = 0.05$), and a significant positive correlation between symptoms of depression and leisure screen time ($r = 0.35$; $p = 0.03$) when adjusted for sex and age.

CONCLUSION: Individuals engaging in longer periods of leisure screen time showed higher scores of depressive symptoms, as well as lower perceptual-cognitive functioning. Although not statistically significant, trends of an inverse association were evident between habitual physical activity and depressive scores. Introducing regular exercise may serve as a low-cost intervention in the management of depressive symptoms in young adults. Replacing screen time with regular physical activity may improve depressive symptoms, improve cardiorespiratory fitness and perceptual cognitive functioning.

CROSS-SECTIONAL ASSOCIATIONS OF ACCESS TO PARKS WITH TIMING-SPECIFIC PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOR IN OLDER ADULTS

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INTRODUCTION: Parks play important roles to promote physical activity among older adults, however, it remains unclear its associations with physical activity and sedentary behavior depending on the time of the day. Thus, this study examined whether access to parks is associated with timing-specific physical activity and sedentary behavior in older adults.

METHODS: We included 214 older adults (mean age: 80.2 ± 7.0 years) from Taiwan in this cross-sectional study. Assess to parks within 400-, 800-, and 1600-m of participants' residential address were estimated using a geographic information system. An accelerometer (Actigraph) was used to calculate their daily physical activity and sedentary behavior during three time periods: morning (6:00 to 12:00), afternoon (12:01 to 18:00), and night (18:01 to 24:00). Multiple linear regression was performed after adjustment for potential covariates to examine the associations of park accessibility with physical activity and sedentary behavior during different time periods.

RESULTS: After adjusting for confounders, favorable access to parks within 400-m buffer is positively associated with older adults' total physical activity in afternoon (B = 3.00; 95% CI, 1.25 - 4.75) and evening (B = 2.42; 95% CI, 0.84 - 4.00), as well as negatively related to sedentary time in afternoon (B = -3.00; 95% CI, -4.75 - 1.25) and evening (B = -2.42; 95% CI, -4.00 - -0.84). Above-mentioned associations were found within 800-m buffer, but not in 1600-m buffer. No association was found between access to parks and older adults' physical activity and sedentary behavior during morning.

CONCLUSION: Regardless of 400-, and 800-m buffer, favorable access to parks in the neighborhood is positively associated with older adults' total physical activity and negatively related to their sedentary time in afternoon and evening. Future research applying longitudinal methods is required to further understand these associations.

GET STRONG TO FIGHT CHILDHOOD CANCER: AN EXERCISE INTERVENTION FOR CHILDREN AND ADOLESCENTS UNDERGOING ANTI-CANCER TREATMENT (FORTEE)

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INTRODUCTION: Picmanova, V., Heisserer , B., Mongondry, R., Bloch, W., Rizvi, K., Fridh, M.K., Lucia, A., Fiuza-Luces, C., Götte, M., Spreafico, F., Konda, B., Stefanovic, M., Sowa-Israel, M., Baader, T., Faber, J.

Cancer is the leading cause of death by non-communicable diseases in children in Europe. During cancer treatment, patients' morbidity is increased due to e.g. physical inactivity and cancer-related fatigue. Personalised exercise training during the intensive phase of cancer treatment in children and adolescents is a promising therapy to mitigate above mentioned issues. However, evidence for

using exercise to counteract fatigue and improve health-related quality of life is lacking in paediatric oncology.

The FORTEe research project intends to evaluate a personalised and standardised exercise intervention in 450 children, adolescents and young adults undergoing cancer treatment in nine centres across Europe. This randomised, controlled multicentre trial aims to generate high evidence for an innovative, patient-centred exercise treatment as part of the standard of care. Experiences

and expertise in paediatric exercise oncology within Europe were merged to develop specific exercise training and testing protocols which are to be implemented with the help of digital, innovative technologies.

The elaborated protocols are standardised to enable adapted personalised exercise training. A meticulous approach to tailored exercise includes a sensitive functional evaluation system to set the appropriate exercise dosage, aiming atdefining type, frequency and intensity. Precision exercise training protocols are adapted and personalised to the cancer patient □ ́s clinical phenotype. The

intensity, time and volume of exercise are adjusted to the cancer treatment intensity and to each patient ́s clinical condition and response. For this purpose, different modalities are included that allow training sessions in-person but also

remotely, supported by innovative technologies.

As a progress beyond the current state-of-the-art, FORTEe has the ambition to implement paediatric exercise oncology as an evidence-based standard in clinical care for all childhood cancer patients worldwide.

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Conventional Print Poster

CP-PN07 Physiology: Muscle Metabolism

EXERCISE-INDUCED REDUCTIONS IN MITOCHONDRIAL ADP SENSITIVITY ARE LINKED TO MUSCLE GLYCOGEN DEPLETION

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INTRODUCTION: Mitochondrial oxidative phosphorylation is dependent on the supply of substrates such as ADP. While the sensitivity of mitochondria to ADP is acutely impaired in response to exercise, the mechanisms and physiological consequences remain unknown. It is possible that the decline in mitochondrial ADP sensitivity could concentrate ADP within the cytosol, and since cytosolic ADP activates glycogen phosphorylase, this could be a mechanism to promote glycogen breakdown. Despite this possibility, the relationship between mitochondrial substrate sensitivity and the extent of glycogen depletion during exercise remains to be understood.

METHODS: 12 endurance-trained male cyclists (25 ± 5 years, VO2max: 66 ± 5 mL/kg/min) performed a standard ~2 hour glycogen depletion protocol on a cycle ergometer in a fasted state. The protocol consisted of 2 min blocks alternating between high and low intensity cycling. The high intensity blocks started at 90% Wmax and were decreased by 10% Wmax (80%, 70% Wmax) when intervals were no longer able to be completed (60 rpm). The low intensity blocks were performed at 50% Wmax. Muscle biopsies were obtained pre-exercise and 2 hours post-exercise. Mitochondrial ADP sensitivity (Michaelis-Menten kinetics, Vmax constrained at 105) and pyruvate sensitivity (one-phase association, plateau constrained at 100) were measured in permeabilized muscle fibres. Muscle glycogen content was determined in freeze-dried whole muscle homogenate. Data were analyzed using paired t-tests and expressed as mean ± SD.

RESULTS: The glycogen-depleting cycling protocol decreased muscle glycogen content nearly 3-fold (226 ± 44 mmol/kg dry weight pre- vs. 77 ± 39 mmol/kg dry weight post-exercise, $p < 0.0001$). While exercise did not alter maximal mitochondrial respiratory capacity, mitochondrial ADP sensitivity was decreased ~12%, indicated by an increase in the apparent Km (1098 ± 102 µM ADP pre- vs 1229 ± 127 µM ADP post-exercise, $p = 0.0008$). In contrast, mitochondrial pyruvate sensitivity was increased post-exercise (half-time: 98 ± 13 µM pyruvate pre- vs 92 ± 8 µM pyruvate post-exercise, $p = 0.03$), suggesting an increase in the ability to utilize glycogen for oxidative phosphorylation. While no significant correlation was found between changes in pyruvate sensitivity and the decline in muscle glycogen content, in contrast, the change in the ADP Km was significantly correlated ($r = -0.60$, $p = 0.04$) with the extent of glycogen depletion.

CONCLUSION: The present data suggest the exercise-induced decrease in mitochondrial ADP sensitivity is a mechanism promoting glycogen breakdown during prolonged intense exercise in human skeletal muscle.

RELATIONSHIP BETWEEN MITOCHONDRIAL RESPIRATORY VARIABLES AND CONVENTIONAL DETERMINANTS OF ENDURANCE EXERCISE PERFORMANCE IN HEALTHY ADULTS

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INTRODUCTION: It is well documented that exercise economy, lactate or gas exchange threshold, and VO2peak are important determinants of endurance exercise performance. However, the extent to which these systemic endurance performance determinants relate to local muscle respiratory function is comparatively unclear. Therefore, the purpose of the current study was to assess the extent to which skeletal muscle mitochondrial respiratory variables were associated with the classical determinants of endurance exercise performance.

METHODS: Eighteen recreationally-active (VO2peak, 47 ± 5 ml/kg/min) male participants reported to the laboratory on two separate occasions. On the first visit to the laboratory, participants completed a linear ramp incremental cycle test, at rate

of 30 W/min, until exhaustion. Pulmonary gas exchange and ventilatory variables were collected throughout the test for later determination of peak aerobic power (PAP), gas exchange threshold (GET), respiratory compensation point (RCP), VO2-work rate (VO2-WR) slope (as a marker of exercise economy), and VO2peak. On the second visit to the laboratory, a muscle biopsy was obtained from the m. vastus lateralis for determination of mitochondrial respiratory variables in permeabilised muscle fibre bundles. Specifically, uncoupled leak respiration through complex I (CIL), saturating adenosine diphosphate stimulated respiration through complex I (CIP) and complex I+II (CI+IIP), and maximal electron transfer system activity through complex I+II (CI+IIE), complex II (CIIE) and complex IV (CIVE) were assess using high-resolution respirometry. In addition, coupling control ratio (CIL/CI+IIP; 1/RCR) was used as a marker of oxidative phosphorylation coupling efficiency. The relationship between the variables determined through the ramp incremental test and high-resolution respirometry were assessed using Pearson's correlation coefficient (r) with statistical significance accepted as P≤0.05.

RESULTS: There were negative relationships between 1/RCR and PAP (r = -0.52), GET (r = -0.59), RCP (r = -0.50) and VO2peak (r = -0.47), as well as CIL and PAP (r = -0.57) and GET (r = -0.61). There was a positive relationship between CIVE and VO2peak (r = 0.47), and CIIE and RCP (r = 0.46). There were no further significant correlations between variables obtained from the ramp incremental exercise test and high-resolution respirometry.

CONCLUSION: Oxidative phosphorylation coupling efficiency, inferred from the 1/RCR coupling control ratio, was inversely associated with established determinants of endurance exercise performance. These observations suggest that improved mitochondrial oxidative phosphorylation coupling efficiency is associated with higher physiological thresholds which may have implications for enhancing endurance exercise performance.

THE COMBINED TREATMENT OF VITAMIN E SUPPLEMENT AND VOLUNTARY WHEEL RUNNING ENHANCES SKELETAL MUSCLE MITOCHONDRIAL FUNCTION INDEPENDENT OF OXIDATIVE STRESS IN OVARIECTOMIZED MICE

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INTRODUCTION: Menopausal women experience obesity mainly due to skeletal muscle metabolic dysfunction. During exercise, skeletal muscle fibers consume greater oxygen compared to resting state contributing to the unbalanced state of increased oxidative stress, which can be alleviated by vitamin E supplement, one of the strong insoluble antioxidants. The findings from previous studies investigating the effect of vitamin E combined with exercise are somewhat mixed. The purpose of the present study was to investigate whether the combined treatment of vitamin E supplement and voluntary wheel running can enhance metabolic function including skeletal muscle mitochondria in ovariectomized mice, and whether this improvement is associated with lower oxidative stress marker.

METHODS: This 12-week study used female C57BL/6J wild type mice (n=40, 8 weeks old), which were randomly assigned to Sham (SHM), ovariectomy (OVX), ovariectomy with exercise (OVXVE), ovariectomy with vitamin E (OVXV), and ovariectomy with exercise and vitamin E (OVXVE) groups. Fat/lean mass and whole-body metabolic rate were assessed using dual-energy x-ray absorptiometry (DXA) and indirect calorimetry, respectively. Mitochondrial function and PGC1α protein content were assessed using OROBOROS O2K and Western blot. Carbonyl protein content, a marker of oxidative stress, was measured by protein carbonyl assay kit.

RESULTS: Lean mass did not differ between groups, but in fat mass, OVXV and OVXVE were significantly higher than SHM, and OVXVE was higher than OVX and OVXE. The metabolic rate was significantly greater in SHM than other groups. While mitochondrial function in gastrocnemius muscle was not significantly different between groups, interestingly in soleus, OVXVE was significantly greater than SHM, OVX, and OVXE (82.7±5.7, 87.9±5.4, 90.4±5.1, and 112.2±5.4 pmol*sec-1*mg-1, all P<0.05, SHM, OVX, OVXE, and OVXVE, respectively). This trend was confirmed by the assessment of PGC1α protein content in soleus, such that only OVXVE was significantly greater than SHM and OVX groups. However, protein carbonyl content was lower in OVXV and OVXVE compared to OVX in gastrocnemius, whereas there was no significant group difference found in soleus.

CONCLUSION: The combined treatment with vitamin E and exercise enhanced mitochondrial function and PGC1α protein content of soleus skeletal muscle, which was independent of oxidative stress marker. More studies are necessary to investigate the underlying mechanism by which the synergetic effect of vitamin E and exercise treatment on mitochondrial function differs between soleus and gastrocnemius muscles in ovariectomized mice.

MITOCHONDRIA OF HUMAN TYPE II MUSCLE FIBERS HAVE HIGHER A INTRINSIC RESPIRATORY RATE WHICH IS MEDIATED THROUGH ELEVATED COMPLEX II RESPIRATION.

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INTRODUCTION: Human skeletal muscle consists of a mixture of slow- and fast-twitch fibers with distinct capacities for contraction mechanics, glycolysis, and oxidative phosphorylation (OXPHOS). While the divergence in mitochondrial volume favoring slow-twitch fibers is well established, data on the fiber type-specific intrinsic mitochondrial function are highly limited with existing data mainly being generated in animal models. However, translating animal models comparing oxidative (I/IIA) to glycolytic (IIX/IIB) fibers onto human physiology is difficult, given that our muscles consist of mainly slow or fast-twitch oxidative fibers (I/IIA) with limited glycolytic (IIX) fiber content. This highlights the need for more human data on the topic.

METHODS: Skeletal muscle biopsies were collected from seven young and healthy men and women in a fasted state. Immediately after collection, individual muscle fibers were dissected from the whole muscle tissue, fiber typed using the newly developed THRIFTY-method and subsequently pooled according to their fiber type. The whole procedure from sample collection, dissection, typing, and pooling took 5-6 hours. The type I and type II muscle fibers pools were then permeabilized with saponin followed by measurement of mitochondrial respiration using a two-channel high-resolution Oroboros respirometer. A median of 48 (range 15-52) type I and 31 (21-54) type II fibers were included per participant in the respiratory measurement following fiber typing, with 285 slow-twitch fibers and 232 fast-twitch fibers included across all participants. To account for mitochondrial volume in each fiber pool, samples were recovered from the respirometer chambers and analyzed for mitochondrial volume markers residing in both the outer and inner mitochondrial membranes using immunoblotting.

RESULTS: As expected, full ADP stimulated respiration, i.e. OXPHOS capacity was higher in the slow-twitch type I fibers (59 vs 47 pmol x s-1 x mg-1, $P<0.05$) and assessment of mitochondrial volume markers revealed approximately 3-fold higher mitochondrial content in the type I fiber pools. When expressed per mitochondrial volume, type II fibers had approximately 50% higher ($P<0.05$) respiration compared to type I fibers. No difference in the respiratory rates were observed during states of both fat oxidation and complex I capacity between the mitochondria of type I and type II fibers. However, when the combined respiration of complex I and complex II were related to only complex I respiration, values were significantly higher in type II fibers. Moreover, type II fibers had 2-fold higher complex II protein levels compared to type I fibers ($P<0.05$).

CONCLUSION: Mitochondria of human type II muscle fibers compensate for their lack of volume by increasing the expression of key proteins regulating OXPHOS capacity. Human fast-twitch mitochondria also have a substantially elevated intrinsic respiratory rate which is primarily mediated through elevated complex II respiration.

THE INFLUENCE OF SEX ON FIBER-SPECIFIC SKELETAL MUSCLE CHARACTERISTICS LINKED TO AEROBIC ENERGY METABOLISM

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INTRODUCTION: Increased fat oxidation reported during moderate-intensity endurance exercise in females compared to males may be due, in part, to sex differences in resting skeletal muscle characteristics. For example, females have been demonstrated to have greater whole-muscle mitochondrial content (1) and capillarization (2), which may be explained by a higher proportionate area of slow-oxidative type I fibers compared to males. However, it is also possible that the oxidative potential of type I and II muscle fibers is elevated in females, but this has yet to be explored. The purpose of this study was to investigate the influence of sex on human skeletal muscle fiber composition and fiber-specific indices of mitochondrial content and capillarization. The secondary objective was to investigate sex differences in biomarkers of mitochondrial content, mitochondrial dynamics, and fat metabolism in whole muscle homogenates.

METHODS: Resting skeletal muscle biopsy samples from the vastus lateralis were collected from untrained females (n=14; 23±5yr, 23.3±3.2kg/m2) and males (n=13; 23±4yr, 23.1±2.4kg/m2). Through immunofluorescent analyses we determined type I, IIa, and IIx fiber-type distribution, proportionate area and cross-sectional area (CSA), as well as fiber-type specific mitochondrial content and capillarization. Fiber-type specific mitochondrial content was quantified via COX IV pixel intensity of type I and II fibers. Fiber-type specific capillarization was determined via quantification of CD31-labelled capillaries and calculation of capillary-to-fiber ratio, capillary-to-fiber perimeter exchange index and capillary density of type I and II fibers. Western blot analysis was performed on whole muscle homogenates for determination of protein content of markers related to mitochondrial content (COXIV), mitochondrial dynamics (MFN2, DRP1) and fat metabolism (β-HAD).

RESULTS: Compared to males, females had increased proportionate area of type I fibers (42±12 vs 29±10%, p=0.01) and decreased proportionate area of type IIa fibers (39±6 vs 49±13%, p=0.02). The CSA of type IIa (5774±1146 vs 4183±1068 µm2, p=0.003) and IIx (4424±1380 vs 2744±688 µm2, p=0.002) fibers were greater in males compared to females. There were no sex differences in indices of capillarization or mitochondrial content among type I or type II fibers ($p>0.05$). However, increased capillary density of type I vs type II fibers was observed in males only (364±88 vs 280±66 capillaries/mm2; $p<0.05$). There were no sex differences in whole-muscle COX IV, DRP1, MFN2, and β-HAD protein content ($p>0.05$).

CONCLUSION: Our results suggest that a greater proportionate area of type I muscle fibers in females, rather than sex differences in the oxidative potential of type I or type II fibers, may contribute to previously reported sex differences in substrate metabolism during endurance exercise.

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2) Roepstorff, C et al.(2006). J Physiol, 574, 125–138.

INCREASED BLOOD LACTATE LEVELS VIA VENOUS INFUSION REDUCES CIRCULATING FREE FATTY ACIDS IN HUMANS AT REST

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INTRODUCTION: Several lines of evidence, from in vitro and rodent based research, suggests that lactate possess hormonal-like properties in a number of tissues. Here, one of the most highlighted tissues is adipose tissue, where elevated lactate exposure is described to suppress lipolysis. Through binding to the G-protein coupled receptor 81 (GPR81), lactate

stimulates a reduction in cyclicAMP and thus suppresses lipolysis. The half maximal effective concentration (EC50) for lactate stimulation of GPR81 is described to range between 1.5 to 5 mM depending on experimental condition. The hormonal-like properties of lactate in humans in vivo are however largely unexplored. Accordingly, the objective of this study was to study the signaling properties of lactate in adipose tissue in humans at rest, with focus on the regulation of lipolysis.

METHODS: Twelve young healthy individuals (six male and six female) took part in two experimental trials in which they received a venous infusion of sodium lactate (125 µmol/kg fat free mass/min) or volume matched saline, in a randomized cross-over fashion. Experiments were performed in the morning, with subjects in the over-night fasted state. Following baseline blood sampling and subcutaneous adipose tissue biopsy sampling, venous infusion was performed for 60 min. Blood samples were taken every 10 min during infusion and 15, 30, 45, 60, 90 and 120 min after infusion. Additional subcutaneous adipose tissue biopsies were taken immediately and 60 min after infusion. Blood samples were immediately analyzed for lactate, pH, sodium, potassium, base excess and hematocrit using automated systems. Serum levels of free fatty acids (FFA) were quantified using an enzymatic spectrophotometric assay.

RESULTS: The sodium lactate infusion increased blood levels of lactate from 0.6±0.1 mM at rest to 5.4±0.2 mM after 60 min of infusion and returned to baseline levels at 90 min post infusion. During saline infusion blood lactate levels decreased from 0.7±0.1 mM at rest to <0.5 mM after infusion. Based on changes in hematocrit there was an approximate 5% plasma volume expansion in both trials. Average baseline serum levels of FFA were 0.57±0.21 mM in both trials. In the saline trials serum FFA decreased by 10% after 60 min of infusion but returned to baseline 120 min post infusion. In the lactate infusion trials serum FFA were reduced by 40% immediately after infusion and remained 20% below basal levels at 120 min post infusion

CONCLUSION: Moderately elevated blood lactate levels, achieved by venous infusion, in humans at rest significantly reduces serum levels of FFA. We propose that this effect is due to lactate-GPR81 signaling in adipose tissue that inhibits lipolysis.

EFFECTS OF ANAEROBIC LACTIC METABOLISM ON THE SLOW COMPONENT OF OXYGEN UPTAKE KINETICS DURING HIGH INTENSITY EXERCISE IN HUMANS

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INTRODUCTION: The origin of the slow component of the oxygen uptake kinetics, which appears during exercise above the critical power and the maximal lactate steady state, is still a matter of discussion. Among the various hypotheses, Capelli et al (Eur J Appl Physiol 66: 189-195, 1993) postulated that, during intense exercise, the progressive decrease of muscle pH may be responsible for the slow component. In fact they showed that, during prolonged exercise, the intensity of which was betweeen 60 and 80% of VO2max, the rate of oxygen uptake increase after the 5th min of exercise was directly proportional to that of blood lactate accumulation. If this statement was correct, we would expect 1) a linear relationship between the amplitude of the slow component and the changes in blood lactate concentration during exercise, and 2) a slope of this linear relationship corresponding to the energy equivalent of blood lactate accumulation. Aim of the present study was to test the above hypotheses.

METHODS: On 13 male subjects (age 25 +/- 6 years, body mas 73 +/- 7 kg, height 178 +/- 7 cm), who performed tests at 60, 65, 70 and 80 % of individual VO2max up to exhaustion, we measured oxygen uptake (VO2) breath-by-breath, and blood lactate concentration ([La]b) at rest, and during exercise at min 5, 10, 20, 30 and at exhaustion. The volume of oxygen (DVO2) above the maximal power at steady state for VO2 and [La]b was then calculated, assuming that the slow component starts at the beginning of exercise and that the VO2 increase due to the slow component is linear, in agreement with the tested hypotheses.

RESULTS: At maximal lactate steady state, power was 176 +/- 24 W and VO2 corresponded to 64 +/- 5 % of individual VO2max. The linear relationship between DVO2 and [La]b was described by the following equation: $y = 2.90 x + 13.33$, $r = 0.77$. The intercept was slightly but significantly higher than 0. The slope fell inside the expected values for the energy equivalent of blood lactate accumulation.

CONCLUSION: These results appear substantially in agreement with the tested hypotheses. The highly significant linear relationship between DVO2 and [La]b was characterised by a slope corresponding to the energy equivalent of blood lactate accumulation indeed (Ferretti G, Energetics of Muscular Exercise, Springer, 2015). Since lactate accumulation at powers higher than that yielding the maximal lactate steady state occurs in a substantially linear manner, this may justify indeed a linear treatment of the time course of the slow component of oxygen uptake kinetics during high-intensity exercise, as done in this study.

THE IMPACT OF RAMP SLOPE ON THE NEAR-INFRARED SPECTROSCOPY DEOXYHEMOGLOBIN BREAKPOINT AND THE RESPIRATORY COMPENSATION POINT

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INTRODUCTION: Near-infrared spectroscopy (NIRS) has become a commonly used, non-invasive technique to gain insight into muscle oxygenation responses. During ramp-incremental (RI) cycling exercise, the deoxygenated hemoglobin ([HHb]) NIRS signal in the vastus lateralis demonstrates a plateau-like response in the latter portion of the test. This response,

named the [HHb] breakpoint ([HHb]BP), has been shown to be repeatable measure that corresponds to exercise intensity at the respiratory compensation point (RCP). While studies have investigated the impact of variables such as pedalling rate, fraction of inspired oxygen, and fitness status on oxygen uptake (VO2) at the [HHb]BP and its correspondence to the RCP, the impact of RI slope has not been examined. Therefore, this study aimed to determine whether the VO2 at which the [HHb]BP and RCP occur is affected by variations in RI slope. We hypothesized that, due to the physiological nature of the [HHb]BP, the VO2 at which the [HHb]BP and RCP occur would not be different between tests.

METHODS: Twelve healthy participants (9 M, 3 F) reported to the laboratory on three separate occasions to perform a RI cycling exercise test to task failure. Each test consisted of a 4-min baseline at 20W, followed by a 6-min moderate intensity square-wave transition to 60-80 W, and 4-min at 20W before a RI test with a slope of 15, 30 or 45 W/min. The order of testing was randomized for each participant, and each visit was separated by 48-72 hours. The NIRS derived [HHb] signal in the vastus lateralis as well as VO2 were continuously measured throughout each test.

RESULTS: VO2 at the [HHb]BP was not different between slopes at 3.08 ± 0.53 L/min, 3.10 ± 0.68 L/min, and 3.04 ± 0.64 L/min for the 15, 30 and 45 W/min slope, respectively ($p>0.05$). VO2 at the RCP was 3.16 ± 0.65 L/min (15 W/min), 3.20 ± 0.73 L/min (30 W/min), and 3.17 ± 0.75 (L/min) with no difference between slopes ($p>0.05$). There were no differences between VO2 at the [HHb]BP and the RCP for any of the RI slopes ($p>0.05$). Correlation values, bias, and confidence intervals (CI) between the VO2 at the [HHb]BP and RCP were: $r=0.91$ ($p<0.01$), bias -0.08 L/min ($p=0.34$), CI -0.25 to 0.19 (15 W/min); $r=0.97$ ($p<0.01$), bias -0.10 L/min ($p=0.10$), CI -0.22 to 0.02 (30 W/min); and $r=0.88$ ($p<0.01$), bias -0.12 L/min ($p=0.26$), CI -0.35 to 0.10 (45 W/min). Intraclass correlation coefficients for the VO2 at the [HHb]BP vs the RCP were 0.94 (15 W/min), 0.98 (30 W/min), and 0.93 (45 W/min).

CONCLUSION: The results of this study demonstrate that the VO2 at which the [HHb]BP and the RCP occur is unaffected by variations in the slope of ramp-incremental cycling exercise. Additionally, the fact that the VO2 at the [HHb]BP and RCP were not different between tests, were highly correlated, and had no significant bias provides further evidence of their shared physiological basis.

ENDOTHELIAL FUNCTION AFFECTS MUSCLE PROTEIN ANABOLIC RESPONSE IN HEALTHY AND DIABETIC OLDER ADULTS AFTER 12 WEEKS OF RESISTANCE EXERCISE TRAINING

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INTRODUCTION: Aging is characterized by a slow and physiological decline in muscle quality and function. Resistance exercise (RET) is known to restore muscle quality in healthy older adults; however, Type 2 diabetes (T2DM), which is associated with an altered muscle protein metabolism and vascular functions, may reduce the anabolic effect of exercise. The aim of this study was to indagate the effectiveness of RET in a group of healthy and diabetic older adults.

METHODS: 15 healthy older adults (68.3±4.3 years) and 15 diabetic older adults (71.1±4.7 years) underwent to 12 weeks of RET. Muscle strength, body composition analysis and muscle biopsies from vastus lateralis were obtained before and after 12 weeks of training. Muscle protein synthesis (MPS) was assessed during a stable isotope infusion experiment wherein subjects ingested an essential amino acid (EAA) mixture to test their anabolic response. Cross-sectional area (CSA), satellite cell abundance (SC) and capillary content were measured immunohistochemically.

RESULTS: Both T2DM and healthy older adults increased appendicular muscle mass and strength after training. Basal MPS was significantly different between groups before the intervention ($p=0.048$) and increased in both group with training; whereas, contrary to the healthy group, T2DM didn't show any anabolic response to EAA before or after the RET intervention, which seems to be explained by a decreased in the amino acid transport. Moreover, only healthy older adults increased total fiber CSA ($p<0.05$), with a specific increase in fiber type II size (+23%; $p<0.05$). Healthy older adults also presented a higher capillary and SC content compared to the T2DM pairs ($p<0.05$), but training did not affect these parameters.

CONCLUSION: T2DM seems to be characterized by an anabolic resistance and this may be due to an endothelial dysfunction. Unfortunately, 12 weeks of RET seems only to partially ameliorates the discrepancy.

COMBINED EFFECTS OF MECHANICAL STRESS AND NUTRITION ON MUSCLE HYPERTROPHIC SIGNALS BY USING CONTRACTILE 3D-ENGINEERED MUSCLE

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INTRODUCTION: Given that muscle cross-sectional area and muscle strength are correlated, increases in muscle mass constitute key components of conditioning in various sports. To effectively induce muscle hypertrophy, mechanical stress (e.g., resistance exercise) and nutritional support may be attractive strategies. Indeed, our recent research showed that maca can induce muscle hypertrophy in C2C12 skeletal muscle cells [1]. However, a combined effect of maca and mechanical stress has not been investigated.

Usually, electrical pulse stimulation (EPS) can lead to mechanical muscle contraction and mimic the overall intracellular signal activation to exercise in skeletal muscle cell culture, albeit these cells are structurally different from in vivo skeletal muscle tissue [2]. On the other hand, three-dimensional (3D)-engineered muscle (3D-EM) is structurally composed of highly dense, parallel-orientated fascicle-like structures of myofibers, forming sarcomere structures like those found in living muscle. Thus, a 3D-EM may more closely represent in vivo muscles [3].

Thus, in this study, we aimed to investigate the effect of combining exercise (EPS) and nutrition treatment (maca) on muscle hypertrophic cell signaling in 3D-EM.

METHODS: 3D-EM were cultured as in the previous study [3]. After 2 weeks of differentiation, all the 3D-EM were divided into 3 groups: control (C) group (n=3), EPS (E) group (n=6), and maca + EPS (ME) group (n=6). The C group and E group were incubated normally, and the ME group was treated with 1mg/ml of maca. The medium was changed every 2 days, for one week. After changing the medium each time, we applied 30V, 1Hz, and 2 msec EPS to 3D-EM for 24h, and then rested for 24h. The EPS also continued for a week. 24h after the last time of EPS, intracellular signals of muscle protein were analyzed by Western blotting.

RESULTS: In the ME group, the phosphorylation of ERK tended to be prompted compared with the C group ($p=0.06$), and the phosphorylation of mTOR also tended to be higher than that in the C group ($p=0.09$). Furthermore, the treatment of maca and EPS promoted the phosphorylation of AMPK compared with the C group ($p<0.05$). On the other hand, the expression of MAFbx and MuRF-1 were not significantly different.

CONCLUSION: Since the treatment of maca and EPS tended to promote a part of the signals of MPS without significant differences in the signals of MPB except for the increase in the AMPK phosphorylation, it is considered that the combination of maca and mechanical stress may have a potential to promote muscle hypertrophic process. However, more samples are needed in further studies for a robust conclusion. Nonetheless, given that few prior studies investigated the effects of EPS and nutritional treatment on this mold of 3D-EM, our preliminary study might provide important findings to explore effective prescriptions for muscle hypertrophy.

[1] Yi D, et al. Int J Mol Sci. 2022

[2] Sugimoto T, et al. Int J Mol Sci. 2022

[3] Nakamura T, et al. J Biosci Bioeng. 2017

Conventional Print Poster

CP-AP04 Apps and Sensors

A COMPARISON OF FULLTRACK AI APP AS AN ALTERNATIVE TO RADAR GUN MEASURED CRICKET BALL DELIVERY SPEED

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INTRODUCTION: Ball delivery speed is a key performance indicator in cricket. Whilst 3D motion capture is accepted as the gold standard in movement analysis [1], radar guns are commonly used in cricket training due to their immediacy in providing ball speed, accessibility and portability but are often cost inhibitive. In contrast, the development of app-based approaches have become feasible alternatives, providing both ball trajectory visualisation and expanded metric reporting, including speed. This study investigated the practical agreement between a validated radar gun [2] and a new app-based approach to measure ball speed under cricket training conditions.

METHODS: 467 deliveries were recorded, via radar gun (Stalker ATS2) and app (Fulltrack AI), on an indoor cricket wicket (bowled or thrown (Sidearm Pro)). Of these, 163 deliveries were captured at the higher level of acceptable setup tolerance for the radar gun (offset 20 degrees relative to wicket) [1] and both raw and corrected (via applying the cosine law [3]), data (km/hr) were analysed. Fulltrack AI data were recorded from an iOS device positioned behind the stumps following the app-calibration procedure. Ball speed (km/hr) from Fulltrack AI was extracted post-session into Microsoft Excel for tabulation with radar gun data. Statistical analyses were conducted in R Statistical Software [4]. Differences between methods (radar gun vs app) were assessed via a linear mixed model after normality assessment and removal of extreme outliers (bestNormalize package [5]). Agreement, 95% limits of agreement (LOA) were calculated using Bland-Altman [6]. Reliability was further assessed with intraclass correlation coefficient (ICC).

RESULTS: Statistically significant mean differences ($p<0.001$) in ball speed were identified between the radar gun and app. When setup behind the wicket, the radar gun measured speeds 0.51 km/hr lower (95% CI: -0.98, -0.03), compared to the app. At 20 degrees offset from the wicket, the radar gun reported speeds 4.08 km/hr slower (95%CI: -4.41, -3.74), or 1.01 km/hr faster (95%CI: 0.67, 1.35) when corrected via the cosine law. Whilst LOA established fair agreement (<2SD) and reliability coefficients indicated near perfect agreement (ICC=0.94) when behind the wicket, LOA decreased (poor-to-fair; 2-3SD, [6]) when the radar gun was offset by 20 degrees, whilst ICC remained near perfect (ICC>0.95).

CONCLUSION: The Stalker ATS2 radar gun and Fulltrack AI app demonstrated sound practical agreement in monitoring ball delivery speed for cricket bowlers. For the practitioner, whilst the app is a viable field-based approach instead of using the radar gun, the statistically significant differences in speed suggest caution should be taken if using the two devices inter-changeably to directly compare ball speed to monitor a bowler's performance.

1.Van Der Kruk & Reijne (2018) 2.Smith & Burke (2021) 3.Castro et al (2012) 4.R Core Team (2022) 5.Peterson (2021) 6.Bland & Altman (1986)

NEW TECHNOLOGICAL ADVANCES TO PROTECT PEOPLE WHO EXERCISE IN VARIOUS THERMAL ENVIRONMENTS

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INTRODUCTION: Adverse thermal conditions, such as the ones often experienced by people who exercise in the heat, together with the increased metabolic demands that frequently accompany an exercise session, often exceed the human capacity for thermoregulation. This, in turn, reduces physical performance and increases the overall risk for life-threatening diseases and accidents. Despite the importance of proactivity, which is undeniable and plays a key role in many fields of our daily routine, there is currently no easy way for sport scientists, exercise physiologists, and coaches to provide state-of-the-art guidance to people who exercise in unsuitable thermal and exercise conditions. Therefore, the aim of this study was to develop an intelligent mobile phone application that will allow sport scientists, exercise physiologists, and coaches to provide individualized heat-health guidance to people who exercise and/or compete in unsuitable environmental conditions.

METHODS: We used concurrent technological advances and thermophysiological modelling to develop a mobile phone application that predicts the physiological heat strain experienced by people who perform in various conditions and provide them with personalized heat mitigation strategies (e.g., clothing, exercise intensity, exercise/rest cycles, and water consumption suggestions) that will help them to preserve physical performance and reduce physiological heat strain. To examine the construct validity of the newly-developed mobile phone application, the present study involved monitoring 37 healthy participants [gender: 29 (M) and 8 (F); body mass: 77.1 ± 14.8 kg; height: 175.2 ± 9.0 cm; age: 28.9 ± 5.7 years) during various physical activities (duration: 104 to 180 mins; metabolic rate: 106.1 to 601.8 W/m2] that took place in various environmental conditions (Wet-Bulb Globe Temperature: −11.5 to 26.9 °C). Core body temperature measurements were continuously recorded using ingestible telemetric capsules to examine the predicting capacity of our mobile application in preclassifying individuals with increased risk for experiencing elevated physiological heat strain, based on the guidelines (≥ 38 °C) of the World Health Organization.

RESULTS: The core body temperature predictions made by the newly-developed mobile phone application were strongly related ($r = 0.66$, $p < 0.05$) with the actual physiological measurements taken by our participants, and, more importantly, our mobile application was able to correctly predict 92% of the people who experienced increased physiological heat strain.

CONCLUSION: Mobile phone applications integrating thermophysiological models may be used in the future as a means to provide individualized heat-health guidance to safeguard the health and physical performance of those who often experience increased physiological heat strain.

DESIGN OF A SOFTWARE SUITE TO SUPPORT INDEXING, ANNOTATING, AND ANALYZING CLIMBING VIDEOS

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INRIA 1, FFME 2

INTRODUCTION: Capturing high-resolution videos is now accessible to coaches and athletes during training sessions and competitions. This leads to accumulating hours of footage without means to store and retrieve this content easily when studying specific athlete performances. Commercial solutions exist but may imply significant fees. We designed and built a software pipeline in collaboration with the French Federation for Climbing (FFME) to efficiently index and annotate performance videos that supports analysts and coaches when analyzing videos.

Keywords: Video indexation, video annotation, analytical tools

METHODS: To build this application, videos of individual athlete performances captured during official competition by the coaches have been indexed following results made available on-line by the International Sports Climbing Federation (IFSC). Videos from training sessions have been also included using a dedicated indexing. We built a web application (Dash Plotly [1]) allowing the FFME members to navigate through the database, and designed an annotation tool to support analysis [2] that enables categorizing events in a performance (similar to [3, 4]) and visualizing quantitative data (e.g., average grasping time). All data and software are secured on a server respecting the European General Data Protection Regulation (GDPR).

RESULTS: Analysts and coaches used the tools to upload 923 videos that represent 72 GB of data and 43.7 hours of video. They annotated 498 videos with an average of 156 [150,162] (95% confidence intervals) annotations per videos. The annotation sessions lasted in average 30.3 min [28.6, 32.1]. This collaborative work fostered discussions on the need to use analytical tools, and revealed the lack of technological support international teams might face.

CONCLUSION: Sport teams might be missing conventional measures of performance and tools to support analyzing large quantities of videos. A dedicated software pipeline enabled them to capitalize on the video content they accumulated. We are currently completing this pipeline with an interactive tool to support exploring annotation data. Despite we collaborated with climbing experts, we expect such a software pipeline to easily transfer to other sport disciplines with similar needs. We started working with the French boxing federation to ascertain this claim.

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GAME-DESIGN FOR A HIGH-INTENSITY EXERGAME: TRAINING VOLUME AND FITNESS IMPROVEMENT WHILE PLAYING TO PROMOTE PHYSICAL ACTIVITY

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INTRODUCTION: Active video games to promote physical activity are not recommended by health guidelines. Thus, the studys goal was to assess the ability of new gameplay to encourage physical activity and provide beneficial physical fitness changes.

METHODS: A total of 19 inactive (9 women and ten men) completed the study. Pre- and post-training measurements included 1) body composition, 2) aerobic capacity, 3) muscle endurance, and 4) flexibility. The participants engaged in 45-60 min per week for five weeks, ten sessions playing an active video game where the volume was measured with a heart rate monitor. During the intensity validation of the game, the oxygen uptake (VO2) and energy expenditure (EE) was measured with a portable metabolic analyser (K4b2, Cosmed, It.)

RESULTS: The average METs during the games were 4±1 to 7±1 METs, and the % VO2max extrapolated in an average of games was between 44±6 and 85± 10 %, with some peaks at maximal effort. The range average training volume during the intervention was 288-480 METs min/week. Significant improvements were seen in all three components before vs after the intervention: 1) a decrease in percent body fat (28±7 vs 26±8%, $p<0.05$) and from waist circumference (83±10 vs 77±14 cm, $p=0.01$), 2) the aerobic capacity increased (34±5 vs 38±6 ml/kg/min, $p<0.01$); 3) upper (push-ups) and lower (squats) muscle endurance increased (24±12 vs 43±12, $p<0.01$), and (46±8 vs 65±9, $p<0.01$) respectively; and 4) flexibility increased (21±11 vs 26±11, $p<0.05$).

CONCLUSION: In conclusion, it appears that 45-60 min per week for five weeks of medium to high-intensity exercise with this gameplay was sufficient to induce significant changes in body composition, aerobic capacity, and muscle endurance in inactive individuals, even if the volume training was lower than the ACSMs recommendations of more than 500-1000 METs min/week. These results emphasize the potential health benefits of using this tool to promote physical activity and increase activity gradually for the inactive population. However, further investigation will need to be done to observe the adherence of this game in an ecological environment.

LIGHT REFLECTION-BASED SYSTEM FOR SPIN MEASUREMENT OF TABLE TENNIS BALLS

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INTRODUCTION: Mastering spin is crucial to win a match in table tennis. Spin is one of the keys performance indicators for a player, alongside with placement, ball speed, technique and precision. Therefore, it is crucial to measure performance.

However, spin measurement is hard to perform in real match conditions because the speed is high (+/-800 rad/s)[1], unless using a high-speed cameras and using image processing algorithms.[2]–[5]

We proposed a new low-cost tool for spin measurement based on observation of light reflection on balls. The proposed system is also able to measure linear speed from a moving object in its field of view (FOV).

METHODS: To calibrate accurately our system, comparisons are made with a high-speed camera Miro C210 from Phantom.

First experiment is the measure in controlled conditions. The system is used to measure a spinning ball mounted on a motor with constant speed (to ensure the measurement quality of the device).

Second experiment is the observation of the spin on real strokes. Strokes were performed by an experienced senior player. Services and hits were realized several times with increasing spin given by the player. Balls were delivered by a ball thrower robot (Amicus Expert from Butterfly).

Spin estimation with camera is obtained through frame by frame analysis, while our system is expressing spin by frequency and waveform analysis.

RESULTS: Experiment 1 shows a measured spin at 468,7 rad/s (+/-18,8 rad/s).

Experiment 2 shows various spin measures, for strokes and services. Services observed spin range goes from 174 rad/s to 329.23 rad/s.

Strokes performed for topspin forehand shots range goes from 391.75 rad/s to 808.6 rad/s.

Strokes performed for topspin backhand shots range goes from 569.8 rad/s to 769 rad/s. Linear speed measured on forehand & backhand shots is really close from the one measured by camera (+/3.46%).Estimated error between High speed camera and our system is +/-5.6%.

CONCLUSION: Although results are consistent with high-speed camera, we observe that the system is light-sensitive. It would not be able to detect in a fully lightened or a fully dark environment or at least with a larger error.

We are using bicolored balls which won't be allowed in real match conditions. Traditional match balls, with their natural brands are not reflective enough to get a meaningful output.

Nonetheless, the presented system, shows strong results in accordance with a high-speed camera for both measuring linear and rotational speed.

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REPEATABILITY AND REPRODUCIBILITY OF AN ON-FIELD DEVICE FOR MEASURING LOW- TO HIGH-FREQUENCY MUSCLE FORCE RATIO.

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INTRODUCTION: Low-Frequency Fatigue (LFF) refers to a long-lasting impairment of muscle contractility, induced by a fatiguing physical task. Its gold standard assessment, commonly restricted to laboratory studies, is based on the low- to high-frequency force ratio produced by an electrically stimulated muscle (L/HFratio); the higher the exercise-induced depression of L/HFratio, the higher the LFF. A recent study has tested a portable device (MYOCENE, Liège, Belgium) as a measurement tool of L/HFratio (called Powerdex value, expressed in percentage) in the field [1], allowing the quadriceps LFF monitoring of sport practitioners. The aim of the present study is to evaluate the repeatability and reproducibility of Powerdex measurements, under field conditions.

METHODS: 16 healthy students volunteered for an initial familiarization session with MYOCENE measurements. Then, two experimental sessions (over two weeks) aimed to study 1) the repeatability of two consecutive Powerdex measurements (seven minutes apart), and 2) the effect of time of day (8:00 a.m., 12:00 p.m. and 5:00 p.m.) on the reproducibility of Powerdex measurements. For all sessions, participants were asked to refrain from moderate to intense physical activity, the measurements were performed by the same operator, with the same device, and the position of the skin muscle electrical stimulation electrodes was exactly the same throughout each session. For each session, the agreement between the pairs of within-subjects measurements was assessed by a Bland & Altman plot [2]: the bias was estimated as the mean of the paired differences, the repeatability coefficient was estimated at 1.96 x standard deviation of paired differences, and upper and lower limits of agreement were calculated as the bias ± 1.96 x standard deviation of paired differences.

RESULTS: The analysis of repeatability shows an anecdotal bias (-1,6%) between the second and the first Powerdex measurement, probably due to a small fatigue effect caused by electrical muscle stimulation. The repeatability coefficient is 2,97 %. The largest bias between the Powerdex values measured at different times of the day (reproducibility analysis) is 1,2 %, the largest upper limit of agreement is 10,9 % and the largest lower one is -11,4 %.

CONCLUSION: The repeatability of the paired Powerdex measurements suggests that an exercise-induced Powerdex depression of at least 3 % is required to conclude to the onset of Low-Frequency Fatigue. Further studies are required to assess more accurately the reproducibility of the device, as the daily activities may have modified the muscular contractility, either by a slight potentiation or a small fatiguing effect.

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IS MARKERLESS MOTION TRACKING A FEASIBLE APPROACH FOR IN FIELD KINEMATIC ANALYSIS OF WEIGHTLIFTING?

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INTRODUCTION: In weightlifting, a quantitative kinematic analysis of an athlete can be useful to assess the performance during the snatch. A marker-based approach (MB) is widely used to obtain kinematic data in weightlifting [1]. Yet, it is not suitable for in field activities such as competitions. Recently developed markerless video-based systems (VB) working with deep learning-based pose estimation algorithms might be an alternative approach [2]. However, the applicability and accuracy of VB systems in assessing highly dynamic full body activities remain mostly unexplored. Hence, the aim of this study was to compare the kinematics of a snatch using a VB along with a MB approach.

METHODS: 24 experienced weightlifters (17 Male, 7 Female) each performed 6-9 snatches with a load between 65-85% of their individual one repetition maximum. MB (200Hz using Vicon Nexus) and VB (100Hz using Contemplas with Theia3D for pose estimation) 3D motion capture were used to analyze snatch kinematics of 140 trials. The results of the VB tracking

system were compared to the MB system to validate the technology regarding the accuracy during the snatch. Statistical parametric mapping (SPM) and paired t-tests were used to demonstrate differences between the two systems.

RESULTS: Preliminary results of 4 subjects (29 trials) showed that on average joint center estimation between the systems differed by 30±9mm for the knees, 27±9mm for the ankles, 49±10mm for the hip and 48±9mm for the shoulder joints. This resulted in significant differences ($p < 0.05$) regarding joint angle estimations (e.g. maximal flexion, maximal angular velocity, and average velocity). Average differences were 5±2° for the knee, 18±5° for the hip and 8±4° for the ankle joint. SPM analysis revealed significant differences throughout the majority of all phases of the snatch. For example, the transition phase between first and second pull was far less pronounced or barely detectable by the VB system.

CONCLUSION: In preliminary results, we found significant differences in all variables analyzed. Joint center location was similar to previous studies [3].The major difference found was the far less pronounced transition phase in the VB tracking results, which is a key phase to analyze during the snatch. Besides that, overall shape of lower limb kinematics was similar. However, shoulder kinematics were barely comparable with maximal shoulder abduction angles highly underestimated by the VB system (25%). Further, big differences regarding maximum angular velocities indicate difficulties in the comparability between the two systems. As a result, our preliminary results suggest that accuracy of VB motion capture is not yet sufficient for high quality kinematic analysis of weightlifting. However, given the practicality, it should be a promising alternative to analyze weightlifting performance in the future.

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IMPROVEMENT IN PERIPHERAL VISUAL ATTENTIONAL PERFORMANCE IN PROFESSIONAL SOCCER PLAYERS FOLLOWING A SINGLE NEUROFEEDBACK TRAINING SESSION

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INTRODUCTION: The effectiveness of EEG-neurofeedback (EEG-NFB) in modulating cognition has been the subject of much research for several years, particularly concerning attentional functions in healthy subjects and those with attentional deficits. However, its effectiveness on sports performance remains poorly studied, and its use is not widely practised among athletes, notably because of its questionable accessibility and effectiveness. This study aims to show that this technology can be accessible and that Alpha EEG-NFB is immediately effective. Fifteen professional soccer players took part in this study.

METHODS: Using a novel EEG headset installed in less than one minute and new processing software, the players performed three sessions of two different peripheral attentional tasks: immediately before, immediately after and one month after a single Alpha EEG-NFB training session.

RESULTS: The results showed a significant effect on both tasks immediately after EEG-NFB training, with an immediate performance increase of more than 30% that remained at 20% one month later.

CONCLUSION: This study, the first to use this headset and software, shows that improvement in sports performance can be related to cognitive performance, especially peripheral visual attentional functions. Furthermore, it demonstrates that the EEG-NFB is accessible and effective for high-level athletes. This simple paradigm could supplement existing rehabilitation approaches depending on the individual's needs and abilities to alleviate persistent spatial attention deficits.

AI-DRIVEN SPRINT KINEMATICS ANALYSIS USING SAGITTAL VIDEO FOOTAGE FOR HIGH-PERFORMANCE SPRINTING

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INTRODUCTION: Sprint kinematics can be a key factor to prevent injuries during running, but obtaining accurate measures using motion capture devices is costly, impractical and time consuming. We present an AI driven method for sprint performance analysis. The proposed approach utilizes RGB cameras placed in the sagittal plane to capture video footage of the sport activity. A deep learning model (1) is then used to locate human body joints on the image for each frame. The cameras are positioned such that main joint angles and kinematics can then be precisely computed throughout the sprint.

Although the presented method can be used as a tool for general sport analysis, it is extensively studied here in the context of high performance sprinting. Validity of such 2D measures from videos is a subject of high interest that remains badly explored (2).

METHODS: Six different athletes performed six sprints of different lengths with various force loads. The five first and five last meters of each run were recorded using two RGB cameras placed along the track in the sagittal plane. An optical measurement system is also employed to record precise foot contact events.

Video footage are then processed and obtained contact events are compared with the

measurements.

From the video stream, the athlete is detected with a neural network YOLOX. From an extracted thumbnail around the athlete, pose estimation is computed with (1). From analysis of bottom limb joint trajectories, ground contact instants are pointed out. Finally, from a weak calibration between the track coordinate system and the image one, 3D positions are estimated at each ground contact instant.

RESULTS: Pose estimation with AI methods depends on the learning databases. However, these only give the position of the knee and ankle for the lower limbs. The parameters of flight time, contact time and stride length are therefore deduced from the kinematic derivatives of these points and will be qualified with respect to the gold-standard of the optical system on the ground. The evolution of the measurement bias over time is also a parameter that will be evaluated.

CONCLUSION: From our preliminary results, we note that the characterization of the time of contact onset and contact termination is more difficult to determine precisely than the length of the stride, which is relatively stable given that the feet on the ground are fixed during contact. A more complete model including tip of the foot localization would most certainly lead to more precise kinematics. Nevertheless, the simplicity of the method and its ease of use make it an efficient and valuable tool for computing kinematics and gaining insights about the sprint performance.

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CP-PN02 Molecular Biology and Biochemistry

MANIPULATION OF ROS DURING ACUTE EXERCISE AND SPRINT INTERVAL TRAINING USING POST-EXERCISE ISCHAEMIA-REPERFUSION DEMONSTRATES A DIFFERENTIAL REGULATION OF NOX ISOFORMS IN HUMAN SKELETAL MUSCLE.

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INTRODUCTION: The main function of isoforms 2 and 4 of NADPH Oxidase (NOX) in human skeletal muscle (hSM) is the production of free radicals. NOX2 resides in the sarcolemma and t-tubules and generates ROS during contractile activity. NOX4 is a monomeric enzyme located in the SR and mitochondria and associated with basal ROS production in SM. Superoxide produced by these enzymes regulates ryanodine receptor opening and Ca2+ release from SR. The present investigation aimed to determine the plasticity of NOX2 and NOX4 with acute intense exercise (IE) and sprint interval training (SIT), with usual or exacerbated ROS production by using severe hypoxia and post-exercise ischaemia. We hypothesised that NOX2 would be the isoform primarily upregulated by acute exercise and training and that the magnitude of the changes would depend on the level of ROS incurred.

METHODS: In study 1, 11 active males performed IE in Normoxia (Nx) and Hypoxia (Hyp) (PIO2:73 mmHg). Immediately after IE, the circulation of one leg was instantaneously occluded (300mmHg). Biopsies from VL were taken before (PRE1), 10 (POST, solely occluded leg) and 60s after exercise from the occluded (OC1M) and non-occluded (nOC1M) legs. In study2, 10 active subjects were tested before and after SIT (4-6 30s sprints with 4 min recovery periods, 6 sessions in 2 weeks). Immediately after each 30s sprint, the circulation of one leg was occluded for 30-50s. VL biopsies were obtained at rest before (PRE2) and after training bilaterally from the leg training with free circulation (FCL) and the leg training with post-exercise ischaemia (IS). Protein expression was measured (WB). Statistics: t-student and repeated-measures ANOVA.

RESULTS: Study1: compared to PRE, phospho-p47phox subunit of NOX2 was increased 4 and 10-fold at POST and OC1M, respectively ($p<0.001$) and similarly in Nx and Hyp (time effect $p<0.001$). phospho-p47phox subunit of NOX2 was maintained elevated in nOC1M ($p= 0.008$). No significant changes were seen for NOX4 (time effect $p=0.10$), although there was a reduction in NOX4 (18%) from PRE to OC1M when both conditions were analysed conjointly (time effect $p=0.026$). Study2: phospho-p47phox subunit of NOX2 was increased 4.3-fold and 3.0-fold in IS and FCL, respectively (time effect $P=0.002$, time*ischaemia $P=0.29$). gp91 subunit of NOX2 was increased 1.6-fold and 1.4-fold in IS and FCL, respectively (time effect $P=0.004$, time*ischaemia $P=0.28$). It did not alter NOX4 expression in either IS or FCL (time effect $p=0.68$).

CONCLUSION: This investigation shows that IE and SIT upregulate the skeletal muscle expression of NOX2 subunits but not NOX4 in humans. Manipulating ROS by including severe hypoxia or brief post-exercise ischaemia during SIT did not further upregulate NOX2. It remains to be determined why upregulation of NOX2 is required in response to acute high-intensity exercise and SIT.

Grants: DEP2017-86409-C2-1-P; PID2021-125354OB-C21, Swedish Olympic Committee (070–4058960), CSD (EXP_75119), Cabildo GC (12/22) and FDCAN.

EXERCISING TO EXHAUSTION IN NORMOXIA AND SEVERE ACUTE HYPOXIA ACTIVATES STAT SIGNALLING IN HUMAN SKELETAL MUSCLE: POTENTIAL MECHANISMS.

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INTRODUCTION: The Signal Transducer and Activator of Transcription (STAT) signalling pathway plays a crucial role in the regulation of cell differentiation, proliferation, and apoptosis. STAT3 and STAT5 are stimulated by extra and intracellular signals such as interleukins and RONS and are involved in the regulation of metabolism and antioxidant response. Conflicting results have been reported in human skeletal muscle (HSM) on whether STAT signalling is upregulated by acute exercise and on how exercise intensity, type and concomitant redox perturbations may influence STAT signalling. However, studies have yet to elucidate the mechanisms that could explain such differences in STAT activation. The present investigation aimed to determine whether the STAT signalling is activated by incremental exercise to exhaustion and to elucidate the role in this process of IL-6 and FGF-21, oxygenation and metabolite accumulation. We hypothesized that exercise eliciting high levels of RONS, such as hypoxia and a large metabolite accumulation, are required for STAT activation in HSM.

METHODS: Eleven physically active men performed IE in Normoxia (Nx) and Hypoxia (Hyp) (PIO2:73 mmHg). Immediately after IE, the circulation of one leg was instantaneously occluded (300 mmHg). Protein expression (WB) and muscle metabolites were measured in m. vastus lateralis biopsies before (PRE), 10 (POST, solely occluded leg) and 60s after exercise from the occluded (OC1M) and non-occluded (nOC1M) legs. Blood was sampled from the femoral vein. Statistics: repeated-measures ANOVA.

RESULTS: Compared to PRE, pSTAT3-Tyr705, pSTAT5-Tyr694 and pSTAT5-Tyr694+pTyr705-STAT3 and FGF21 were increased at POST and OC1M ($p<0.001$), similarly in Nx and Hyp. Compared to PRE, SOCS3 was 16% and 22% lower at POST and OC1M ($p=0.008$) regardless of PiO2. Consequently, the ratio pTyr705-STAT3/Total STAT3 was increased 4.9 and 4.1-fold at POST and OC1M, respectively ($p=0.005$), regardless of PiO2. pSTAT3-Tyr705, the ratio pTyr705-STAT3/Total pSTAT5-Tyr694, pSTAT5-Tyr694 + pTyr705-STAT3, FGF-21, and SOCS3 returned to pre-exercise values at nOC1M ($p>0.05$ vs PRE). IL-6 expression (25kda+45kda isoforms) was 22% lower after exercise compared to the average of both PRE.

CONCLUSION: In summary, this study demonstrates a fast activation of STAT3 and STAT5 signalling with exercise to exhaustion in HSM, which is driven by the level of oxygenation and the accumulation of metabolites, but independent of FiO2. The activation of the JNK/STAT3 signalling pathway may be mediated by FGF-21, which has been shown to reduce inflammation and oxidative stress after exercise in skeletal muscle. Furthermore, STAT3 phosphorylation may occur despite a reduction in muscle IL-6. Therefore, the fast kinetics of these signals after exercise should be considered when analysing and interpreting muscle signalling responses to exercise.

Grants: DEP2017-86409-C2-1-P; PID2021-125354OB-C21, Swedish Olympic Committee (070–4058960), CSD (EXP_75119), Cabildo Gran Canaria (12/22) and FDCAN.

THE ABILITY OF AN INFRARED RADIATION EMITTING FABRIC TO ACTIVATE ENOS AND CAMKII IN C2C12 CELLS

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INTRODUCTION: Angiogenesis, the formation of new capillaries, and mitochondrial biogenesis, the synthesis of mitochondria, are two adaptive responses to exercise training. Pertinent to these adaptive responses are activation of the endothelial nitric oxide synthase (eNOS) (1) and upstream signalling proteins such as Ca2+/Calmodulin (CaM)-dependant kinase II (CaMKII) (2). Infrared radiation (IR) emitting lamps have been shown to activate eNOS, increasing nitric oxide (NO) production, and CaMKII (3) in vitro. KYMIRA garments powered by Celliant are a novel IR emitting technology that re-emit absorbed body heat as IR. Whether activation of eNOS and CaMKII is apparent when an IR emitting fabric is the source of IR is unknown. We hypothesised that KYMIRA IR emitting fabric would activate adaptive pathways in cultured C2C12 cells.

METHODS: Differentiated C2C12 cells were exposed to either a KYMIRA powered by Celliant IR emitting fabric (IR) or no fabric (CON) for 0, 5, 15, 30, 60 or 90 minutes (n=6) or for 0, 2, 4, 8, 24 or 48 hours (n=12), in two separate experiments. Each timepoint had time-matched IR and CON cells. Cell lysate was frozen for subsequent analysis of total and phosphorylated eNOS and CaMKII by Western blot. Total protein expression was normalised to a Ponceau S stain and phosphorylated protein to total protein expression, with data presented as a fold change. Data were analysed using a two-way (condition x time) ANOVA with Bonferroni post-hoc analysis where a significant main effect or a significant interaction was present. Statistical significance was accepted at $p < 0.05$. Data are presented as mean ± SD.

RESULTS: There was no change to eNOS phosphorylation, with total eNOS expression reduced at 24 hours in IR vs CON (1.8 ± 0.8 vs 2.6 ± 0.8 fold; $p=0.008$). There was greater CaMKII phosphorylation with IR exposure compared to CON after 5 minutes (8.9 ± 3.2 vs 5.3 ± 0.8 fold; $p=0.030$) with IR being less phosphorylated compared to CON after 48 hours (2.4 ± 1.2 vs 5.6 ± 1.9 fold; $p=0.005$). Total CaMKII expression was reduced after 48 hours in IR vs CON (13.7 ± 2.6 vs 15.8 ± 2.8 fold; $p=0.012$).

CONCLUSION: These results suggest that IR exposure increased CaMKII activity in C2C12 cells after 5 minutes and reduced such activation after 48 hours. eNOS activity appears not to have been changed, a finding that was unexpected but

that may be due to the type of cell used. An explanation for the CaMKII result is not clear, however one possibility is CaMKII was S-nitrosylated.

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ZYNAMITE PX SUPPLEMENTATION MODULATES SKELETAL MUSCLE SIGNALLING ELICITED BY EXERCISE AND POST-EXERCISE ISCHAEMIA-REPERFUSION IN HUMANS.

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INTRODUCTION: Zynamite PX (Zyt) is a natural polyphenol mixture rich in mangiferin combined with quercetin. Zyt is a potent antioxidant due to the iron-chelating effect of mangiferin and the inhibitory action of mangiferin and quercetin on the ROS-producing enzymes xanthine oxidase (XO) and NADPH oxidase (NOX). XO and NOX generate ROS during high-intensity exercise and ischaemia-reperfusion. Zyt enhances performance during repeated sprint exercise and attenuates post-exercise muscle damage. Experiments in cells and rodents indicate that mangiferin and quercetin may upregulate nuclear factor erythroid-derived 2-like 2 (Nrf2), a master switch of the antioxidant response. However, it remains unknown whether Zyt increases basal and exercise-induced Nrf2 signaling. Therefore, we hypothesized that Zyt would enhance basal antioxidant capacity resulting in a blunted ROS-mediated signaling response to exercise and ischaemia-reperfusion in human skeletal muscle.

METHODS: Twenty-six volunteers were assigned to a control (17 males) or supplementation group (8 males), the latter supplemented with Zyt (140 mg of MLE + 140 mg quercetin) every 8h for two days. The next day subjects reported to the laboratory fasted, and received the last dose of Zyt, followed one hour later by an incremental exercise to exhaustion (IE) and unilateral leg occlusion for 60s. Upon cuff release, subjects sprinted maximally (30s Wingate), and the same leg was again occluded for 90s. Biopsies were taken from m. vastus lateralis at baseline, 20s after IE (occluded leg) and 10s after Wingate (occluded leg), and from the occluded and non-occluded leg at 90s and 30min post-Wingate. Protein expression was determined by western blot. Statistics: repeated-measures ANOVA.

RESULTS: Compared to the controls, the Zyt group showed increased basal protein expression of total Nrf2 ($P=0.099$), Thr287-CaMKIIδD (2-fold, $P=0.007$), Ser9-GSK3B (1.3-fold, $P=0.004$), and Ser40-Nrf2 (1.2-fold, $P=0.061$). In the control group, there was an upregulation with exercise and recovery of total Nrf2, Nrf2/Keap1 ratio, catalase, GR, and Thr287-CaMKIIδD protein expression (1.2-1.7-fold, all $P<0.05$; time x supplement interactions $P<0.05$). Thr180/Tyr182-p38 was similarly elevated in response to exercise and recovery in both groups ($P<0.001$, interaction $P=0.08$).

CONCLUSION: Zyt ingestion increases basal Nrf2 expression in skeletal muscle, likely by a mechanism involving activation of CaMKII, which phosphorylates GSK3B at Ser9, causing its inhibition. This mechanism impedes Nrf2 ubiquitination and proteasomal degradation elicited by GSK3B phosphorylation of β-TrCP. During exercise and recovery, Zyt supplementation blunts the Nrf2, catalase, GR, and CaMKIIδD responses, indicating a reduced signalling response to ROS. Therefore, this study demonstrates the antioxidant properties of Zynamite PX, which may explain its ergogenic and protective effects against eccentric-exercise muscle damage previously reported in humans.

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AEROBIC EXERCISE TRAINING-INDUCED IRISIN SECRETION PREVENTS ATHEROSCLEROSIS WITH IMPROVEMENT OF ENDOTHELIAL FUNCTION IN APOE-DEFICIENT MICE

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INTRODUCTION: Endothelial dysfunction leads to the development of atherosclerosis because endothelial function regulates vascular homeostasis such as vasodilation, inhibition of inflammation responses, and suppression of smooth muscle cell proliferation. This function is mainly mediated by arterial nitric oxide (NO) produced by endothelial NO synthase (eNOS). Aerobic exercise training (AT) improves endothelial function via acceleration of NO production. Irisin is a myokine secreted from skeletal muscle and the secretion accelerated by habitual aerobic exercise. Moreover, irisin affects endothelial function via acceleration of NO production. However, it remains unclear whether AT-induced irisin secretion from skeletal muscle is involved in suppressing a progression of atherosclerosis. This study aimed to clarify whether irisin secretion is related to the suppression of atherosclerosis induced by AT.

METHODS: As an animal atherosclerosis model, 8-week-old apolipoprotein E (ApoE)-deficient mice were divided into 2 groups: ApoE-deficient sedentary group (ApoE-SED group: n=13) and ApoE-deficient aerobic exercise training group (ApoE-AT group: n=13, voluntary running exercise on a wheel for 16 weeks). ApoE-deficient mice were fed a high fat diet. In addition, normal diet-fed C57BL/6J mice were used as control sedentary group (WT-SED group: n=13). Aortic rings of each mouse were isolated for evaluation of acetylcholine-induced (endothelium-dependent) and sodium nitroprusside-induced vasorelaxation (endothelium-independent) using a wire myograph. Plasma irisin levels (ELISA) and arterial eNOS protein

expression (immunostaining) were measured. The one-way ANOVA was used to compare among 3 groups. Relationships between plasma irisin levels and eNOS expression or atherosclerotic lesion were determined using Pearson correlation coefficients. A $p<0.05$ was considered statistically significant.

RESULTS: In the ApoE-SED group, epididymal fat mass, plasma levels of LDL cholesterol and triglyceride, and fat accumulation of atherosclerotic lesion were significantly higher than those in the WT-SED group (each $p<0.05$). However, these parameters were significantly lower in the ApoE-AT group compared with the ApoE-SED group (each $p<0.05$). Additionally, plasma irisin levels, arterial eNOS protein expression, and endothelium-dependent vasorelaxation were significantly lower than those in the WT-SED group (each $p<0.05$), but these parameters were significantly higher in the ApoE-AT group compared with the ApoE-SED group (each $p<0.05$). No significant difference in endothelium-independent vasorelaxation among 3 groups were observed. Moreover, plasma irisin levels were positively correlated with arterial eNOS protein expression ($r=0.603$, $p<0.05$) and negatively correlated with fat accumulation of atherosclerotic lesion ($r=-0.838$, $p<0.05$).

CONCLUSION: These results suggest that AT-induced increase in irisin secretion may be involved in suppressing the progression of atherosclerosis with improvement of endothelial function.

THE IMPACT OF ALPHA-ACTININ-3 R577X AND ANGIOTENSIN-CONVERTING ENZYME I/D ON PHYSICAL FITNESS LEVELS AND ADAPTATION TO HIGH-INTENSITY RESISTANCE TRAINING IN PATIENTS WITH ANOREXIA NERVOSA.

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INTRODUCTION: Muscle depletion accounts for 15-45% of the total body weight (BW) loss in patients with anorexia nervosa (AN). However, research has shown that up to 77% of the BW gains are achieved due to increases in fat mass while muscle tissue is not fully recovered [1]. Despite the known benefits of resistance training (RT) on muscular fitness (mass and function), the inclusion of patients with AN in RT programs has been controversial. Genetic factors – such as angiotensin-converting enzyme (ACE) and alpha-actinin-3 (ACTN3) R577X polymorphisms – have been linked to specific muscle phenotypes (i.e. mass, function) in several populations. This study aimed to analyze the distribution and influence of ACTN3 and ACE polymorphisms in physical fitness and adaptations to resistance training (RT) in AN.

METHODS: A total of 84 (age=13.5±1.2 years), 65 and 40 patients were included in the distribution, association and intervention analyses respectively. ACTN3 and ACE genotypes, body composition [including muscle cross-sectional-area (CSA)], strength and cardiorespiratory fitness were assessed.

RESULTS: ACE ID distribution was significantly different (37% vs. 50%, $p<0.001$) from general population. Association analyses showed significant differences in CSATHIGH (124.9±22.9cm2 RR, 139.0±22.9cm2 RX, 122.3±11.2cm2 XX, $p=0.039$) and Leg Press (LP) test (76.3±15.2kg RR, 89.21±18.9kg RX, 72.3±11.0 kg XX, $p=0.008$) between ACTN3 genotypes. Post hoc analysis showed significant differences (RR+RX>XX) in LP test. BW (48.8±6.8 kg DD, 45.2±7.5 kg ID, 41.63±6.7 kg II, $p=0.038$), CSAARM (25.9±7.1cm2 DD, 22.4±4.6cm2 ID, 19.6±5.5cm2 II, $p=0.021$) and LR (41.8±6.4kg DD, 35.2±6.8kg ID, 37.6±7.6kg II, $p=0.002$) were different when comparing ACE genotypes. Post hoc analysis confirmed significant differences (DD>II) for CSAARM and LR test. RT significantly improved body composition (i.e. BW, body mass index, muscle mass index, CSAARM and CSACALF) and strength (i.e. maximal and relative strength), without negative effects in body fat. Additionally, moderate-to-large effect sizes ($d=0.46–1.14$) were observed in muscular fitness (D vs. II, and R vs. XX) after intervention.

CONCLUSION: Our results suggest that patients with muscularity-power genotype (R and D allele carriers) maintain and/or improve muscle mass and function during hospitalization alone (without exercise) to a greater extent than those displaying non muscularity-power genotype (XX and II). Although all patients can benefit from RT regardless of their genotype, implementation of individualized high-intensity and high-frequency RT programs might be more critical for II and XX genotypes. This study uncovers a novel clinical application of individualized exercise programming – based on ACTN3 and/or ACE genotype – as complementary strategy to aid in the treatment in patients with AN. More research is needed to understand the impact of screening ACTN3 and ACE on individualized exercise programs in with AN during all treatment phases.

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GENOME -WIDE ASSOCIATION STUDY FOR MUSCLE FIBER COMPOSITION IN JAPANESE POPULATION

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INTRODUCTION: Human skeletal muscle is composed of different fiber types, which are classified as type I (slow twitch) and/or type II (fast twitch). Although skeletal muscle fiber composition is largely affected by genetic factors, their details remain poorly understood. Here, we conducted a genome-wide association study (GWAS) to identify genetic polymorphisms associated with muscle fiber composition in humans.

METHODS: Step 1: Approximately 660,000 genetic polymorphisms were genotyped using the Japonica array and the proportion of myosin heavy chain isoform type I (MHC-I; an indicator of muscle fiber composition) in the vastus lateralis muscle of 214 Japanese individuals was analysed (men: n = 107; women: n = 107). Genome-wide associations for the proportion of MHC-I were assessed using a multiple linear regression model adjusted for age and sex. Step 2: To validate the possible associations observed in Step 1, meta-analyses were performed with an additional 656 Swedish individuals. Step 3: To examine the underlying mechanisms of their associations, differential gene expression analysis was performed by using RNA sequence data from the vastus lateralis muscles of 22 Japanese individuals.

RESULTS: Step 1: We detected 146 polymorphisms (for 28 genomic loci) associated with the MHC-I proportion that had a GWAS suggestive level ($P < 5\times10\text{-}5$), although none achieved the GWAS significance level ($P < 5\times10\text{-}8$). Step 2: In the Swedish cohort, 138 out of the 146 polymorphisms detected in Step 1 were found. Meta-analyses of the Swedish and Japanese cohorts revealed that 16 polymorphisms (four loci) were potential determining factors related to the proportion of MHC-I (Bonferroni adjusted $P < 3.6\times10\text{-}4 = 0.05/138$). A rs72558391 T/G (first locus) is located in TCN2. Other polymorphisms are located in intergenic region. Step 3: differential gene expression analysis showed that rs2378517 T/G (second locus), rs742739 C/T (third locus), and rs11071241 C/A (fourth locus) polymorphisms located in each intergenic region altered the gene expression profiles including CDKN1A, INO80B-WBP1, and 7SK, respectively.

CONCLUSION: We identified 16 novel polymorphisms (four loci) associated with muscle fiber composition.

ASSOCIATION BETWEEN THE GALNTL6 POLYMORPHISMS AND POWER-ORIENTED ATHLETES

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INTRODUCTION: N-acetylgalactosaminyltransferase-like 6 (GALNTL6) polymorphisms are associated with various categories such as memory, smoking behavior, and body size (GWAS catalog). Recently, the GALNTL6 rs558129 polymorphism has been associated with sports performance (Rankinen et al., 2016, Díaz Ramírezet al., 2020, Zmijewski et al., 2021). Therefore, this study aimed to compare the gene frequency of GALNTL6 rs558129 polymorphism between power-oriented athletes and controls (Study 1) and to detect other power athletic status-related genotypes by comprehensive polymorphism analysis in the GALNTL6 gene region in wrestlers and controls (Study 2).

METHODS: Study 1 enrolled 1,515 Japanese subjects, including 376 elite power-oriented athletes who competed in national and international competitions, including the Olympic games (257 men and 119 women), and 1,139 controls (448 men and 691 women). The sports practised by the power-oriented athletes were wrestling (n = 146), weightlifting (n = 151), and powerlifting (n = 79). The analysis of GALNTL6 rs558129 polymorphism was performed by TaqMan SNP Genotyping Assay using DNA extracted from saliva (Oragene-DNA Kit). Study 2 included 33 elite wrestlers and 211 controls, and the comprehensive polymorphism analysis was conducted. The comprehensive polymorphism analysis in the GALNTL6 gene region (162 SNPs) was genotyped using the Japonica Array v2. The p-value < 0.0003 (0.05/162) was considered statistically significant.

RESULTS: No significant difference in polymorphism frequencies between all power-oriented athletes and controls in Study 1 was found. On the other hand, the frequency of the TT genotype of rs558129 was significantly higher in wrestlers compared to that in the controls ($p = 0.044$). In the Study 2, there was no significant difference in GALNTL6 polymorphisms. The top SNP of the GALNTL6 polymorphisms were the rs10622983 polymorphism ($p = 0.002$).

CONCLUSION: The TT genotype of the GALNTL6 rs558129 polymorphism was only associated with wrestlers. Furthermore, GWAS showed that the GALNTL6 rs10622983 polymorphism was most relevant in wrestlers.

Conventional Print Poster

CP-PN08 Muscle damage and repair

MUSCLE FORCE PROFILES IN THE RAT TIBIALIS ANTERIOR AS A FUNCTION OF VARIOUS FREQUENCIES OF ECCENTRIC MUSCLE CONTRACTION

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INTRODUCTION: High-intensity eccentric contractions (ECC) cause muscle damage and result in muscle function deficits. According to previous reports, prior ECC-induced muscle damage reduces the severity of subsequent muscle-damage symptoms. However, there remains a lack of understanding of the adaptations in muscle strength to the frequent performance of high-intensity ECC. We examined the effects of frequent ECC on the twitch and tetanic contraction forces in the rat tibialis anterior (TA).

METHODS: Thirty-two 12-week-old male Fischer 344 rats were assigned to one of seven groups: control with no intervention (Cont); single-bout of high-intensity ECC (1-bout); four weeks of high-intensity ECC with one repetition (1-bout_4w), two repetitions (2-bouts_4w), four repetitions (4-bouts_4w), or eight repetitions (8-bouts_4w); and an age-matched control

with no intervention (Cont_4w). The high-intensity ECC was elicited by tetanic electrical stimulation (ES) of the TA muscle. We first measured the twitch and tetanic contraction forces in the TA evoked by the ES, then harvested the TA after the four-week intervention period.

RESULTS: Maximal tetanic force, twitch force, and dP/dt in the 1-bout group were significantly smaller than in the Cont group. The maximal tetanic and twitch forces decreased exponentially ($R^2 = 0.80$) by approximately 40–50% and 10–50%, respectively, as the number of repetition counts increased. The dP/dt in all ECC groups decreased by approximately 20% relative to the Cont group.

CONCLUSION: These results suggest that a four-week ECC repetition intervention will reduce muscle contraction performance in the TA in accordance with the number of repetitions. Repeated high-intensity ECC interventions may reduce the force-generating capacity of the muscle fibers, resulting in an alteration in lower-limb muscle contractile properties.

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REPEATED SPRINTS TRAINING DAMAGES MUSCLE MITOCHONDRIA AND INCREASES OXIDATIVE STRESS STATUS.

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INTRODUCTION: The integrity of the muscle mitochondria can be monitored by measuring striated muscle mitochondrial-specific isoenzyme, sarcomeric mitochondrial creatine kinase (sMtCK), which is extremely susceptible to oxidative damage [1]. Since oxidative stress (OS) is a dynamic process involving several pro-oxidant components, e.g., malondialdehyde, and anti-oxidant components, e.g., superoxide dismutase, integrative-based quantification methods such as OS index (OSI) may be used to fully understand the complex interaction between exercise-induced muscle damage and OS [2]. Therefore, the purpose of the research was to determine the OS time course induced by damage to muscle mitochondria and its relationship with muscle function following repeated sprint training (RST) in humans.

METHODS: Healthy males [n = 16, age = 22.4 ± 3.2 years, BMI = 23.8 ± 1.6 (mean ± SD)] and females [n = 14, age = 22.2 ± 3.1 years, BMI = 22.1 ± 2.3 (mean ± SD)] underwent 10 repeated 40-meters sprints with a 3-minute rest pause between repetitions. Serum biomarkers (sMtCK, OSI) and indirect indicators of muscle damage in lower limbs [force-generating capacity (FGC), range of motion (ROM)] were tested at baseline and during 72-hours post-RST. Participants whose sMtCK values at 72 hours were above the baseline values were grouped as high responders (HR), while the remaining participants were classified as low responders (LR). Three-way repeated measures ANOVA [time (pre, 24h, 48h, 72h) x group (HR, LR) x sex (female, male)] was conducted to identify the effect of time on serum biomarkers, FGC and ROM, followed by post-hoc Bonferroni-corrected paired t-test. Effect sizes (ES) were calculated using Cohen's d and associations between variables were analyzed using Spearman's Rho correlation coefficient. The level of significance was set at $p < 0.05$.

RESULTS: RST increased serum sMtCK by 244.9% in HR participants at 24h ($p < 0.001$; ES = 1.38) and remained elevated by 130.0% at 72 hours post-RST ($p < 0.001$; ES = 1.13), so the model was effective in damaging mitochondrial structure. In this way, OSI was increased and remained elevated at +72h in HR group ($p < 0.001$; ES = 1.20). There were no differences between sex in the interaction of time and group for sMtCK ($p = 0.268$) and OSI ($p = 0.153$). Moreover, peak sMtCK was positively correlated to peak OSI ($r = 0.712$, $p < 0.001$). Finally, HR participants reported both a decrease in FGC at 48 hours of 17.3% ($p = 0.003$; ES = 0.61), which remained decreased by 16.4% ($p = 0.003$; ES = 0.96) at 72 hours post-RST, and a decrease in ROM during the 72 hours recovery period.

CONCLUSION: RST is an effective model to generate moderate damage to muscle mitochondria and associated oxidative stress in HR individuals. Further, FGC and ROM remain impaired during the 3-day post-RST recovery period.

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ASSOCIATION BETWEEN TOTAL GENOTYPE SCORE AND MUSCLE INJURIES IN TOP-LEVEL FOOTBALL PLAYERS: A PILOT STUDY

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INTRODUCTION: Recently, genetic predisposition to injury has become a popular area of research and the association between a few Single Nucleotide Polymorphisms (SNPs) and the susceptibility to develop muscle injuries in football has been shown (1,2). This pilot study aimed to investigate the combined influence of common gene polymorphisms previously associated with muscle injuries in Italian football players.

METHODS: Total of 64 Italian top-level football players (age 23.1±5.5years; height 179.3±7.3cm; weight 73.0±7.9kg) were genotyped for 4 gene polymorphisms (ACE I/D rs 4341, ACTN-3 R/X rs 1815739, COL5A1 C/T rs 12722, MCT1 A/T rs1049434). Genomic DNA was extracted using a buccal swab, and genotyping was performed using a PCR method. Structural-mechanical injuries and functional muscle disorders were collected over 10 years (2009-2019).

RESULTS: Logistic regression analyses showed a significant association of all four polymorphisms with muscle injury incidence (P<0.01), while the ACTN-3 and the COL5A1 polymorphisms were significantly associated with the severity of injury (P = 0.042 and P = 0.012, respectively). Moreover, the mean total genotype score (TGS) was significantly higher in injured than in non-injured (control) football players (Injured: 57.5±15.5 vs non-injured: 36.6±13.7, t=6.33, P<0.001) and it was a strong predictor of muscle injury (OR=2.93, 95%CI: 0.06-0.18, P>0.001).

CONCLUSION: These data suggest that the carriage of a high number of "protective" gene variants could influence the individual susceptibility to develop muscle injuries in football. Further studies are needed to confirm these findings in other professional football player cohorts.

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A NOVEL LOCUS FOR PREDISPOSITION TO MUSCLE STRAIN INJURY IDENTIFIED USING A GWAS FOR MUSCLE STIFFNESS

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INTRODUCTION: Passive muscle stiffness is suggested to influence the risk of muscle strain injury. Identifying the biological mechanisms determining individual muscle stiffness differences may thus contribute to the development of preventive approaches for muscle strain injury. To identify the genetic underpinnings of muscle stiffness, we performed a genome-wide association study (GWAS) (Step 1), followed by an association analysis of the identified loci with muscle strain injury in athletes (Step 2).

METHODS: Step 1: A GWAS for passive muscle stiffness in the biceps femoris long head (BFlh) was performed in 365 Japanese individuals (males: n = 223, females n = 142). Passive BFlh stiffness of the right leg was assessed using ultrasound shear wave elastography. All participants were genotyped for approximately 660,000 single nucleotide polymorphisms (SNPs) using the ethnicity-specific Japonica Array. Standard quality controls (QC) and imputation with the 3.5KJPN haplotype reference panel were performed. Genome-wide associations for passive BFlh stiffness were tested under an additive genetic model using a linear regression analysis adjusted for sex, age, and stretching exercise habit. The genome-wide significance level was set at P < 5×10-8. Step 2: SNPs with P < 5×10-8 in Step 1 were tested for associations with muscle strain injury in 1127 Japanese athletes (males: n = 759, females: n = 368) from various sports. The history of muscle strain injury was assessed using a questionnaire. Genotyping of all athletes was performed using the same method as in Step 1.

RESULTS: Step 1: After QC, 5,414,785 autosomal SNPs in 365 individuals were available for analysis. Six SNPs in two loci on chromosome 11 were significantly associated with passive BFlh stiffness (P < 5×10-8). The first locus contained five SNPs located an intergenic region, and the second locus contains a single SNP located within CCDC73. Step 2: The top SNP (rs61908632 C/T) of the first locus was significantly associated with muscle strain injury in athletes (P = 0.027 by logistic regression analysis adjusted for age, sex, and sporting event), where T allele (muscle stiffness-increasing allele) carriers exhibited a higher frequency of athletes with muscle strain injury (Odds ratio: 1.70, 95% confidence interval: 1.08–2.66, under a T-allele additive genetic model). No association was observed between the second locus and muscle strain injury.

CONCLUSION: The unbiased GWAS for passive muscle stiffness identified a novel locus related to the risk of muscle strain injury, which deserves further exploration for the underlying molecular mechanisms.

IMPROVING RETURN TO PLAY: INTERMITTENT HYPOBARIC HYPOXIA EXPOSURE ACCELERATES SKELETAL MUSCLE RECOVERY

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INTRODUCTION: Muscle injuries are one of the main causes of injury suffered in sport. Due to its high incidence and impact on the athletes´ career, the muscle regeneration process has been widely studied and characterized. However, it has not been proposed yet a gold standard therapy that allows accelerating the muscle regeneration and reducing the rate of re-injury. Intermittent hypobaric hypoxia (IHH) has been used as a tool to improve performance of athletes, because of the adaptations that IHH can elicit on muscle tissue to maintain muscle homeostasis and functionality when oxygen availability is reduced. We hypothesize that IHH may also be a suitable therapy to enhance the muscle regeneration process and our main objective was to assess the time course of some muscle functional parameters and several regeneration markers after an IHH recovery protocol.

METHODS: Eighteen adult male rats were surgically injured in the right gastrocnemius muscle and randomly divided into two groups; 1) Control group (CTRL), with passive recovery in normoxia; 2) Hypoxic group (HYPO), subjected to IHH 4h/day into a hypobaric chamber (simulated altitude of 4,500 m). Muscle functional properties: peak force (PF), tetanic force (TF)

and low frequency fatigue resistance at 30 Hz (LFF) of injured and contralateral non-injured gastrocnemius muscles were measured in vivo at 9 and 21 days after injury. Collagen I deposition and developmental myosin heavy chain (dMHC) expression at the injury site were measured in histological slides. AKT, mTOR and AMPK protein expression were analysed by Western blot.

RESULTS: CTRL animals presented significant reductions in the functional parameters of the injured gastrocnemius at both time points (PF: 9 days: p=0.012; 21 days: p=0.049; TF: 9 days: p=0.034; 21 days: p=0.024; LFF: 9 days: p=0.053; 21 days: 0.038). However, HYPO animals showed a full recovery. After 9 days of IHH a significant reduction in dMHC expression (p=0.004) and collagen I deposition (p=0.012) compared to CTRL was shown at the injury site. On the other hand, in the injured muscle, HYPO showed a significantly higher expression of the pSer473Akt/total Akt ratio at 9 days (p=0.002), and a higher expression of the pThr172AMPKα/total AMPKα ratio (9 days: p=0.066; 21 days: p<0.001) than CTRL. However, no significant changes where found between groups in pSer2448mTOR/mTOR total ratio at any time point studied.

CONCLUSION: IHH accelerates muscle regeneration in rats as early as after 9 days of treatment, which was evidenced by the recovery of muscle functionality, by a fast maturation of newly formed muscle fibres (reduction of the dMHC positive fibres) and by the reduction of collagen deposition. Our results also suggest that the overexpression of AKT and AMPK proteins (involved in muscle regeneration processes) could play a role in the early recovery of the injured muscle.

ACUTE MELATONIN ADMINISTRATION AFTER PHYSICAL EXERCISE-INDUCED SKELETAL MUSCLE DAMAGE ON PAX7

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INTRODUCTION: High intensity and/or duration of physical exercise generally leads to skeletal muscle damage, which can be observed until days after exercise through PAX7 quantity at muscle cells nucleus, denoting the stage of repair process. The muscle repair is highly involved with cell redox and inflammation state, and melatonin has relevant anti-inflammatory and antioxidant effect, potentially influencing such process. So, we aimed to investigate the effect of melatonin on nucleus myocyte PAX7 in rats submitted to a skeletal muscle damage induction protocol (DIP) prescribed through individually determined exercise intensity in swimming rats.

METHODS: Thirty male Wistar rats were exposed to a light/dark cycle (10/14h) and had their daily spontaneous physical activity gravimetrically determined to set the time of day for interventions, which were performed at wakefulness period under ~15 lux and 600 nm light. At 75 days-old was started the aquatic adaptation to proceed with the graded exercise test (GET) two weeks later. The GET consisted in 5-min stages from 4 to 7% of body mass (%BM), with 0.5%BM increments. Blood was collected to determine the lactacidemic anaerobic threshold (L2, corresponding to maximal lactate steady state intensity). At 97 days-old was conducted the DIP, consisted of 1-min 10 swimming bouts at 120% L2, with a 30-s interval, followed by 20 minutes of continuous swimming at 100% of L2. Immediately after DIP, vehicle solution (C) or melatonin (M; I.P. 10 mg.kg-1) was administered, and the 5 animals per group were euthanized 24 (C24 or M24), 48 (C48 or M48) or 72h after (C72 or M72). White portion of the gastrocnemius muscles were collected to determine PAX7 using immunofluorescence on transverse sections of muscle (6µm) transferred on glass slides. The quantification of PAX7 was performed analyzing the overlap between PAX7 and nucleus markings as well as their intracellular location in relation to laminin. Data were presented as mean ± standard error and significance set at P<0.05. Two-way ANOVA was used to analyze the effects of melatonin (melatonin or vehicle) and time (24, 48 or 72 h), with Newmann-Keuls post hoc.

RESULTS: The peak of spontaneous physical activity was found 3 hours after the start of dark cycle, the time when the procedures were started. The L2 of all groups was 5.63±0.69 %BM and all animals performed the full PID. PAX7 was 9.08±1.36, 10.02±0.50, and 6.94±1.15 to C24, C48 and C72, and 4.09±0.61 to M24, 5.20±0.70 to M48 and 5.33±0.64 PAX/Muscle fiber.103 to M72, with area under the curve 44.1% higher to vehicle in relation to melatonin treatment. Was find melatonin effect on PAX7 (C>M; F=13.90; p<0.01), but no effect of time (F=0.73; p>0.05).

CONCLUSION: Exogenous melatonin administered just after the individually prescribed PID had no relevant effect on the time to peak for PAX7 but reduced the activated PAX7 at muscle nucleus in relation to vehicle solution.

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THE EFFECT OF CAPSAICIN APPLICATION TO THE SKIN ON SYMPTOMS OF EXERCISE INDUCED MUSCLE DAMAGE

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INTRODUCTION: Intense eccentric exercise has been documented to induce muscle damage (EIMD), which is typically manifested by a decrease in the range motion (ROM), reduction of produced muscular force as well as by delayed onset of muscle pain (DOMS) and swelling. Cryotherapy has been suggested as an effective mode of enhancing recovery after EIMD but this approach is highly controversial. On the other hand, recent preliminary findings suggest that thermotherapy may be an alternative intervention for faster recovery after EIMD. The purpose of this study was to determine whether thermotherapy, by means of capsaicin application to the skin, could be an effective strategy to accelerate skeletal muscle recovery following eccentric exercise and enhance performance in subsequent muscular efforts.

METHODS: Twenty-nine healthy, physically active young men underwent eccentric exercise consisted of 6 sets times 20 single-legged drop jumps-from a raised platform (0.20m high) with a 2-minutes break between each set. The eccentric exercise session was performed twice, one for the placebo (PL) and the other for the thermal therapy (HT) using a different

randomly selected leg in each occasion. A two weeks interval was used between the two therapies. The thermal therapy included capsaicin patches (capsicum extract 0,025%) placed for 48 h post exercise on the exercised muscle groups (i.e., quadriceps femoris). Muscle damage indices [i.e. DOMS, ROM, and squat jump (SJ)] were assessed before each eccentric exercise and 48 hours after either placebo or capsaicin therapy. At the same time points, assessment of muscle oxygenation was also performed, using near infrared spectroscopy (NIRS; vastus lateralis).

RESULTS: The eccentric exercise protocol induced significant alterations in all muscle damage indices [i.e., DOMS, ROM and SJ) after both conditions ($p<0.05$). However, DOMS was lower after the heat therapy compared to the placebo therapy ($p<0.026$). No differences were recorded between experimental conditions with regard to local muscular hemodynamics, leaping and range of motion abilities.

CONCLUSION: Despite that the application of capsaicin patches on the skin after intense eccentric exercise has an analgesic effect it does not appear to improve subsequent exercise performance. The analgesic effect of capsaicin application to the skin might be due to the stimulation of thermo sensitive TRPV-1 channels. The unchanged exercise performance following capsaicin treatment remains to be resolved.

EFFECT OF SPERMIDINE SUPPLEMENTATION ON SKELETAL MUSCLE REGENERATION AFTER INJURY

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INTRODUCTION: Athletes practice hard every day to improve their performance. Many athletes experience sports injuries mainly caused by repetitive movements and local overactivity. Establishment of injury prevention, treatment, return to sports and prevention of recurrence are urgent issues. Particulary, "muscle strain" is one of the skeletal muscle injuries, and many athletes suffer because sports activities are greatly restricted during treatment, the period of treatment is long, and the risk of recurrence is high. Spermidine is a type of polyamine contained in foods such as cheese or soybean, and various health functions through oral intake have been reported previously (Madeo et al., 2017). Recently, spermidine intake was shown to promote regeneration of skin after injury (Ito et al., 2021). However, it is unclear whether spermidine intake promotes regeneration of skeletal muscle after injury.

METHODS: Eight-weeks-old C57BL/6j male mice were divided into two groups: the DW group, which was allowed to ingest distilled water (DW) ad libitum, and the SP group, which was allowed to ingest spermidine (SP) mixed with DW to a concentration of 5 mM. Skeletal muscle injury was induced by cardiotoxin (CTX) (10 μM/50 μL in PBS) injection into the left tibialis anterior muscle. Right tibialis anterior muscle was injected with PBS (50 μL) as a control. SP group started taking spermidine-mixed water on the day of injection, and the water was changed every other day. Tibialis anterior muscle was isolated from the mice, 4 and 7 days after the CTX injection and analyzed.

RESULTS: We performed immunohistochemical staining of Laminin-α2, DAPI, and Collagen-1 using muscle sections of tibialis anterior. SP group tended to show lower myofiber CSA than that of DW group in 7 days, but no difference are detected in 4 days. We found no significant changes between the group in the area of fibrosis at 4 and 7 days after injury. We found some significant changes in the autophagy related proteins.

CONCLUSION: Our data suggested that spermidine delays the early stages of skeletal muscle regeneration after injury. Spermidine exerts diverse health functions through activating autophagy (Madeo et al., 2017). Previous studies have shown that the activation of autophagy by genetic modification promoted the recovery of skeletal muscle wet weight in 14 days and myofiber CSA in 21 days after injury(You et al., 2021). Thus, examination of autophagy related proteins in longer period of recovery are required.

NEUROMUSCULAR AND METABOLIC RESPONSES DURING REPEATED BOUTS OF OVERWEIGHTED DOWNHILL WALKING

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INTRODUCTION: It has been well established that performing a bout of unaccustomed, predominantly eccentric exercise may result in a long-lasting muscle function deficit (>24 h) and in a set of symptoms (e.g., muscle soreness, increased levels of circulating proteins). It is also well established that repeating the same bout within few weeks results in reduced loss of muscle function and symptoms of muscle damage compared to the initial bout. It has been suggested that neural, mechanical and cellular adaptations may explain the protection conferred by a single bout of eccentric exercise, called the "repeated bout effect". Some authors suggested an enhanced efficiency (i.e., lesser muscle activity and/or energy expenditure for the same power output) during a second bout of eccentric exercise. It has been shown that neural and mechanical adaptations could be involved in the enhanced efficiency, however there is no consensus. Moreover, it is not known how neuromuscular and metabolic responses could adapt in response to downhill walking/running, a more functional and accessible task compared to traditional one-limb eccentric exercise on an ergometer. The aim of this study was to compare the neuromuscular (i.e., fascicle behavior and muscle activation), cardio-respiratory and fatigue-perceived changes during repeated bouts of downhill walking with load carriage.

METHODS: 17 participants performed two sessions of 45-min loaded downhill walking (DW) separated by 2 weeks. Rating of perceived exertion (RPE), cost of walking (Cw), heart rate (HR), muscle activation of the vastus lateralis (VL), rectus femoris (RF) and biceps femoris (BF), and muscle fascicle behavior of the VL were assessed during the downhill walking. Maximal

voluntary contraction (MVC) torque and muscle soreness, were assessed before (PRE), immediately after (POST), and 24 and 48 h after the two exercise bouts.

RESULTS: MVC torque measured 24 h after the DW was reduced by 25.5 ± 10.3 % and 5.2 ± 13.2 % for the first (DW1) and the second (DW2) DW respectively. Muscle soreness was also significantly reduced after DW2 compared to DW1 ($p < 0.01$). RPE, cardiorespiratory (HR and Cw) and RF muscle activation were significantly decreased during DW2 compared to DW1 ($p < 0.05$). Moreover, VL fascicle elongation was higher during DW2 compared to DW1 ($p < 0.05$).

CONCLUSION: As expected, we found a reduced loss of muscle function and symptoms of muscle damage after the second bout compared to the initial bout of downhill walking. Protective adaptations conferred by the first bout induce a lower perceived exertion and cardiorespiratory responses when the same exercise is repeated within few weeks. Neural and mechanical adaptations could partly explain the lower perceptual and cardio-respiratory responses during a second bout of eccentric biased exercise.

Conventional Print Poster

CP-MH15 Sports medicine I

THE EFFECT OF LIFELONG ENDURANCE TRAINING ON MORNING CORTISOL LEVEL AND SELECTED MARKERS OF STRESS RESPONSE AND INFLAMMATION

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INTRODUCTION: Aging is associated with changes at all levels of living organisms, including hypothalamic-pituitary-adrenocortical (HPA) axis. Altered function of the HPA axis can modify the bodys response to stress, but it also affects other organ systems, including the nervous, hormonal and immune system. Via this connection, the proper function of the HPA axis has a fundamental impact on human health. Regular physical activity may have a protective effect on the age-related disruption of HPA axis function. Therefore, the aim of our study was to determine whether lifelong physical activity can affect morning cortisol level, selected parameters of the stress response and inflammatory markers.

METHODS: 42 healthy male subjects were divided to four groups according to age and physical activity: young athletes (YA, age 28.20 ± 0.65, BMI 21.89 ± 0.36, n=11), young sedentary (YS, age 25.55 ± 0.71, BMI 27.78 ± 1.57, n=11), elderly athletes (EA, age 69.0 ± 0.98, BMI 24.35 ± 0.79, n=10), elderly sedentary (ES, age 71.10 ± 1.15, BMI 27.74 ± 0.79, n=10). Participants included in the group of athletes had to perform more than 300 min/week of endurance running activity and participate in running competitions. Blood was drawn at 7:30 a.m. and it was evaluated for concentrations of cortisol, C-reactive protein (CRP), and neutrophil to lymphocyte ratio (NLR) in a commercial laboratory. Two-way ANOVA followed by Bonferroni post-hoc test with the factors age and exercise was used as a statistical method. Data are expressed as mean ± SEM.

RESULTS: We did not demonstrate a significant effect of older age ($p=0.183$) or regular physical activity ($p=0.151$) on morning cortisol concentrations. For NLR, we proved significant effect of aging ($p=0.002$) and regular endurance training ($p=0.031$). Moreover, two-way ANOVA provided proof for protective effect of regular endurance training on NLR between two groups of elderly (EA vs. ES: 1.84 ± 0.23 vs. 2.47 ± 0.25, $p=0.032$). Older age was also associated with higher CRP concentrations ($p= 0.002$), while we did not demonstrate a protective effect of regular endurance activity as prevention of inflammation ($p= 0.474$). Indeed, we proved elevated levels of CRP in elderly groups of athletes (EA vs. YA: 1.73 ± 0.80 vs. 0.31 ± 0.06 mg/l, $p=0.042$) as well as sedentary (ES vs. YS: 2.56 ± 0.76 vs. 1.42 ± 0.82 mg/l, $p=0.014$) when compared to young groups.

CONCLUSION: Although we did not demonstrate an effect of long-term endurance training on morning cortisol and CRP concentrations, we found interesting results in NLR. NLR can serve as a measure of chronic stress and subclinical inflammation. The values of NLR in ES group corresponded to the "grey zone" and may be associated with the development of several diseases. However, negative effect of aging on worse NLR seems to be blunted by lifelong endurance training.

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HAIR ANALYSIS FOR SPORTS DRUG TESTING USING UPLC-MS/MS IN A RAT MODEL: COMPARISON WITH PLASMA AND URINE

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INTRODUCTION: Currently, sports drug testing primarily analyzes urine and blood samples from athletes; however, these liquid matrices mainly provide short-term usage information and are not easily stored and transported. In contrast, hair analysis provides long-term usage information for an average of several months. This study will be the first to systematically evaluate different types of all-time prohibited substances in a rat model to investigate the correlation between expo-

sure levels and the concentration of prohibited substances in the hair, as well as the association of prohibited substances in the hair with urine and plasma.

METHODS: In this study, hair, plasma and urine were collected from SD rats during a 28-day control period for 18 representative all-time prohibited substances in 4 types (S1 anabolic agents, S3 beta-2 agonists, S4 hormone and metabolic modulators, and S5 diuretics and masking agents) at 4 different doses (0, 1, 2, and 4 mg/kg). After pre-treatment, the samples were analyzed by ultra performance liquid chromatography - tandem mass spectrometer (UPLC-MS/MS) with ESI and the data were processed by MassLynx® software for semi-quantification of the 18 all-time prohibited substances in different matrices using a quantification line.

RESULTS: More than half of the 18 representative all-time prohibited substances were found to be linear (>0.99) using hair, urine and plasma, and three biological samples were able to reach the sub-parts-per-billion (sub-ppb) level of quantification using this method. Hair samples from the back of rats (13.1 ppb-1080.80 ppb) were actually analyzed after 28 days of controlled intake of 18 all-time prohibited substances.

CONCLUSION: Although not much research has been done on hair analysis related to prohibited substances in sports until now, the results of this study suggested that the use of hair analysis in sports drug testing can help to complement the current doping control in increasingly diverse cases of prohibited substances. More research is needed to develop the multiple application of this analytical method before it can be used in doping control to help maintain fair competition.

O2 SUPPLEMENTATION IMPROVES OXYGEN-UPTAKE KINETICS AND EXERCISE CAPACITY IN PATIENTS WITH INTERSTITIAL LUNG DISEASE (ILD)

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INTRODUCTION: Oxygen (O2) therapy is commonly prescribed for patients with moderate to severe interstitial lung disease (ILD). The precise physiological mechanisms by which ILD patients benefit from O2 during exercise are not clear.

Purpose: We studied the effect of O2 supplementation on exercise physiology in ILD patients.

METHODS: 12 patients (age = 67±10 yrs., 6 males), with moderate to severe ILD (TLC = 67±17% predicted, DLCO = 43±17% predicted) and 11 healthy individuals (age = 51±17 yrs., 7 males,) were tested. ILD patients performed symptom-limited cardiopulmonary exercise tests and constant work-rate tests (CWRTs) at 80% of the work-rate (WR) at the gas exchange threshold (GET) room air (RA, FiO2 = 0.21) were compared to tests performed breathing 30% O2 (FiO2 = 0.30), a clinically relevant level of hyperoxia. Healthy individuals performed a maximal test only with FiO2 = 0.21 and a CWRTs under both conditions (FIO2 = 0.21 and FIO2 = 0.30). Oxygen-uptake (VO2) kinetics were calculated from the CWRTs results using mono-exponential modelling.

RESULTS: In the ILD group, peak WR and peak VO2 improved significantly when breathing with FIO2=0.3 compared to RA (mean ± SD 62±21 vs 73±27 watts and 14.4±2.5 vs 16.7±3.6 ml/kg/min, p=0.005 and p=0.002, respectively). VO2 at the GET was higher with FIO2=0.3 compared to FIO2=0.21 (829±247 vs 751±234 ml/min, p=0.009). O2 saturation (SPO2 %) at peak exercise was higher with FIO2=0.3 (97±4% vs 88±10%, p=0.004). The time constant (tau) of mono-exponential fits of phase II of VO2 kinetics in CWRTs was faster in ILD patients while breathing with FIO2=0.3 (42±10 sec) compared to RA (52±15 sec, p=0.005). The O2 deficit in the CWRTs was lower while breathing with FIO2=0.3 (0.47±0.14) compared to RA (0.53±0.14) p=0.03. SPO2 % during CWRTs was higher with FIO2=0.3 compared to FIO2 = 0.21 (99±2% vs 93±7%, p=0.004). There was a negative linear relation between tau and SPO2% with RA (r=-0.76, p=0.006) and while breathing with FIO2=0.3 (r=-0.68, p=0.02). There was no difference in VO2 kinetics in healthy individuals between FiO2=0.21 and 0.30 (tau 34±6 sec vs 35±6 sec, p=NS).

CONCLUSION: Using a clinically relevant level of O2 supplementation (30%) improved maximal exercise capacity and oxygen-uptake kinetics in ILD patients, apparently by increasing blood O2 content, thus presumably increasing muscle oxygen delivery. This finding has a clinical value for ILD patients.

EFFECT OF EXERCISE TRAINING ON PROGNOSIS IN COMMUNITY-ACQUIRED PNEUMONIA: A RANDOMISED CONTROLLED TRIAL

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INTRODUCTION: Physical inactivity is common during hospital admission with community-acquired pneumonia (CAP) and is associated with an increased risk of adverse outcomes. The aim was to investigate the effect of supervised exercise training during admission with CAP on prognosis.

METHODS: with CAP was conducted at the Copenhagen University Hospital – North Zealand, Denmark, from April 2019 to March 2022. Patients were randomly assigned in a 1:1:1 ratio to either standard of care, standard of care combined with supervised in-bed cycling, or standard of care combined with supervised exercise training, according to a booklet. The primary outcome was length of stay. Secondary outcomes were 90-day readmission and 180-day mortality. Analysis of covariance was used to determine differences in length of stay. Cox proportional hazards regression was used to assess the risk of readmission and mortality.

RESULTS: In the intention-to-treat analysis, length of stay was similar between the standard of care and the in-bed cycling (-2%, 95% CI -24 to 25%, P=0.85) and booklet exercise groups (-1%, 95% CI -22 to 27%, P=0.94). In the available-case analysis, the adjusted hazard ratio for 90-day readmission was 0.63 (95 % CI 0.33–1.21, P=0.17) for the in-bed cycling and 0.54 (95% CI 0.27–1.08, P=0.08) for the booklet exercise groups, compared to standard of care. Post-hoc subgroup analysis showed a significant reduction in 90-day readmission risk with booklet exercise for ≥10 min per day during admission (hazard ratio 0.41, 95% CI 0.18–0.93, P=0.03). The risk of 180-day mortality was similar between the standard of care and the in-bed cycling (adjusted hazard ratio 0.84, 95% CI 0.27–2.60, P=0.76) and booklet exercise groups (adjusted hazard ratio 0.82, 95% CI 0.26–2.55, P=0.73).

CONCLUSION: Supervised exercise training during admission with CAP had no effect on the length of stay and mortality. Subgroup analyses demonstrated a reduced risk of readmission with booklet exercises. Exercise training during admission could be a safe strategy to mitigate the vicious cycle of readmissions in patients with CAP.

BLOOD-FLOW RESTRICTED INTERVAL CYCLING MAXIMIZES LEG MUSCLE EFFORT WITH LESS VENTILATORY WORK COMPARED TO WORK-MATCHED FREE-FLOW EXERCISE: A RANDOMIZED CROSSOVER STUDY

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INTRODUCTION: Endurance training with blood flow restriction (BFR-EN) can improve muscular function and aerobic capacity. We investigated the acute cardiorespiratory response between BFR-EN and traditional interval endurance exercise (TRA-EN). We hypothesized that BFR-EN elicits lower minute ventilation (VE, primary endpoint) while exacerbating perceived leg exertion compared to work-matched TRA-EN.

METHODS: We conducted a randomized crossover study. The protocol involved three cycling intervals interspersed by 1 min resting periods. Respiratory parameters were collected by breath-by-breath analysis. Heart rate (HR) and rate of perceived exertion (RPE, scale from 0 to 10) were assessed. TRA-EN intervals lasted 2 min with an intensity of 65% peak workload. BFR-EN intervals were work-matched to TRA-EN and, thus, lasted 2 min 18 sec with an intensity of 50% peak workload. Arterial occlusion pressure (AOP) was determined before the exercise sessions and 50% occlusion was continuously applied during the BFR-EN condition on both legs. Linear mixed models were used to analyze all metabolic, HR, and RPE data adjusted for multiple measurements and reported as mean differences [95% confidence interval].

RESULTS: Twenty-four healthy individuals (male/female: 15/9, mean (SD) age: 30.5±8.3 yrs, mean (SD) peak oxygen consumption (VO2peak): 45.7±9.9 mL/kg/min) completed the study. TRA-EN elicited higher VE (2.4 L/min [0.98 to 3.82]), oxygen consumption (2.47 mL/kg/min [2.02. to 2.93]), carbon dioxide production (0.2 L/min [0.17 to 0.22]), RPE Dyspnea (0.7 [0.55 to 0.85]) and HR (4.5 bpm [1.71 to 7.2]) compared to BFR-EN. RPE Leg (-1.24 [-1.46 to -1.03]) was lower in TRA-EN compared to BFR-EN.

CONCLUSION: BFR-EN at 50% peak workload and 50% AOP resulted in lower VE and perceived dyspnoea compared to TRA-EN at 65% peak workload. For people with short-term lung restriction (e.g. shortly after a cold) or with lung disease BFR-EN could provide endurance training with less respiratory effort while augmenting leg muscle effort.

THE RUNNING INJURY CONTINUUM: AN EXAMINATION OF RECREATIONAL RUNNERS' DESCRIPTION AND MANAGEMENT OF INJURY

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INTRODUCTION: A critical step in understanding and preventing running-related injuries (RRIs) is appropriately defining RRIs [1]. Current definitions of RRIs may not represent the process of injury development, failing to capture lower level injuries that athletes train through [2]. Understanding runners' description of injury may allow for appropriate examination of all levels of injury. The aim of this study was to examine recreational runners' description and management of the injury development process.

METHODS: A qualitative study with seven semi-structured focus groups including 31 recreational runners (13 male and 18 female) took place. Focus groups were audio and video recorded, and transcribed verbatim. Transcripts were reflexively thematically analysed. A critical friend approach was taken to data coding, and multiple methods of trustworthiness were executed.

RESULTS: Runners describe a nine-level continuum of injury, with lower and higher level injuries identified. They nine levels of injury are: Running smooth, Discomfort, Niggle, Twinge, Persistent niggle, Non-responsive injury, Injury: short-term effect, Injury: long-term effect, and Career-ending injury. Each level is described across four categories of descriptors: physical description, outcome (effect on running and daily life), psychological description, and management.

CONCLUSION: Unique to this study, we identified two categories of injury: lower level injuries, spanning from Discomfort to Non-responsive injury, and higher level injuries, spanning from Injury: short-term effect to Career-ending injury. Higher level injuries reflect research to date, specifically the consensus definition of injury [3], while lower level injuries expand on previous research [4]. However, we present novel findings in the identification of further lower level injuries. This continuum is useful for injury surveillance (for healthcare professionals (HCPs) and researchers) and for research investigating RRI risk factors. HCPs, and researchers must ensure they monitor the development of all levels of RRIs, across all categories of descriptors.

EFFECT OF A NONLINEAR EXERCISE PROGRAM THROUGH MHEALTH SYSTEM (ATOPE+) ON ISOKINETIC STRENGTH IN PATIENTS WITH BREAST CANCER UNDERGOING MEDICAL TREATMENTS

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INTRODUCTION: Knee strength is one of the indicators of oncological health(1). An important progress has been the initiation of physical exercise programs in patients who undergo chemotherapy (CT) or radiotherapy (RT), as they lead to strength deterioration. However, adherence may be low due to health fluctuations, for that reason, nonlinear exercise is being recommended for these patients. Thus, the aim of this work was to analyse the effect of a nonlinear exercise program through mHealth system on lower limb isokinetic performance in women with breast cancer undergoing medical treatment.

METHODS: A pre-post study was carried out. Newly diagnosed women with breast cancer were recruited from two Hospitals in Granada (Spain). After obtaining written informed consent, women were derived to receive CT or RT. The ATOPE program consisted of 18 sessions of multimodal physical exercise program, doses were prescribed based on heart rate variability and clinimetric assessments through daily assessments using the mHealth system ATOPE+(2). Strength and aerobic bouts oscillated between moderate and high intensity, progressing in velocity execution and/or number of repetitions and duration time, respectively. Increments of physical activity was encouraged from 10,000 up to 12,500 steps per day. Isokinetic strength was measured with HUMAC NORM at 60º/s, 180º/s and 300º/s at baseline and after the program. Two-way analysis of variance (ANOVA) was used.

RESULTS: Thirty-two women were included (52.31±9.62 years), 17 underwent CT and 15 RT. The ANOVA showed an intragroup effect in torque max isokinetic 60º/s extension $F(1,21)=53$, $p<0.01$, $\eta^2=0.716$; where the CT group reduced 49.20 N from baseline (from 109.10±10.27 to 59.90±5.85 N, $p<0.001$), as well as the RT group reduced 22.54 N from baseline (from 85.69±9.01 to 63.15±5.13 N, $p=0.002$). Additionally, a significative intragroup effect was found in 60º/s flexion $F(1,21)=9.62$, $p=0.005$, $\eta^2=0.314$; where an increase of 23.92 N was observed only in the RT group (from 62.39±5.49 to 86.31±7.02 N, $p<0.001$). Regarding 180º/s, a significative intragroup effect in torque max extension was found $F(1,21)=20.43$, $p<0.01$, $\eta^2=0.493$, that revealed a reduction of 24.78 N in the CT group (from 71.89±6.50 to 47.11±3.46 N, $p<0.001$). Finally, an effect in torque max isokinetic 300º/s extension $F(1,20)=5.39$, $p<0.031$, $\eta^2=0.212$ and a intragroup reduction of 12.22 N were found in the CT group (from 49 ±4.44 to 36.78±2.95, $p=0.004$).

CONCLUSION: Since patients with cancer normally show a CT and RT induced deterioration of strength, an increase but also the maintenance of strength is an important finding. A recent study found an isokinetic strength improvement in patients undergoing CT of 20.8 N, ES = 0.57 compared to the control group after the program(3). In our study, for ethical reasons, a control group was not used.

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POLYCYSTIC OVARY SYNDROME DOES NOT ALTER RESTING CEREBRAL BLOOD FLOW

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INTRODUCTION: Polycystic Ovary Syndrome (PCOS) is the most common endocrine condition, affecting up to 21% of women. PCOS is associated with cardiovascular risk factors such as hypertension, hyperandrogenism and elevated insulin resistance which lead to increased morbidity and mortality from cardiovascular disease. PCOS patients have altered white matter microstructure and reductions in cerebral volume, which may explain their diminished cognitive performance. However, despite differences in cerebral structure, the impact on cerebral blood flow and regulation has not been determined in these patients.

METHODS: Women diagnosed with PCOS via the Rotterdam criteria (Age: 34 years ± 7; BMI: 29.4 kg/m2 ± 6.1) (n = 7) and healthy age- and BMI-matched controls (Age: 30 years ± 4; BMI: 28.1 kg/m2 ± 4.7) (n = 6) were recruited. Baseline cerebrovascular function was assessed. Following a period of supine rest, end tidal carbon dioxide (ETCO2), mean arterial pressure (MAP) and mean arterial blood flow (Q) were measured. Longitudinal B-mode ultrasound images were collected through the right common carotid (CCA), internal carotid (ICA) and vertebral (VA) arteries using a 12MHz transducer and stored for offline analysis. Blood pressure was measured using finger plethysmography. Global cerebral blood flow (gCBF) was calculated by: 2 • (mean ICAQ + mean VAQ). Cerebrovascular conductance index (CVCi) was calculated locally as (⟦ICA⟧ _Q or ⟦VA⟧ _Q)/MAP. An independent groups t-test was utilised to determine differences in gCBF between groups , with significance set at $P < 0.05$.

RESULTS: Groups were matched for age (P=0.23) and BMI (P=0.67). There was no difference in ETCO2 (PCOS: 36.3 mmHg ± 3.9; CON: 35.4 ± 2.6)[P = 0.68], MAP (PCOS: 95.3 mmHg ± 13.5; CON:82.93 mmHg ± 15.3)[P = 0.14], CVCICA (PCOS: 2.03 ± 0.7; CON: 2.53 ± 0.6)[P = 0.20] and CVCVA (PCOS: 0.55 ± 0.24; CON: 0.80 ± 0.25)[P = 0.10]. gCBF (PCOS: 457 ml.min-1 ± 87.8; CON: 542 ml.min-1 ± 131.9) was similar between groups (P = 0.19).

CONCLUSION: Despite women with PCOS presenting with altered cerebral structure, gCBF remains similar to healthy, matched controls. MAP, and thus CVCi in both ICA and VA supplying the cerebrum are also similar. This may suggest that despite elevated cardiovascular risk, resting cerebrovascular function is maintained in the brain of women with PCOS. Therefore, further research is warranted to better understand the mechanisms at work, and ascertain the cause of the altered cerebral structure in PCOS.

Conventional Print Poster

CP-MH31 Health and Fitness VI

OUTDOOR FITNESS COURT FUNCTIONALITY: ITS RELATIONSHIP TO CVH AND COMMUNITY ENGAGEMENT

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INTRODUCTION: Cardiovascular disease (CVD) describes diseases of the heart or blood vessels. The four main types include coronary heart disease, stroke, peripheral arterial disease, and aortic disease. According to the World Health Organization Statistics (2022), heart disease is the leading cause of death for men, women, and people of most racial and ethnic groups. Heart disease accounts for 17.9 million deaths annually. Therefore, health initiatives must be established to combat the effect of CVD across the globe. Recent research indicated that health initiatives like exercise is medicine, lifestyle medicine, using wearable technology, outdoor activities/fitness gym, high intensity interval training (HIIT), and health and wellness coaching were effective strategies that can get people moving and lead to a reduction in CVD in society (Kercher et al., 2022). Due to the continued worldwide influence of the COVID-19 pandemic on our health and health outcomes, there is an increase demand for wearable technology and outdoor activities/fitness gym. Organizations like the National Fitness Campaign are poised to install over three thousand outdoor activities/fitness gym worldwide to build healthy communities and improve health outcomes for all. This study expands scholastic inquest into the instillation impact on cardiovascular health (CVH) and community engagement in a rural community. More specifically, the purpose of the research is two-fold: 1) to explore the National Fitness Campaign Outdoor Art Fitness Court/Gym impact on CVH in a rural Community and 2) to investigate the Keith Haring Art Fitness Court Instillation impact on community engagement and fitness in a rural community.

METHODS: The study employed a mixed method research design. Investigators utilized a convenient sampling technique to recruit participants 18 years and older. A sample size of one hundred participants was determined by effect size and Z-score with levels of significance for the test. IBM SPSS Statistics 27 was used to analyze an outdoor information Kiosk data, cardiovascular physical assessments, and the Life's Essential 8 survey. Descriptive analysis and constant comparison method are employed to analyze the SOPARC and audit trail data from two fitness challenges.

RESULTS: Preliminary research findings yield pragmatic implications on how practical initiatives can enhance community engagement and its sustainability. It indicates that the finding will help local government officials identify areas for CVH education and avenues to operationalized practical health initiatives to better serve communities.

CONCLUSION: After COVID-19, people desire more outside activities. So, the outdoors fitness courts/gyms have seen a significant upward trending trajectory. This provides a clear pathway for research and initiatives with pedagogical and technological advances, data sharing, and instillation of more outdoor fitness courts/gyms across the globe. More significantly, an individual CVH can improve with this approach.

IS PHYSICAL EXERCISE-INTERVENTION CAN BE VALUABLE THERAPY FOR COVID-19 ?

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INTRODUCTION: COVID-19 has become a pandemic and endemic affecting on physical health, physical conditioning, well-being, and mental health status. And moreover, It also brings about on the educational problem, economic, social networks, cultural, and psychological problems as well as physical health.

This kind of home confinement, social distancing and physical inactivity impacts on the many health disease such as obesity, diabetes mellitus, hypertension, hyperlipidemia, cardiovascular and mental health problem such as depression, sleep quality. Systemic review research reported that regular and

repeated (2-3 sessions/week) aerobic programs (cycling or walking with an intensity of 60-80% HR max, 20-60min/ session) increase physical and mental health as well as immune functions. This kind of physical activity increased immunological markers such as lymphocytes, leukocytes, neutrophils,

monocytes, IL-6 and even low graded inflammation. Therefore, the present research is to analyzed the impacts of tailorized exercise-interventions on physical and mental health problems of COVID-19 patients in the main text.

METHODS: For this research, PubMed database were evaluated from the January 2020 to September 2021 using predefined search terms 'COVID-19 pandemic' , exercise-intervention, and 'mental health'.

Using this references, we analyzed the connections between exercise-intervention and mental, physical health problems of COVID-19 pandemic patients.

RESULTS: One systemic review research reported that regular and repeated (2-3 sessions/week) aerobic programs (cycling or walking with an intensity of 60-80% HR max, 20-60min/ session) increase physical and mental health as well as immune functions. This kind of physical exercise increased immunological markers such as lymphocytes, leukocytes, neutrophils, monocytes, IL-6 and even low graded

inflammation. Therefore, enhanced immune functions appeared following the exercise-intervention especially to the disease and elderly people.

Especially, COVID-19 patients usually suffer from the symptoms of airway and pulmonary health Problems, therefore It should be prescribed as pulmonary rehabilitation such as posture, stretching, manual therapy, physical activity with breathing exercise.

Breathing exercise and respiratory support such as yoga, thoracic expansion exercises, airway clearance methods, breathing control and regular physical exercise will be helpful for physical health and mental health as well as immune responses.

CONCLUSION: Tailored multipronged exercise-intervention should be developed and applied to provide the existing mental challenges and enhance mental health of pandemic periods. Furthermore, the continuous epidemiological distribution of physical and mental health problems were heterogeneous among the general public. More scientifical interdisciplinary and intertribal studies about exercise- intervention on physical and mental health problems is urgently needed in this pandemic

periods.

EFFECTS OF IYENGAR YOGA ON FLEXIBILITY AND STRESS OF THAI STUDENTS: A CASE STUDY OF STUDENTS MAJORING IN SPORTS SCIENCE OF SILPAKORN UNIVERSITY

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INTRODUCTION: The recent outbreak of COVID-19 had a devastating effect on the physical, mental, emotional, and social health of Thais especially teenagers. Yoga has been associated with positive outcomes in physical performance and improvements in mental health [1]. Flexibility and stress has also been managed in teens using yoga [2]. The authors hypothesized that this approach would enhance flexibility and ameliorate COVID-19 stress symptoms in university students. The purpose of this research was to compare the effects of Iyengar yoga training on the flexibility and stress levels of Silpakorn University students.

METHODS: The sampled population comprises 15 male student volunteers in the Sports Science program at Silpakorn University. Participants had 60 minutes of Iyengar yoga sessions thrice (Monday, Wednesday, and Friday) weekly for 8 consecutive weeks. Prior to commencing the session, a Sit and Reach Test was conducted; this was also repeated after week 4 and week 8 of training. An 8-week self-assessment and stress evaluation was also performed during the study. Data analysis was conducted using Mean, Standard deviation, and One-Way ANOVA with Repeated Measure were estimated. A Bonferroni Post-Hoc Test was employed with an alpha level of .05 for all statistical tests.

RESULTS: 1. Pre-test flexibility training score was 10.00+7.5. Mean flexibility score increased to 11.30+7.14 and 13.10+7.04 at weeks 4 and 8 of training respective Pre-test mean stress effect score was 15.73+6.74; this score decreased to 12.40+6.12 and 11.00+5.90 at weeks 4 and 8, respectively.

2. The comparison between the results of flexibility and stress tests before the training and after weeks 4 and 8 of training was statistically significant ($p < 0.05$).

CONCLUSION: Iyengar yoga training has a favorable effect on increasing flexibility and reducing stress associated with university life.

References:

[1] Goodman, M. (2014). The effects of selected asanas in Iyengar yoga on flexibility: pilot study, Journal of Bodywork and Movement Therapies. 2014. 18(3):399-404.

[2] Uebelacker L.A. et al., Teens perspectives on yoga as a treatment for stress and depression. Complementary therapies in medicine. 2021. 59:102723.

ASSOCIATION OF SPORTS CLUB MEMBERSHIP WITH HEALTH LITERACY, HEALTH BEHAVIOURS, AND HEALTH STATUS AMONG JAPANESE UNIVERSITY STUDENTS

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INTRODUCTION: Health literacy is associated with individual health status and is a key social determinant of health. Previous research has shown that adolescents who participated in sports club activities have higher levels of health literacy. However, the relationship between health literacy, health behaviors, health status, and sports club membership among Japanese university students has not been well studied. The aim of this study was to examine the mediating effect of sports club membership on the association between health literacy, health behaviors and health status.

METHODS: An anonymous voluntary online survey was used to collect data on 517 participants from two Japanese universities in July 2022. Data were collected on the following participant characteristics: age, residence, number of commute days, number of friends, sports club membership status, health behaviours, self-rated health, and general trust. Participants were asked about 10 health behaviours: exercise/sports activity, diets, sleep, smoking, drinking, stress coping, tooth brushing, weight management, health check-ups, and health information. We measured health literacy using the short version of the European Health Literacy Survey Questionnaire for Japanese (J-HLS-EU-Q16). The health literacy score was calculated according to the recommendations of the European Health Literacy Project. The chi-square test was used to evaluate for statistical differences between sports club membership and participant characteristics, health behaviours, and health literacy score. All statistical analyses were performed using IBM SPSS 26.0.

RESULTS: Participant's average age was 19.39 ± 1.19 years, and 203 participants (39.3%) were female. 398 participants (77.0%) lived with their families, while 247 (47.8%) commuted to university five days a week. 128 participants (24.7%) were sports club members. The average health literacy score was 36.5 ± 6.4. Health literacy levels significantly differed by sex, commute days, sports club membership, self-rated health, and general trust. Sports club membership was significantly associated with sex, number of friends, self-rated health, several health behaviours (exercise/sports activity, diets, and weight management), and health literacy score.

CONCLUSION: These results suggest that Japanese university students who were sports club members had higher health literacy levels and engaged in healthier behaviours than non-members. Further studies are needed to confirm the importance of health literacy in promoting the health of young people.

LONG-TERM TAI CHI TRAINING IMPROVED COGNITIVE PERFORMANCE: A CROSS-SECTIONAL STUDY

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INTRODUCTION: The dose-response of long-term Tai Chi training effect on cognitive function is largely unclear. The purpose of this study is to compare the effectiveness of three Tai Chi proficiency levels (i.e., ≤ 1 year; ≥ 10-30 years; > 30 years) on executive function and long-term memory.

METHODS: A total of 39 age-matched healthy Tai Chi practitioners were recruited in this study. The practitioners were categorized into three groups based on their years of experience in Tai Chi training: 1) Novice (≤ 1 year, n=13, age: 68.4±3.4 yrs); 2) Master (≥ 10-30 years, n=15, age: 66.5±7.5 yrs); and 3) Top Master (≥ 30 years, n=11, age: 67.0±4.7 yrs). All practitioners practice Yang-style Tai Chi in their usual training. The executive function and long-term memory were assessed by the completion time in the Trail Making Test (TMT) (i.e., Part A score, Part B score, Part B-A score, Part B/A; lower TMT score indicates better executive function) and Chinese-version Rey Auditory Verbal Learning Test (i.e., the number of recalled words after 30 minutes), respectively.

RESULTS: Significant group effects were detected on the TMT Part A score (p=0.023), the TMT Part B score (p=0.003), and TMT B-A different score (p=0.024). The post-hoc analysis indicated that the Top Master demonstrated a significantly lower TMT Part A score (p=0.032), TMT Part B score (p=0.002), and TMT Part B-A score (p=0.034) compared to the Novice. The Master group demonstrates lower scores in TMT Part A (p=0.092), TMT Part B (p=0.078), and TMT Part B-A (p=0.093) than the Novice. No significant differences were observed in all parameters from the Chinese-version Rey Auditory Verbal Learning Test.

CONCLUSION: The present study demonstrated that prolonged Tai Chi training may lead to better improvement in executive function among older-aged adults.

PREVENTIVE EFFECT OF EXERCISE ON DEPRESSION-LIKE BEHAVIOR VIA DECREASING HIPPOCAMPAL TSPO

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Introduction

Depression and other mental disorders have occurred in about 322 million people worldwide.

Recent studies have reported that Translocator protein 18 kDa (TSPO) is involved in the depression as well as inflammatory cytokines and immune related molecules in the brain. Additionally, there are many studies advocating the positive effects of exercise on mental health. However, the involvement of TSPO in the effect of exercise on depression remains unclear. In this study, we examined whether or not TSPO is involved in the depression preventive effects of exercise.

Methods

Four-week-old male C57BL/6 mice (n=40) were treated with sedentary control (Ctrl), socially defeated stress for 10 days (SDS), SDS after the wheel running for 10 weeks (SW) and administration of PK11195, an antagonist against TSPO, during SW (SW-P). As SDS, mice were treated to physical interactions with ICR mice, which are aggressive effector mice, for 5 min once per day and then the mice were housed on the opposite side of the stress cage over the subsequent 24-h period daily for 10 days. After the experimental period, the social interaction, forced swimming and sucrose preference tests were performed to evaluate the depression-like behavior in mice. The protein expression of TSPO was measured by western blotting.

Results

Although the thymus gland weight in SDS group was significantly smaller than that in Ctrl group ($p<0.05$), this SDS-induced atrophy was attenuated by wheel running ($p<0.05$). Additionally, social score in SDS group tended to be lowered, compared with that in Ctrl group, and was slightly improved by wheel running. We observed a decrease in the protein level of TSPO in hippocampus in SW group compared with Ctrl and SDS groups. Moreover, the TSPO expression was similar between SW and SW-P.

Conclusion

Wheel running may have a preventive effect on depression-like behavior with a decrease in hippocampal TSPO.

THE EFFECTS OF AN EXERCISE TRAINING ON CORTISOL REACTIVITY PREADOLESCENT CHILDREN

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INTRODUCTION: Over the past years, exercise training has been suggested as a significant moderator that increases neurogenesis and improves neuroplasticity as well as overall mental health. Studies so far suggest that acute exercises as well as exercise training have an impact on the Steroid Hormones, which modulate multiple physiological processes in the human body. Depending on the intensity, an acute bout of exercises was found to affect the Hypothalamic-Pituitary-Adrenal (HPA)-axis responsiveness. As an indicator for HPA-activity, the current study investigates the acute effect of exercise on salivary Cortisol reactivity before and after a 10week exercise training.

METHODS: 71 children at the age of M = 9.4 years (SD = 0.6) were assigned to an interventional (n = 50) and a control group (CON, n = 21). While the CON participated in assisted homework sessions, the interventional group was either joining an aerobic or a coordinative exercise training with a moderate intensity of 64%-76% HRmax. All programs were applied 3x/week for a total of 10 weeks. Salivary cortisol levels were raised immediately, 15 minutes and 30 minutes after an acute exercise session of 45 minutes. As an indicator for Cortisol reactivity the Area Under the Curve with respect to the Ground (AUCG) was calculated. This procedure was applied before (t1) and after (t2) the 10week exercise training program.

RESULTS: The 2x2 ANOVA Model revealed a main effect of time ($F(1,69) = 5.76$ $p = .010$, $\eta2 = 0.08$) and group ($F(1,69) = 2.97$, $p = .045$, $\eta2 = .04$) regarding cortisol AUCG. The time*group interaction was not significant ($p = >.05$). Using single dependent t-Tests a significant increase in the interventional group was found ($p = .013$, $d = 0.36$), while no significant changes in the CON were observed ($p > .05$).

CONCLUSION: Therefore, we argue that a 10week exercise training might increase acute Cortisol reactivity in preadolescent children.

EXPLORING THE CHANGE PATTERNS OF SPEECH FEATURES UNDER DIFFERENT EXERCISE STATES

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INTRODUCTION: This study aimed to explore the variation in physiological vocal parameters under different exercise intensities.

METHODS: All participants were recruited from the Chinese University of Hong Kong using a cross-sectional study design with convenience sampling method. A total of 31 participants were recruited for the present study. Participants were asked to wear a heart rate detector to complete three different exercises and then read aloud a passage at the end of each exercise. The fundamental frequencies (F0) were extracted from the speech data, one-way Repeated Measures Analysis of Variance (RM-ANOVA) was used to investigate the difference of speech features in each exercise state. Pearson's product-moment correlation and simple linear regression was carried out to examine the relationship among each feature.

RESULTS: The RM-ANOVA had statistically significant differences between the means of the speech duration($F (3, 90) = 7.89$, $p = .001$, $\eta2 = .21$), F0 ($F (3, 90) = 34.32$, $p < .001$, $\eta2 = .53$), F0 range in 25% and 75% ($F (3, 90) = 10.68$, $p < .001$, $\eta2 = .26$), pause times ($F (3, 90) = 60.21$, $p < .001$, $\eta2 = .67$) and pause duration ($F (3, 90) = 63.27$, $p < .001$, $\eta2 = .68$). F0 and its range in 25% and 75% under vigorous intensity exercise were significantly different from the other states. The duration of speech throughout the paragraph also increased as the exercise intensity rose. The number and duration of pauses were more discriminative across exercise states. Compared to F0, which differs only under vigorous intensity exercise, features of pause also allowed to separate moderate intensity from resting states.We tested the correlation between heart rate and speech features. The correlations were significant for most of groups. And most of the regression equations had R2 above 20%, which means at least 20% of the variance in our speech data can be explained by the variable of heart rate. Among these equations, heart rate of males predicted three features: 1) F0 mean = 110.90 + .16 * heart rate; 2) Pause times = 4.25 + .05 * heart rate; 3) Pause duration = 1.26 + .04 * heart rate. For females, heart rate predicted four features: 1) F0 mean = 164.13 + .42 * heart rate; 2) Range = 26.77 + .12 * heart rate; 3) Pause times = 4.43 + .04 *heart rate; 4) Pause duration = .57 + .04 * heart rate.

CONCLUSION: This study explored the change patterns of speech features under different exercise states. The speech features explored in this study were handcraft features that provide a reliable choice of parameters for further exploration of the association between speech features and exercise states.

INVESTIGATING KEY DETERMINANTS OF LUNG FUNCTION TRAJECTORIES IN CHILDREN AND YOUNG PEOPLE, AND THE INFLUENCE OF PHYSICAL ACTIVITY ON THESE VALUES

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INTRODUCTION: Respiratory disease is considered a major threat to morbidity and mortality. Whilst the manifestation of lung disease usually occurs in adulthood, the underlying disease processes may begin much earlier in childhood. In order to identify the onset of disease with more certainty, a better understanding of both the trajectory of lung function, and the influencing lifestyle factors, such as physical activity (PA) are needed. Whilst the development of the lung is, at least in part, subject to perinatal factors, a variety of different factors and exposures have been shown to influence, and potentially maximize, function. This study sought to better understand the developmental trajectories of lung function and the complex relationship PA may have on lung function in childhood.

METHODS: Using latent growth curve analysis and structural equation modelling, the developmental trajectories over three time-points spanning x years of forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV1) were investigated. Separate multi-nomial logistic regression models for boys (n=398; x ± y yrs) and girls (n=372; x ± y yrs) were then used to determine whether MVPA influenced FEV1 and FVC trajectories, and whether this differed by sex when controlling for height, body mass and ethnicity.

RESULTS: Whilst three distinct trajectories were identified for males (low=30.9%; medium=57.9%; high=11.2%), four trajectories were identified in girls for FEV1 (low=6.3%; medium=43.6%; high=38.9%; very high=11.2%). Similarly, for FVC, three distinct classes were identified for boys compared to four trajectories in girls. The distributions indicated that trajectory groups for FEV1 differed significantly on the proportion of male and female students (X^2=12.816, p=0.002) with distributions in Group 2 higher for females (40.9%) than males (29.4%), whereas the distributions within Group 1 and Group 3 was higher for males (14.8% and 55.8% respectively) than females (9.7% and 49.5%). For FVC, the distribution between trajectory groups differed significantly according to sex (X^2=42.500, p<0.001), with greater proportion of boys in groups 2 and 3 higher (61.3% and 13.1%, respectively) than girls (48.4% and 5.1% respectively), whilst group 1 was higher for girls (46.58%) than boys (25.6 %). When using PA as a predictor of trajectory class, regression analysis did not reveal any significant relationships.

CONCLUSION: These findings highlight the, often overlooked, but important role that sex plays in determining lung function in youth. Given that little is known as to why females suffering from respiratory disease often experience poorer disease control and outcomes, these findings have important implications in beginning to understand this discrepancy. Further research is warranted to investigate this disparity between the sexes and the role that PA may play towards this.

24-HOUR MOVEMENT BEHAVIORS AND EXECUTIVE FUNCTIONS IN PRESCHOOLERS: A COMPOSITIONAL AND ISOTEMPORAL REALLOCATION ANALYSIS

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INTRODUCTION: This study explored the association between 24-hour movement behaviors and executive function (EF) in preschooers.

METHODS: This cross-sectional study was carried out with 447 preschoolers (242 boys, means age= 4.4 ± 0.9 years). Physical activity (PA) and sedentary behavior (SB) were assessed using an accelerometer for seven consecutive days. Sleep time was obtained through the parent-report questionnaire. Components of EF (cognitive flexibility, inhibitory control, and working memory) were assessed using the computerized behavioral tasks. To verify the association between 24-hour movement behaviors and EF, the compositional data analysis was used, and for the time reallocation, the compositional isotemporal substitution analysis was used.

RESULTS: The daily composition, adjusted for age, gender, and BMI, was significantly associated with inhibitory control (p<0.001; r2= 0.12), and working memory (p<0.001; r2= 0.30). The addition of MVPA at the expense of SB and LPA, LPA at the cost of sleep, were associated with significant inhibitory control improvements. The reallocation between MVPA and LPA yielded significant association with working memory. The impact of MVPA replacing LPA is stronger than MVPA replacing SB on inhibition control.

CONCLUSION: These findings highlight the importance of maintaining or increasing MVPA in EF development in preschoolers.

Conventional Print Poster

CP-PN09 Hypoxia

NO ADDITIONAL EFFECT OF HYPOXIA OR PLACEBO OVER NORMOXIA DURING A 3- WEEKS REPEATED-SPRINT TRAINING: A DOUBLE-BLIND STUDY

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1 UNIVERSITY OF MONTPELLIER 2 SEMAXONE

INTRODUCTION: Repeated-sprint training in hypoxia (RSH) seems to be particularly effective in increasing anaerobic performance of athletes in various sports. However, belief in the positive effects of altitude is widespread among coaches and athletes, raising the issue of a putative placebo effect of such training. The purpose of this study was to determine the respective effects of normobaric hypoxia and placebo combined to a repeated-sprint training.

METHODS: Thirty moderately trained participants [age (mean ± SD) 20.7 ± 3.1 years] were randomly allocated to 3 groups: normoxia (RSN; inspired oxygen fraction (FiO2) 20.9%) placebo (RSN-P; FiO2 20.9%) or hypoxia (RSH; FiO2 14.5%). Participants from the RSH and RSN-P groups were connected to a hypoxic generator during training and were told they trained under simulated altitude (between 2500 and 3500 m). Participants from the RSN group knew they were training at sea level. Training consisted in six cycling sessions comprising three sets of 8 x 6-s sprint with 24-s over three weeks. Power outputs were measured during a Wingate (30 s) and a repeated-sprint ability test (RSA; 10 x 6-s sprint with 24-s recovery) before, one and two weeks after training.

RESULTS: None of the participants in the RSN-P and RSH groups estimated being in normoxia during training, and mean estimated altitude was not different between groups (2500 ± 445 and 2605 ± 425 m in RSN-P and RSH, p = 0.60 respectively). As expected, the RSH group was the only one with SpO2 values that differed from those of the RSN group (85.5 ± 2.6%, 96 ± 1.4%, and 95.8 ± 0.6%; p < 0.001 for RSH, RSN-P, and RSN, respectively).

The relative intensity during training (power output normalized by the mean power output sustained during the pre-RSA test) was not different between the 3 groups (91 ± 3.9, 91.2 ± 6.28, and 87.2 ± 3.7%; p = 0.14 for RSH, RSN-P, and RSN, respectively), whereas the subjective rating of perceived exertion was higher in the RSH group (15.3 ± 0.9, 14.3± 0.8, and 14.4 ± 1; p = 0.04 for RSH, RSN-P, and RSN, respectively). Mean and peak power outputs on RSA and Wingate tests were significantly increased after training in all groups. However, no group has progressed more than another.

Regarding the ability of participants to achieve a maximum number of sprints more powerful than 85% of the best performance of the RSA pre-test, no evolution exists (p = 0.91).

CONCLUSION: These data show that repeated-sprint training is effective in improving anaerobic performance and that hypoxia exposure during training did not provide additional benefit.

EXCLUSIVE, ADDITIVE AND INTERACTIVE EFFECTS OF COLD AND HYPOXIA ON MAXIMAL ENDURANCE EXERCISE AND LACTATE THRESHOLD PARAMETERS.

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CERISM - UNIVERSITY OF VERONA

INTRODUCTION: Endurance athletes often train and compete at high altitude and/or within extreme cold conditions[1]. Exclusive effect of hypoxia and cold has been widely studied, but to what extent combined stressors exposure affects endurance performance[2] and throughout which mechanism (additive or interactive)[3] is unknown. The aim of this study was to evaluate the influence of combined acute normobaric hypoxia and cold on maximal and lactate threshold parameters.

METHODS: 14 trained male subjects (age:27±3, VO2max:64±5 mL/kg/min) randomly performed a maximal incremental test on a motorized treadmill (slope:25%) under four environmental conditions: Normothermic Normoxia (N:18°C,20.9%FiO2), Normothermic Hypoxia (H;18°C,13.5%FiO2), Cold Normoxia(C:-20°C,20.9%FiO2) and Cold Hypoxia(CH:-20°C,13.5%FiO2). Workload (WL), Heart Rate (HR), RPE and ventilation (Ve) at maximal and lactate threshold (LT) intensities[4] were determined.

RESULTS: At maximal intensity, WL and HR were reduced in C (-2.3% and -3.2% respectively, all p<0.001) and H (-18.0% and -5.0% respectively, all p<0.001) compared to N, with no interactive (p>0.20) but additive effect in CH (-21.5% and -7.7% for WL and HR). Relative additive effect was seen also on maximal Ve, which decreased by 14.6% in C (p<0.001), 6.9% in H (p=0.017) and 16.6% in CH (interaction effect p=0.12). Maximal RPE was not affected by the environmental condition. At LT intensity, WL and HR were reduced in C (-3.5% and -2.8% respectively, all p<0.013) and H (-21.7% and -3.8% respectively, all p<0.004) compared to N, with no interactive (p=0.81 and p=0.62 for WL and HR) but additive effect in CH (-24.6% and -5.7%, respectively). Exclusive effects of hypoxia were noted on HR expressed as % of maximal HR (p<0.001), and on RPE (p<0.001) associated with LT intensity. An interactive effect (p=0.007) of the two stressors combined was noted at LT intensity on Ve, which resulted lower in CH (86±15 L/min) if compared to N (97±15 L/min), C (102±13 L/min) and H (94±15 L/min).

CONCLUSION: The combination of cold and hypoxia exerts additive rather than interactive effects, decreasing LT and maximal exercise workload and heart rate to an extent that is equal to the sum of the two stimuli alone. However, both exclusive effects of hypoxia and interactive effects of cold and hypoxia were found on the investigated physiological and perceptual variables. This highlights the need for trainers to take into account environmental stressor effect on endurance performance for optimal exercise intensity prescription, pacing strategy decision and training load monitoring in athletes training/competing in hypoxic and cold environments.

1. Bortolan et al. (2022) 2. Tipton et al. (2012) 3. Lloyd et al. (2016) 4.Bishop et al. (1998)

EFFECTS OF ALTITUDE OF RESIDENCE ON HAEMATOLOGICAL CHARACTERISTICS AND PERFORMANCE IN YOUTH MALE COLOMBIAN CYCLISTS.

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INTRODUCTION: To compare physiological and haematological characteristics and performance variables between youth and junior cyclists (YC and JC, respectively) born and trained at high altitude (HA, >2500 m) vs sea-level (SL, <1000 m).

METHODS: 51 YC (15-16 years; n=31) and JC (17-18 years; n=20) born and trained at HA and SL participated in the study. Hemoglobin mass (Hbmass, g.kg-1), blood (BV, L) and plasma volume (PV, L) were determined by CO rebreathing and hematocrit (Hct, %) by capillary blood drop sample. Maximal oxygen consumption (VO2max, mL.kg-1.min-1) was estimated on a stationary bicycle. Training experience (TE, month); Weekly training volume in hours (WTV, h), daily training volume (DTV, min); weekly sessions (FTW) and peak power output (PPO, W.kg-1) were also analysed.

RESULTS: All training parameters (TE, WTV, DTV and FTW) were not different between HA and SL cyclists in both YC and JC groups.

However, in YC, HA residents had higher values in VO2max (65.5±4.6 vs 60.7±5.0 mL.kg-1.min-1, p=0.014); Hct (47.5±2.2 vs 45.7±1.8%, p=0.023); [Hb] (16.2±1.0 vs 15.5±0.7 g.dL-1; p=0.027); Hbmass (Hbmass, 15.1±1 vs 13.6±1.3 g.kg-1, p=0.002) and PPO (6.4±0.8 vs 5.8±0.6 W.kg-1, p=0.021). Similarly, in JC, values of VO2max (67.4±3.1 vs 61.1±5.6 mL.kg-1.min-1, p=0.008); Hct (49.5±1.6 vs 45.1±2.3%, p<0.001) and [Hb] (16.9±0.6 vs 15.1±1.0 g.dL-1, p=0.0001) were higher in HA than SL cyclists. However, no differences were found between these groups for Hbmass, (14.8±0.9 vs 14.2±1.3 g.kg-1, p=0.221), BV (5.6±0.7 vs 6.3±1.1 L, p=0.079) and PPO (6.2±0.4 vs 5.8±0.5 W.kg-1, p=0.118). Of interest, in the JC group, PV was lower (3.1± 0.4 vs 3.8±0.8 L, p=0.021) in native HA residents than in native SL residents, suggesting an altitude-induced hemoconcentration.

CONCLUSION: Although the training loads were not different between native residents of HA and SL, there were significant differences in the hematological variables, indicating the effect of birth and residence at altitude. In YC, these hematological advantages translated to higher PPO. The present study confirms that altitude of residence could denote an advantage for high-performance road cyclists, as already suggested (Garzon et al., 2022; Mateo-March et al., 2022).

THE ACUTE EFFECTS OF MODERATE EXERCISE IN HYPOXIA ON PHYSIOLOGICAL RESPONSES AND MUSCLE RECOVERY IN FEMALES

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INTRODUCTION: In the last decades, normobaric hypoxia (HYP) has increasingly gained attention in the field of sports science. However, there is still relatively little evidence available on HYP-induced performance enhancement, especially in the female population [1]. Therefore, this trial aimed to investigate the effects of moderate exercise, performed in HYP and normobaric normoxia (CON), on physiological responses and muscle recovery in females.

METHODS: Twenty recreational active females (23.3±2.3 years) were assigned to HYP (FiO2:12%) or CON (FiO2: 21%) using block randomization. One week after baseline measurements (BL), both groups performed a moderate muscle-damaging exercise protocol (5 x 20 drop jumps). Physiological makers (knee extensor muscle oxygen saturation [SmO2], capillary oxygen saturation [SpO2], heart rate [HR], core temperature (Tcore), local skin temperature of the anterior thigh [Tskin]), ratings of perceived exertion (RPE), and dyspnea (DYS) were assessed at BL, and after each exercise set (ES). Muscle recovery was evaluated by taking venous blood samples (for assessing CK, CRP, and blood sedimentation rate), investigating muscle swelling of the quadriceps femoris muscle, delayed onset of muscle soreness, counter-movement jumps, and maximal voluntary isometric contraction of the knee extensor muscles, at BL, 24-, 48- and 72-hrs post-exercise.

RESULTS: SpO2 was significantly lower in HYP compared to CON throughout the entire exercise task (ES1 to ES5: all p<0.001). In HYP, values remained also lower at the end of ES1 to ES5 compared to BL (all p<0.001), whereas there was no difference compared to BL values in CON. In SmO2, a trend towards lower values in HYP compared to CON was detected at ES3 (p=0.06) and ES4 (p=0.06), which reached significance at ES5 (p=0.03). Compared to BL, SmO2 values decreased significantly in HYP at ES2 (p=0.02) and ES3 (p=0.01). For SmO2, there were no within-group differences observed in CON. No physiological difference between HYP and CON were observed in HR, Tcore, Tskin, RPE and DYS ratings during the exercise task (all p>0.05). Likewise, for all muscle recovery markers, no differences between HYP and CON were found throughout the 72-hrs follow-up period (all p>0.05).

CONCLUSION: This study shows that moderate exercise under HYP leads primarily to reduced capillary- and muscle oxygenation in healthy females, compared to moderate exercise under normobaric normoxia. The response from recovery-, inflammatory- and subjective parameters are comparable to moderate exercise in normoxia. These findings support the idea that hypoxia-induced training adaptations are primarily caused by reduced oxygen availability and tissue oxygenation levels.

1.Millet et al., Is Hypoxic/Altitude Training an Important Topic in the Field of Hypoxia? Journal of Science in Sport and Exercise, 2022. 4(4): p. 293-305

THE EFFECTS OF THREE WEEKS INTERMITTENT HYPOXIC THERAPY ON MITOCHONDRIAL FUNCTION: A PILOT STUDY

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INTRODUCTION: Normobaric intermittent hypoxia (NIH) therapy is a method, where repeated episodes of reduced FiO2 can be used for therapeutic purposes. Mitochondrial functioning is fundamental for human life due to its importance in energy production, besides other important roles. Taking several factors into account, the bioenergetic health index (BHI) was developed to evaluate mitochondrial functioning [1]. Although the literature in this field is growing, there is a lack of studies, investigating the effects of NIH on the BHI. Therefore, this pilot-study aimed to investigate the effects of a three-week lasting NIH therapy on mitochondrial functioning in healthy participants.

METHODS: Six healthy volunteers (n= 4 females, n= 2 males, 26.8±2.2 years, 72.7±14.1kg, 171.3±9.0cm) underwent 9 sessions of passive NIH for a duration of 3 weeks. The volunteers were seated and inhaled hypoxic air from an altitude generator (Everest Summit II, Hyoxico, Bickenbach, Germany) using a face mask. Capillary oxygenation saturation (SpO2) was measured using a pulse oximeter (Nonin 7500, Amsterdam, Netherlands) on the right index finger. Each session lasted 45 minutes and consisted of 10±0.6 hypoxic periods, where the participants SpO2 was reduced to 80-85% for an interval duration of 2 min. After the hypoxic interval, reoxygenation of SpO2 values to baseline was followed by the next hypoxic interval. At baseline and after three weeks of NIH, a venous blood sample was taken to determine the bioenergetic health index (BHI).

RESULTS: The BHI (mean difference: +0.09±0.03) of the volunteers showed a trend (p=0.06) for enhanced mitochondrial functioning after the three week lasting therapy. Mitochondrial ATP production (mean difference: +0.88±0.83%; p=0.03), and non-mitochondrial O2 consumption (mean difference: +1.32±0.16 pmolO2·min-1; p=0.03) both increased. The mitochondrial proton leak significantly decreased (mean difference: -0.87±0.83%; p=0.03) after the NIH therapy. The results demonstrated a tendency towards increased basal mitochondrial respiration (mean difference: +2.72±1.01 pmolO2·min-1; p=0.06), maximum mitochondrial O2 consumption (mean difference: +32.9±16.0%; p=0.06) and ATP reserve capacity (mean difference: +3.0±0.8%; p=0.06).

CONCLUSION: In conclusion, the preliminary results of this study show promising effects of NIH on the mitochondrial level with an overall borderline to significant BHI. The inner mitochondrial membrane is less permeable to protons, which return from the intermembrane space back into the matrix and are therefore available for ATP synthesis. The reduced proton leak after NIH can therefore explain the increase in mitochondrial ATP-production and ATP reserve capacity in our study. Future research should investigate further investigate NIH in a patient set-up and using a larger sample size.

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REPEATED-SPRINT TRAINING IN HYPOXIA INDUCED BY HYPOVENTILATION AT LOW LUNG VOLUME: A META-ANALYSIS

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INTRODUCTION: Repeated-sprint training in hypoxia (RSH) is a popular and effective method to improve physical performance (Brocherie et al., 2017). However, it requires hypoxic chambers, tents or hypoxic simulators. RSH induced by voluntary hypoventilation at low lung volume (RSH-VHL) is a recent method which can provide a low-cost alternative to RSH (Woorons et al., 2019). This method requires athletes to perform repeated-sprint efforts while holding their breath at the end of expiration, provoking systemic hypoxia as well as hypercapnia. The aim of this study was therefore to review the scientific literature and perform a meta-analysis on the effects of RSH-VHL vs. similar training with normal breathing (RSN) on physical performance.

METHODS: The PubMed/MEDLINE, SportDiscus®, ProQuest, and Web of Science online databases were examined for articles published up to February 2023 which evaluated changes in physical performance following RSH-VHL and RSN. The meta-analysis was conducted to determine the standardized mean difference (SMD) between the effects of RSH-VHL vs. RSN on repeated-sprint ability (RSA) related variables: best and mean performance (velocity or power output), sprint decrement score (Sdec), maximal blood lactate concentration ([Lamax]), single-sprint reference (Ref) and maximal oxygen consumption (VO2max).

RESULTS: After screening, 6 studies were considered for this meta-analysis, including a total of 127 individuals (mean age 21.2 ± 7 years, 115 males). These studies included 6-10 training sessions over 2-5 weeks. The training protocols consisted in 3 ± 1 sets of 9 ± 4 repetitions of 7 ± 1 s sprint with 22 ± 3 s intra-set recovery and 6 ± 6 min inter-set rest. Average recorded oxygen saturation (SpO2) for sprints in RSH-VHL was 89.4 ± 2.7 %. Maximal (SMD = 0.37, P = 0.04; small to moderate effect) and mean performance (SMD = 0.49, P = 0.01; small to moderate effect), as well as Sdec (SMD = 0.58, P < 0.01;

moderate to large effect) were significantly enhanced with RSH-VHL vs. RSN. The increase in [La]max following RSA in RSH-VHL compared to RSN was not significant (SMD = 0.32, P = 0.1; small to moderate effect). No significant effect was observed for RSH-VHL Ref (SMD = -0.14, P = 0.51) and VO2max (SMD = 0.54, P=0.11).

CONCLUSION: The present meta-analysis indicates that repeated-sprint training in hypoxia induced by hypoventilation at low lung volume provides putative gains in repeated-sprint maximal and mean velocity and fatigue resistance (sprint decrement score) than similar training with normal breathing. Whether this method induces similar or additional benefits compared to repeated-sprint training in hypoxia – demonstrated to induce higher hypoxic stress (Imai et al., 2022) but without hypercapnic stimulus – remains to be elucidated.

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Imai et al., 2022. doi: 10.20463/pan.2022.0008.

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EFFECT OF ENDURANCE EXERCISE IN HYPOXIA ON SYMPATHETIC AND PARASYMPATHETIC NERVOUS ACTIVITIES DURING NIGHT

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INTRODUCTION: Exercise under hypoxic condition has been previously shown to cause health benefits in various types of populations. In addition, endurance training in hypoxia is expected to reduce arterial stiffness, body fat mass compared to the same training in normoxia. Endurance exercise in hypoxia promotes sympathetic nervous activity during exercise and 1 h after exercise, but the time course changes in sympathetic nervous activity during night following the exercise in hypoxia remain unclear. The aim of the present study was to compare time-course changes in sympathetic and parasympathetic nervous activities during night following a single session of endurance exercise under either normoxic or hypoxic conditions.

METHODS: Ten young men (20.5±0.2 years) were recruited for the study. All of them carried out three trials on different days: (1) pedaling exercise in normoxia (FiO2: 20.9%; NOR), (2) pedaling exercise in hypoxia (FiO2: 14.5%; HYP), and (3) rest in normoxia (REST). Each trial was separated at least one week, with randomized orders. The exercise consisted of 60 min of pedaling exercise at 60% of maximal oxygen uptake (70 rpm), and the exercises in HYP and NOR trials were started at 17:00. During exercise, heart rate (HR), rating of perceived exertion (RPE) and arterial oxygen saturation (SpO2) were determined. In REST trial, the subjects rested for 60 min and HR, RPE, and SpO2 were monitored. Also, HR variability was continuously monitored until next morning (17:00-7:00) to calculate the power in the high frequency (HF), and the ratio of low frequency (LF) and HF (LF/HF) using a wearable HR sensor. On the following morning, the scores of fatigue, sleepiness, vitality, and quality of sleep were measured by visual analog scale (VAS).

RESULTS: During exercise, HR showed significantly higher value in HYP than in NOR ($p<0.001$). In addition, SpO2 was significantly lower in HYP(83.4±0.5%) than in NOR (96.8±0.3%, $p<0.001$). During 1-3 h after completing exercise (19:00-22:00), LF/HF showed tendency of high values in both NOR and HYP compared to REST. During whole night sleep (23:00-7:00), averaged LF/HF did not differ significantly among the trials ($p>0.05$). However, HYP showed significantly lower HF compared to REST ($p=0.015$), whereas no significant difference was observed between HYP and NOR($p>0.05$). Moreover, vitality showed lower score in HYP than REST on the following morning($p=0.02$).

CONCLUSION: Although LF/HF during whole night sleep did not differ significantly among three trials, HF in HYP showed significantly lower value compared to REST. The lowered HF during sleep may be due to increased sympathetic activity during the exercise in hypoxia. In conclusion, endurance exercise in hypoxia changed automatic nerve activity during post-exercise and impaired the parasympathetic nervous activity during sleep compared to the day without exercise.

PUPIL DYNAMICS IMPLIES AN INCREASE IN EXERCISE-EVOKED AROUSAL BY HYPOXIA: ASSUMING THE INVOLVEMENT OF ELEVATED CARDIORESPIRATORY RESPONSES

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INTRODUCTION: While exercising in a hypoxic condition is becoming popular, the brain state during that remains unclear. Arousal is one of the typical brain states that may be altered prominently during exercise and potentially by hypoxia as well. However, it is challenging to directly measure arousal-related brain activity during exercise. Pupil diameter has been thought to reflect the arousal state and may be a useful indicator of the arousal state during hypoxic exercise. Hypoxia increases relative exercise intensity, such as cardiorespiratory responses, during exercise, potentially resulting in enhanced exercise-induced pupil dilation. To address this issue, we explored whether pupil dilation during exercise is enhanced by a hypoxia-induced increase in relative exercise intensity by examining the difference in pupil dynamics when the work rate (WR) and heart rate (HR) during exercise were matched.

METHODS: A total of thirty-six participants were recruited for this study. The experiments consisted of two conditions: hypoxia (HY) and normoxia (NO) conditions. In the HY condition, participants performed 10 min of moderate-intensity exercise with a normobaric hypoxic gas inhalation (FIO2 = 0.16). In the NO condition, participants inhaled ambient air instead of the hypoxic gas. The pupil diameter was measured before, during, and after the exercise. In Experiment 1 (n = 18, fe-

males = 8, 22.3 ± 2.4 years), WR was matched between conditions. In Experiment 2 (n = 18, females = 9, 20.6 ± 2.3 years), HR was matched between conditions by adjusting the exercise intensity of the NO condition.

RESULTS: HR and ventilation during exercise were higher in the HY condition in Experiment 1 but were equal in Experiment 2, indicating that HR was successfully matched in Experiment 2. The saturation of percutaneous oxygen during exercise in the HY condition was approximately 90% in both experiments. In both experiments, moderate-intensity exercise robustly dilated pupil diameter. When the WR was matched, exercise-induced pupil dilation was higher in the HY condition compared to the NO condition (dilation percentage from pre: NO = 109.6 ± 1.4%, HY = 114.1 ± 1.3%, p = 0.01). On the other hand, exercise-induced pupil dilation was similar between conditions when the HR during exercise was matched (dilation percentage from pre: NO = 112.4 ± 1.6%, HY = 113.1 ± 1.4%, p = 0.53).

CONCLUSION: Here we found that if the WR was matched, exercise-induced pupil dilation was higher in the HY condition compared to the NO condition; on the contrary, it was similar between conditions when the HR during exercise was matched. These results lead us to postulate that cardiorespiratory responses are potential candidates for hypoxia-induced arousal elevation during exercise. The finding of this study could deepen understanding not only of the specific brain states during hypoxic exercise but also of the fundamental mechanisms underlying exercise-induced arousal enhancement.

POST-INHIBITORY REBOUND POTENTIATION OF HEART RATE VARIABILITY AFTER ACUTE NORMOBARIC HYPOXIC EXPOSURE IN HEALTHY YOUNG SUBJECTS

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INTRODUCTION: Higher heart rate variability (HRV) is associated with high-stress resilience, positive emotional response and high cognitive function. Several interventions (exercise, meditation, biofeedback) are used to improve HRV. Under hypoxic conditions, heart rate increases predominantly through sympathetic activity, ultimately worsening HRV. However, chronic intermittent hypoxia exposure has been reported to increase overall HRV and improve emotional status. This led us to postulate that autonomic compensatory regulation may work to augment cardiac parasympathetic activity and improve mood states after hypoxia-induced sympathetic tone. To address this hypothesis, we examined cardiac autonomic fluctuations and mood changes after acute hypoxic exposure.

METHODS: Twenty-one healthy young adult participants (age: 23.7 ± 0.6 yr; weight: 61.9 ± 2.5 kg; height: 168.8 ± 2.2 cm) randomly underwent both a hypoxia (HY) and a normoxia (NO) condition, each on different days. Participants sat at rest on an ergometer inhaling normobaric-hypoxic gas (HY; FIO2 = 13.5%) or ambient air (NO; FIO2 = 20.9%) for 10 min and rested for 20 min after hypoxia in ambient air. Every 5 min, participants were asked about their mood states. Percutaneous oxygen saturation (SpO2) was monitored by a fingertip pulse oximeter and HRV was measured with an electrocardiogram. We used the root mean square of successive differences (RMSSD) as an indicator of parasympathetic nerve activity and the standard deviation of NN intervals (SDNN) for overall HRV.

RESULTS: During the HY condition, SpO2 significantly decreased (approximately 88%) compared with the NO condition and was significantly recovered 5 min after hypoxic exposure. No significant autonomic fluctuation occurred in the NO condition during or after normoxia. In the HY condition, HR significantly increased during hypoxia compared to baseline ($p < 0.001$) and with the NO condition ($p < 0.001$). HR decreased after hypoxia to values significantly lower than baseline ($p < 0.001$) and than the NO condition ($p < 0.02$). The RMSSD significantly decreased during hypoxia compared to baseline ($p < 0.001$) and to the NO condition ($p < 0.001$). After hypoxia, it increased significantly compared to baseline ($p < 0.001$) and to the NO condition ($p < 0.02$). The SDNN significantly decreased during hypoxia compared with baseline ($p < 0.05$) and increased significantly after hypoxia compared with baseline ($p < 0.001$) and with the NO condition ($p < 0.008$). Only in the HY condition, pleasure level increased significantly after hypoxia compared to baseline ($p = 0.03$).

CONCLUSION: Under hypoxic conditions, fluctuation of the autonomic nervous system regulates the heart rate for physiological adaptation by the predominance of sympathetic activity. After hypoxia, contrariwise, post-inhibitory parasympathetic rebounded potentiation effects occurred together with pleasant mood change. These results suggest that acute short-term hypoxic exposure has potential as a novel intervention method to improve HRV.

THE ACUTE EFFECT OF FREEDIVING SESSION ON THE MEMORY OF FREEDIVERS

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INTRODUCTION: Competitive freediving is a recent sport that aims to achieve the longest or deepest possible apnea dive, generating significant hypoxia. The high metabolic oxygen demand of the brain makes hypoxia a critical challenge for brain function. Several studies appear to show impact of long apnea on neurocognitive health (1, 2) but usually only after a maximum apnea in the laboratory. We therefore determined the impact of a normal session of apnea training on neurocognitive performance in freedivers and developed a loading index for apnea training.

METHODS: Eighteen freedivers (14 men and 4 women, 35.8 ± 5.8 years, freediving practice for 5.25 ± 3.4 years) participated in this study. Two different freedivers were tested each week over a period of 9 weeks. Each week the sessions were different but lasted one and half hour. The freedivers performed four memory tests before and after the apnea training session. The four memory tests were: the digit span memory task (DSM), the phonemic fluency test (PF), the categorical

verbal fluency test (CF) and the mnemonic similarity task test (MST). During the session, a polar H10 heart rate monitor measured heart rate and apnea starts and ends were recorded. The paired samples t-Test was used to compare memory test before and after the apnea training session. Pearson correlations were used to test relationships between memory scores, training parameters and load index. A statistical level of $p< 0.05$ was accepted.

RESULTS: All memory test were no difference between before and after the training session ($p >0.05$). Their years of apnea practice were negatively correlated with PF ($p=0.01$, $r=-0.590$). The load index of each session calculated by: average percentage of bradycardia of the session * number of apnea in the session * average apnea time of the session; was negatively correlated only with MST after session ($p=0.007$, $r=-0.608$). The mean percentage of bradycardia in the session was positively correlated with the mean apnea time in the session ($p=0.045$, $r=0.477$).

CONCLUSION: Only one apnea training does not appear to affect cognitive function. However, the calculated load index shows that the longer a training with repeated apneas, the greater the impact on MST. The impact of numbers of years of apnea on PF could show dysfunction in the executive function of semantic memory.

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2) Billaut et al., Applied Physiology, Nutrition, and Metabolism, 2018

Conventional Print Poster

CP-PN03 Physiology I

THE EFFECTS OF THE MENSTRUAL CYCLE AND COMBINED HORMONAL CONTRACEPTIVE USE ON SATELLITE CELL REGULATION POST EXERCISE IN RECREATIONALLY ACTIVE WOMEN: A PILOT STUDY.

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INTRODUCTION: Satellite cells (SC) play an important role in muscle regeneration. There is evidence to suggest that fluctuations in endogenous and exogenous sex hormone concentrations across the menstrual cycle (MC) and with combined hormonal contraceptive (CHC) use might influence SC regulation post exercise[1], which could have implications for the time course of recovery post exercise as well as long term adaptation in women. However, currently, evidence is limited. As such, the purpose of this study was to investigate the effect of the MC and CHC use on the SC response post exercise.

METHODS: Nine recreationally active women (27 ± 5 years); five naturally menstruating and four CHC users, took part. Participants performed a strength-based resistance protocol, consisting of five sets of eight repetitions of leg press exercise at 80% of one-repetition maximum, in three phases across the MC (early follicular [EF], late follicular [LF], and mid-luteal [ML] phases) or CHC cycle (withdrawal, and early and late consumption). Vastus lateralis muscle biopsies obtained pre and 72-hrs post exercise were analysed for local mRNA expression of the myogenic markers PAX7, MYOD, myogenin, and cyclin D1. Gene expression was measured using the quantitative real-time PCR technique.

RESULTS: There was no difference in the expression of all myogenic markers pre-exercise across phases or between groups. In naturally menstruating women at 72-hrs post exercise, PAX7, MYOD, and cyclin D1 mRNA expression was higher in the EF phase compared to all other phases ($P \leq 0.001$), but there was no difference in myogenin. In naturally menstruating women the estimated PAX7:MYOD ratio at 72-hrs post exercise indicated that SCs were undergoing myogenic proliferation (ratio = 1) in the EF phase and myogenic differentiation (ratio < 1) during the LF phase, whereas SCs remained at the quiescent stage (ratio > 1) in the ML phase. In CHC users at 72-hrs post exercise MYOD was higher in the withdrawal phase compared to both consumption phases ($P \leq 0.003$), whereas myogenin was higher during the late consumption phase compared to all other phases ($P \leq 0.022$), but there was no difference in PAX7 and cyclin D1. In CHC users the estimated PAX7:MYOD ratio at 72-hrs post exercise indicated that SCs were undergoing myogenic differentiation (ratio < 1) in the withdrawal phase, whereas SCs remined at the quiescent stage (ratio > 1) in the consumption phases. Analysis of sex hormone concentrations is ongoing.

CONCLUSION: These findings indicate that changes in endogenous and exogenous sex hormones across the MC and with CHC use affect SC regulation during the extended recovery time from exercise in a group of recreationally active women. These results could have important implications for the optimal management of the recovery process in women. Further research is required to elucidate whether these changes influence long-term adaptation responses to training in women.

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RESPONSE OF SERUM AND FUNCTIONAL BIOMARKERS AFTER EXERCISE INDUCED MUSCLE DAMAGE. DIFFERENCES BETWEEN MALE AND FEMALE.

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INTRODUCTION: Exercise-induced muscle damage (EIMD) results from an unaccustomed or hight intensity exercise. This physiological process is characterized by loss of strength, delay onset muscle soreness and muscle protein release on serum (1). Sex-differences on EIMD have been studied but results were not conclusive. Most of studies measure muscle damage though creatine kinase (CK) as a single marker. Other markers are recently used to measure muscle damage as sarcomeric mitochondrial creatine kinase (sMtCK) to reflect mitochondrial disruption (2), or CK-MB, localized on slow fibres. To our knowledge, there are no sex-difference studies that measure these markers after EIMD. In terms of functional parameters, whereas some studies report no sex difference on relative strength and recovery over time (3), other suggest a faster recovery on females (4). The main objective is to determine the difference on serum and functional markers between male and female after a high intensity exercise.

METHODS: Thirty healthy males (n=16, 23 ± 0.7 years, BMI 23.8 ± 0.4) and females (n=14, 22 ± 0.8 years, BMI 22.1 ± 0.6) performed 10 repeated maximal 40m sprints with a rest of 3 minutes between repetitions. Changes on force generating capacity, as an indirect markers of muscle damage, and serum levels of muscle enzymes (CK, sMtCK and CK-MB) were measured at baseline and 24-, 48- and 72-hours post-exercise. Two-way repeated measure ANOVA (time x sex) and a pairwise test, with a Bonferroni adjust, was used to identify changes from baseline and differences between groups. Data are presented as mean ± SD and the level of significance was set at $p < 0.05$.

RESULTS: CK activity peak was significative higher on males (p= 0.020). In the same way, sMtCK and CK-MB values were significative higher on males from baseline (p=0.018) to 48h (p= 0.003), and from baseline (p=0.022) to 24h (p= 0.033) after EIMD respectively. However, males recover baseline values faster than females. On functional parameters there are no differences on loss of relative strength between males and females (F= 1.589; p=0.200).

CONCLUSION: Serum markers response after EIMD is different between males and females, reflecting a greatest membrane, mitochondria and sarcomere, damage on males, however, males recover faster their baseline values, suggesting a more efficient recovery process. Functional markers response is similar between sex.

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TYPE 2 MUSCLE FIBER CAPILLARIZATION IS AN IMPORTANT DETERMINANT OF MICROVASCULAR PERFUSION DURING RECOVERY FROM RESISTANCE EXERCISE IN HEALTHY, OLDER ADULTS

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INTRODUCTION: Microvascular perfusion is essential for post-exercise skeletal muscle recovery to ensure adequate delivery of nutrients and growth factors and removal of accumulated waste products. Microvascular perfusion is regulated by both functional and anatomical factors, such as dilation of terminal arterioles and muscle fiber capillarization, respectively. This study assessed the relationship between various indices of muscle fiber capillarization and microvascular perfusion at rest and during recovery from resistance exercise in healthy, older adults.

METHODS: In this cross-sectional study, sixteen healthy, older adults (72±6 y, 5/11 male/female) participated in an experimental test day during which a muscle biopsy from the M. vastus lateralis was collected and microvascular blood volume was determined at rest and following 10 and 40 min of recovery after a bout of resistance exercise by contrast-enhanced ultrasound in the contralateral M. vastus lateralis. Immunohistochemistry combined with fluorescent microscopy was performed on the muscle biopsy samples to determine various indices of mixed and fiber type specific muscle fiber capillarization. Microvascular blood volume measurements were compared using a one factor repeated measures ANOVA with time as within-subjects factor. Pearson (r) correlation analyses were performed between different measures of muscle fiber capillarization and microvascular blood volume. Statistical significance was accepted as $P<0.05$. All data are expressed as mean±SD.

RESULTS: Microvascular blood volume at t=10 was higher compared with rest and t=40 (27.2±4.7 vs 3.9±4.0 and 7.0±4.9 a.u., respectively, both $P<0.001$). Microvascular blood volume at t=40 was higher compared with rest ($P<0.001$), but lower compared with t=10 ($P<0.001$). The microvascular blood volume increase from rest to t=10 was higher compared with rest to t=40 (6.0±3.1 vs 2.5±1.4 fold, $P<0.001$). No associations were observed between different indices of mixed muscle fiber capillarization and microvascular blood volume at rest or during recovery from exercise. Type 2 muscle fiber capillary-to-fiber ratio (C/Fi) was moderately correlated with the microvascular blood volume increase from rest to t=10 min ($r=0.59$, $P<0.05$). Type 2 muscle fiber capillary contacts and capillary-to-fiber exchange index were strongly correlated with the microvascular blood volume increase from rest to t=40 min ($r=0.66$, $P<0.01$ and $r=0.64$, $P<0.01$, respectively). Finally, a

very strong correlation was observed between type 2 muscle fiber C/Fi and the microvascular blood volume increase from rest to t=40 min (r=0.81, P<0.001).

CONCLUSION: Resistance exercise greatly increases microvascular perfusion for up to 40 min after exercise cessation in healthy, older adults. This exercise-induced increase in microvascular perfusion seems to be restricted by type 2 muscle fiber capillarization specifically.

AEROBIC EXERCISE AMELIORATES MOUSE LYMPHEDEMA BY PROMOTING LYMPHANGIOGENESIS

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INTRODUCTION: Lymphedema is the abnormal retention of protein-rich interstitial fluid due to impaired lymphatic function. Secondary or acquired lymphedema occurs following surgery or radiation in cancer survivors. Over time, they suffer from limb swelling, reduced mobility, and recurrent infections. Lymphedematous tissue shows inflammation, adipogenesis, and fibrosis but the mechanism underlying the development of lymphedema is unknown. Currently, physical therapy such as compression bandage or massage is the only option available for alleviating lymphedmea (1). A previous human study indicates that exercise may help to reduce lymphedema (2). Endurance exercise stimulates lymphangiogenesis (3). Using a mouse model with hind leg lymphedema, we hypothesized that exercise reduces the size of lymphedema by promoting lymphangiogenesis.

METHODS: 7-week-old male ICR mice were used for the hind leg lymphedema, which involves removal of the superficial inguinal node, the popliteal lymph node, and the deep inguinal, and electrocauterization of the femoral lymphatic vessel (4). Groups were divided into Normal, Lymphedema (Lym), and Lym/Exercise (Lym/E) (n = 5). The Lym/E mice were subjected to forced wheel running exercise 3 days after surgery. Exercise consisted of 30 min at a low intensity of 4.68 m/min once a day. The Lym/E mice underwent exercise for 7 days, and during the same period, the Lym mice were left on the wheel. Leg swelling was measured with a Vernier caliper every 3 days, and tissue was harvested after the last exercise. The gene expression of lymphangiogensis markers such as LYVE-1, VGFR3, and Prox1 was determined using realtime RT-PCR. The quantification of cDNA copy number was calculated using the ΔΔCt values. Data were analyzed by analysis of covariance, and statistical significance was set at $p<0.05$. All data are expressed as mean and standard deviation.

RESULTS: Swelling of the lymphedema was significantly reduced by 66% in the Lym/E group compared to the Lym group ($p<0.01$). Among the lymphangiogenesis markers tested, downregulation of Prox1 was observed in the Lym group compared to the normal group ($p<0.05$). Upregulatione of LYVE-1 ($p<0.05$), VEGFR3 ($p<0.05$), and Prox1($p<0.05$) was observed in the Lym/E group compared with the Lym group. The expression levels of Prox1 in the Lym/G group were even higher than the Normal group ($p<0.05$).

CONCLUSION: Aerobic exercise ameliorated lymphedema by promoting lymphangiogenesis. These data suggest that aerobic exercise is beneficial in the management of lymphedema.

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HIIT TRAINING IN PREVIOUSLY INACTIVE MALES ENHANCES ORAL NITRATE AND NITRITE LEVELS WITHOUT INCREASING DENTAL CARIES RISK

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INTRODUCTION: Dietary nitrate (NO3-) is reduced to nitrite (NO2-) by commensal oral bacteria. NO2- is converted to vasodilatory nitric oxide (NO) or stored for use when endogenous NO production is impaired. NO3- supplementation reduces the O2 cost of exercise and improves exercise capacity1. NO3- has also been proposed as a prebiotic to encourage growth of bacteria associated with dental health and shift the oral environment away from the conditions seen in disease following carbohydrate consumption2. This has implications for athletes as many factors relating to exercise training drive dental disease, such as carbohydrate supplementation regimes and exercise induced dehydration, favour the bacteria that cause dental caries3.

METHODS: 11 inactive (VO2peak 45 ml·min−1·kg−1), healthy males (25±5 years, 64.0±11.2kg, 171±6 cm) underwent 8-weeks of thrice weekly HIIT followed by 3-months detraining. Unstimulated saliva was collected at baseline (BL), after training (TR), and after detraining (DETR). High performance liquid chromatography was used to quantify NO3- and NO2-. Glucose, lactate and pH were also quantified. Median and IQR is reported for all of the salivary measurements, where differences were measured using Friedmans test, followed by Bonferroni adjusted post-hoc testing where appropriate.

RESULTS: BL NO3-(268.0, 194.6-813.6μM) and NO2-(56.87, 34.47-146.8μM) increased to (455.6, 250.4-931.7μM) and (151.1 105.1-179.6μM) respectively after TR ($p\leq0.018$). Following DETR, NO3-(476.0, 216.0-855.6μM) and NO2-(95.55, 58.98-118.4μM) decreased ($p\leq0.033$). No significant differences were seen between BL and DETR ($p\geq1.00$). Neither TR or DETR were associated with changes in salivary glucose, lactate or pH ($p\geq0.155$).

CONCLUSION: Oral NO3- reduction increases following HIIT and the physiological adaptations and changes to the NO3-reducing oral microenvironment it induces. Prebiotic NO3- could further enable health associated NO3- reducing bacteria to outcompete pathogens, discouraging disease development and improving exercise performance. Oral glucose and

lactate did not increase, indicating thrice weekly HIIT training in isolation does not impact the risk of developing dental disease.

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EFFECTS OF COLD-WATER IMMERSION ON RECOVERY OF NEUROMUSCLULAR AFTER INTERMITTENT-SPRINT EXERCISE

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INTRODUCTION: Contemporary sports activities impose extremely high physical demands on athletes. Many of them are subjected to treatments that involve cold-water immersion (CWI) to obtain therapeutic effects. However, some researchers maintained that CWI could decrease tissue temperature, impair deep feeling in the body, induce neuromuscular deficits occur after cold application and advise athletes against undertaking dynamic training immediately after cryotherapy. However, the effects of CWI on neuromuscular are inconsistent (Costello et al., 2011; Minett et al., 2014), and the mechanism of CWI effects on proprioception are not uniquely conclusive. The aim of this study was to clarify the effects of the effects of post-exercise cooling on recovery of proprioception, physiological, and perceptual responses following intermittent-sprint exercise.

METHODS: Fifteen physically active males performed intermittent repeated sprint that comprised cycling at 40% Wattmax for 30s, followed by 120% Wattmax for 30s until fatigue. After exercise, a 10 min recovery intervention of a passively seated rest (control, CON), or CWI (15°C) was underwent. Active movement extent discrimination assessment (AMEDA) of the right knee which is an index of proprioception was assessed with cerebral oxygenation and muscle activation pre- and post-exercise, post-intervention, and 24h post-exercise. The oxygenated ([HbO]), and deoxygenated ([HHb]) cerebral hemoglobin concentrations throughout the AMEDA test were measured via a functional near-infrared spectroscopy, and The muscle activation was measured via a surface electromyography, and the data were analyzed using wavelet analysis for root mean square (RMS), median frequency (MF) and mean power frequency (MPF). Physiological and perceptual measures were also collected.

RESULTS: Compared to pre-exercise, AMEDA at the post-intervention remained significantly worse in the CON ($P < 0.05$), but no significant differences were observed in the CWI ($P > 0.05$). CWI effectively reduced core temperature, skin temperature and heart rate, decreased perceived muscle soreness and thermal sensation, but failed to affect RMS, MF and MPF of knee extensors and flexors. Neither HbO nor HHb at the left precentral gyrus, postcentral gyrus, anterior parietal cortex and posterior parietal cortex was changed by CWI.

CONCLUSION: Neuromuscular control is based on subconscious information from mechanoreceptors and processes within the central nervous system that allow control movement through coordinated muscle activity (Furmanek et al., 2014). In the present study, we firstly evidenced that CWI failed to affect AMEDA, brain or muscle activation, these results indicate that CWI post-exercise has no effects on recovery of neuromuscular. CWI at 15°C for 10 min decreased the body temperature, while did not change in proprioception. We suggest that the application of CWI is safe for athletes regarding proprioception.

SPECIFIC IMPACT OF A COVID-19 INFECTION ON TRAINING MODALITIES OF ENDURANCE TRAINED ATHLETES.

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INTRODUCTION: Lung is the organ most affected by an infection by coronavirus disease 2019 (Covid-19). Impairment of lung function and its adaptations to exercise have been reported in post-infected healthy individuals [1]. On the other hand, some trained endurance athletes reach and outstrip the functional capacity of their respiratory system limiting endurance exercise [2]. In this context, we hypothesized that endurance-trained athletes would have more difficulty returning to training at their best level after an infection. The objective of this study was to evaluate the impact of a COVID-19 infection on the training modalities of endurance-trained athletes compared to non-endurance-trained athletes.

METHODS: A self-administered online form was carried via LimeSurvey® software between April and May 2022. The questionnaire unfolded if and only if the person had been infected and aged 18 years and more. Four hundred and sixty-eight participants responded to the questionnaire. The questionnaire was distributed through social media platforms, sport teams and federations. It included four sections: demographic and epidemiologic, sport profile of athletes, characteristics of infection, consequence of infection on training modalities and symptoms.

RESULTS: All participants were screened by PCR test (63.96%) or antigenic test (36.54%). Auto-test were excluded. The participants mean age was 29.6 ± 13 years and males represented 52.78% of participants. The classic symptoms were found (headache, cough and fever) during 2 at 7 days. According to the type of sport practice and training modalities, we discriminated between endurance trained athletes (END, n= 246) and non-endurance trained athletes (NEND, n= 222). No between group difference was reported for infection symptoms, persistence of symptoms and difficulties related when

training resumed. END reported a significant trend (p = 0.08) to require more time to resume training than NEND (57.5 vs. 42.5% respectively). Whereas, our study reported a significant reduction of training volume in END compared to NEND (respectively 74.4 vs 25.6%, p<0.001) associated with a longer recuperation after training sessions (respectively 61.7 vs 38.3%, p<0.05).

CONCLUSION: These results highlight that covid-19 infection induces specific changes in the training modalities of endurance trained athletes, causing them to reduce training volume and increase recovery time compared to non-endurance athletes.

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REGULATION OF ENDOCANNABINOIDS AND SATELLITE CELLS BY RESISTANCE EXERCISE IN HYPOXIA

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INTRODUCTION: Endocannabinoids are small lipids that regulate energy metabolism, homeostasis and inflammation in response to stress, a.o. exercise. In addition, hypoxic conditions regulate myogenesis and, when combined with endurance exercise, upregulate plasma endocannabinoids. The purpose of this study was to analyze endocannabinoids and satellite cells markers in response to acute and long-term resistance exercise in hypoxic and normoxic conditions.

METHODS: Healthy young men performed an acute or a long-term resistance exercise (single leg extension) either in normoxia (FiO2=0.21) or in normobaric hypoxia (FiO2=0.14). For the acute exercise, vastus lateralis muscle biopsies were taken at 15min and 4h post-exercise and blood samples were taken before and 2h after exercise. The resistance training lasted for 4 weeks, with 3 sessions a week. Vastus lateralis biopsies and blood samples were taken before and after the training period. Plasma levels of endocannabinoids were measured by mass spectrometry. mRNA levels and protein expression of different markers of the endocannabinoid system and of myogenesis in skeletal muscle were measured. Statistical analysis was realized using a linear mixed model in R.

RESULTS: Following an acute resistance exercise, plasma 2-AG (p=0.029) and PEA (p=0.038) decreased in normoxia. CNR1 mRNA also decreased from 15min to 4h post-exercise in normoxia (p=0.022) and lower CB1 at 4h post-exercise in hypoxia (p=0.018) was observed. MRF4 mRNA, a marker of satellite cell differentiation, decreased from 15min to 4h post-exercise (p<0.001) whereas Myf5 and MyoD, which characterize satellite cell proliferation, remained unchanged by exercise and hypoxia.

Plasma endocannabinoids AEA (p=0.013), PEA (p=0.003) and OEA (p=0.037) decreased from before to after 4 weeks resistance training. No differences were observed in mRNA and protein expression of the endocannabinoid receptors, excepted CNR1 mRNA levels that increased from before to after training (p=0.015). Hypoxia increased the levels of Pax7 (p=0.07), a marker for satellite cell activation, and MyoD mRNA (p=0.006) and protein expression (p=0.059). Exercise training increased myogenin (p=0.029) and MRF4 (p=0.021) mRNA levels.

CONCLUSION: Our results show that resistance exercise and training decrease plasma endocannabinoid levels, which is opposite to the increase commonly observed following endurance exercise. Endocannabinoid receptor activation was shown to increase MyoD and myogenin expression (Zhang et al., 2019). Our observations are in line with this as acute resistance exercise lowered CB1 expression and MRF4 mRNA levels, and exercise training increased CNR1 together as well as Pax7, myogenin, MyoD and MRF4. CB1 and CB2 expression was increased following a resistance training in old people (Dalle & Koppo, 2021). Therefore, the endocannabinoid system could contribute to the regulation of myogenesis. This could explain the opposite activation of endocannabinoids in response to endurance and resistance exercise.

CONCOMITANT CHANGES IN LACTATE AND FAT OXIDATION KINETICS DURING EXERCISE

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INTRODUCTION: Lactate concentrations have been positively correlated with carbohydrate oxidation and negatively associated with fat oxidation in participants with different metabolic characteristics (1). However, no previous study has investigated this association in different situations influencing lactate kinetics. Thus, the purpose of this study was to determine whether changes in lactate kinetics (due to glycogen depletion or heat) alter the fat oxidation pattern during a maximal incremental test.

METHODS: Eight men (21.9±1.4years; 70.7±4.9kg; 1.7±0.02m) and six women (22.3±0.5years; 62.9±4.0kg; 166.5±5.2cm) performed an incremental test on a cycle-ergometer (Lode Excalibur, Germany) in three situations: control, glycogen depletion and hyperthermia (~36°C). It started at 30W and increased 30W every 3 minutes until exhaustion. Capillary lactate levels were analysed using a lactate analyser (Biosen-C-line-EKF Diagnostic, Germany) at rest, in the last 30 seconds of

each step and immediately post-exhaustion. Mean substrate oxidation of the last minute of each step was estimated by indirect calorimetry using a gas analyser (Jaeger-CareFusion, Hochberg, Germany). A mixed linear model was used to compare the individual response (random effect) of lactate or fat oxidation between situations (fixed effect) at the different intensities of the protocol (fixed effect), and Bonferroni for post hoc analyses. Association between lactate and fat oxidation was calculated using Pearson correlation.

RESULTS: Lactate concentration was different between situations ($p<0.001$). Specifically, it was higher in heat (4.5±0.26 mmol/L) compared to control (3.27±0.26 mmol/L; $p<0.001$) and glycogen depletion (2.82±0.26 mmol/L; $p<0.001$). It was algo higher in control compared to glycogen depletion ($p=0.035$). On the other hand, fat oxidation was different between situations ($p<0.001$). It was higher in glycogen depletion (0.33±0.03 g/min) compared to control (0.12±0.03g/min; $p<0.001$) and heat (0.1±0.03g/min; $p<0.001$). Moreover, lactate was negatively correlated with fat oxidation in control ($R2=0.966$; $p<0.001$), glycogen depletion ($R2=0.962$; $p<0.001$) and heat ($R2=0.894$; $p<0.001$).

CONCLUSION: The higher lactate concentration along with a lower fat oxidation observed in the heat situation, and the lower lactate concentration coupled with a higher fat oxidation with glycogen depletion, support the inhibitory effect of lactate on fat oxidation, as previously suggested (1). From a practical perspective, as the inverse correlations between lactate and fat oxidation between situations are strong, lactate measurement alone is an effective way to indirectly evaluate fat oxidation and vice versa. In conclusion, changes in lactate kinetics due to the different situations alter the pattern of fat oxidation during an incremental exercise.

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Conventional Print Poster

CP-MH01 Health and fitness I

THE MEDIATING ROLE OF BODY COMPOSITION IN THE RELATIONSHIPS OF PHYSICAL ACTIVITY AND SEDENTARY TIME WITH INSULIN RESISTANCE IN CHILDREN

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INTRODUCTION: Given the childhood origins of cardiometabolic diseases, childhood levels of insulin resistance (IR) are an important risk factor for developing type 2 diabetes later in life. IR is also associated with adiposity. A reduction in fat mass is seen through a reallocation of sedentary time (ST) to moderate-to-vigorous physical activity (MVPA). It remains unclear, however, whether PA is associated with IR independently of body composition. This study aimed to analyse the mediating role of body fat and lean mass in the relationships of MVPA and ST with IR in children.

METHODS: This study used baseline data from the Physical Activity and Nutrition in Children (PANIC) study. In total, 357 (180 girls, 177 boys) 6–8-year-olds were included in the statistical analyses. Homeostatic Model Assessment for Insulin Resistance (HOMA-IR) was calculated from fasting plasma glucose and serum insulin levels as a measure of IR. Body fat and lean mass were assessed using dual-energy X-ray absorptiometry. A combined heart rate and body movement sensor was used to quantify MVPA and ST. The mediating role of body fat and lean mass in the relationships of MVPA and ST with HOMA-IR adjusted for age and puberty was assessed using a four-way decomposition counterfactual mediation analysis, split by sex, using the Med4way command in Stata.

RESULTS: There was a statistically significant negative total effect for the association between MVPA and HOMA-IR in girls ($B=-0.07$, $p=0.02$) and boys ($B=-0.14$, $p<0.001$) and a statistically significant positive total effect for the association between ST and HOMA-IR in girls ($B=0.14$, $p<0.001$) and boys ($B=0.10$, $p=0.002$).

With fat mass as the mediator, there was a statistically significant pure indirect effect for the association between MVPA and HOMA-IR in girls ($B=-0.029$, $p=0.010$) and boys ($B=-0.085$, $p<0.001$) and for the association between ST and HOMA-IR in girls ($B=0.029$, $p=0.035$) and ($B=0.076$, $p<0.001$). A statistically significant controlled direct effect was also seen for the association between ST and HOMA-IR, when mediated by fat mass, in girls ($B=0.106$, $p=0.002$).

With lean mass as the mediator, no pure indirect effects were statistically significant. Instead, a statistically significant controlled direct effect was found for the association between MVPA and HOMA-IR in girls ($B=-0.068$, $p=0.023$) and boys ($B=-0.155$, $p<0.001$) and for the association between ST and HOMA-IR in girls ($B=0.139$, $p<0.001$) and boys ($B=0.087$, $p=0.005$).

CONCLUSION: The relationships of MVPA and ST with HOMA-IR are mediated by body fat mass but not body lean mass. The prevention of type 2 diabetes by increasing PA should also focus on reducing body fat mass as a mechanism to decrease IR.

EFFECTS OF PHYSICAL ACTIVITY LEVEL ON QUADRICEPS FEMORIS MUSCLE AND INTRAMUSCULAR ADIPOSE TISSUE IN THE ELDERLY

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INTRODUCTION: Sarcopenia is an age-related progressive loss of skeletal muscle mass and function, and the muscle loss is particularly prominent at the anterior thigh muscles. Furthermore, intramuscular adipose tissue modulates insulin sensitivity and triggers inflammation. Hence, it is important to investigate whether physical activity level (PAL) is associated with thigh muscle mass and intramuscular adipose tissue in the elderly. However, whether PAL is associated with thigh muscle and intramuscular adipose tissue is not well understood. The purpose of this study was to examine the association between PAL and thigh muscle cross sectional area (CSA)/intramuscular adipose tissue.

METHODS: Twenty-nine elderly (20 females) participated in this study (age: 70.9 ± 7.1 yr.). We measured total energy expenditure for 16 days using the doubly labelled water method [1]. Basal metabolic rate was predicted using the Ganpule equations for adult men and women [2]. Then, PAL was calculated by dividing the total energy expenditure by basal metabolic rate. The quadriceps muscle CSA and intramuscular adipose tissue were assessed at mid-thigh (50% of the femur) regions using magnetic resonance imaging. We performed the Spearman rank correlation test to examine relationships between PAL and quadriceps femoris muscle CSA/intramuscular adipose tissue content. Data are expressed mean ± SD or median (interquartile range).

RESULTS: Mean PAL, quadriceps femoris muscle CSA, and intramuscular adipose tissue content was 1.47 ± 0.14, 41.8 (36.1-48.3) cm2, and 2.3 (1.7-3.6) cm2. PAL was not correlated with quadriceps femoris muscle CSA (ρ = -0.033, p = 0.865). Conversely, we observed a significant correlation between PAL and intramuscular adipose tissue content (ρ = -0.405, p = 0.030). These results indicate that PAL is associated with intramuscular adipose tissue content, but not with quadriceps femoris muscle CSA in the elderly.

CONCLUSION: The present findings suggest that physical activity may reduce the risk of diseases derived from accumulation of intramuscular adipose tissue in the elderly.

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IMPACT OF EXERCISE TRAINING ON THE RELATIONSHIP BETWEEN COGNITIVE OUTCOMES, PERCEPTION OF MEMORY AND BRAIN BLOOD FLOW IN OLDER ADULTS.

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INTRODUCTION: Cerebrovascular dysfunction may contribute to cognitive impairment in older adults [1]. Exercise is recommended for the management and prevention of cerebrovascular diseases and preserves brain health and cognition [2]. It is not currently known, however, if improvement in cognition is related to changes in cerebrovascular function. We hypothesized that improvements in cognition and perception of memory would relate to changes in cerebral blood flow velocity in older adults following supervised centre-based exercise programs.

METHODS: Sixty-three sedentary older individuals (age=62±7, 26%♂) were randomised to a land-walking (LW), water-walking or usual care control group. Exercise trained individuals (n=41, age=63±7, 27%♂) undertook supervised monitored training 3 times/week for 50 min per session, across 24 weeks [3]. Cognitive outcomes included Repeatable Battery for the Assessment of Neuropsychological Status (RBANS), with perception of memory assessed using the Memory Complaint Questionnaire (MAC-Q). Middle cerebral artery blood flow velocity (MCAv) was assessed at rest and in response to neurovascular coupling, hypercapnic reactivity, and cerebral autoregulation. To maximise power, we pooled the training groups and performed regression analysis for change in cognitive, perceived memory scores and MCAv, adjusted for age, sex, and education level.

RESULTS: No significant group changes in cognition or memory were detected, but improvement in RBANS with training was significantly correlated with decreased resting MCAv (r = -0.386, P = 0.024) in the trained individuals. Improvement in MAC-Q with training was also correlated with a decrease in MCAv (r = 0.357, P = 0.035). No significant correlations were detected between RBANS, MAC-Q and other cerebrovascular outcomes.

CONCLUSION: Improvements in neuropsychological status and perception of memory were associated with reduced cognitive demand at rest, as indicated by decreased brain blood flow velocity. Our results suggest that cognitive efficiency is enhanced with exercise training. We speculate that exercise training may increase cerebrovascular reserve in patients at risk of cognitive impairment by decreasing the blood flow required to subsidise cognitive demand.

EFFECTS OF ONCE-WEEKLY HIGH-INTENSITY INTERVAL TRAINING ON DXA-DERIVED VISCERAL ADIPOSITY IN CENTRALLY OBESE ADULTS: PRELIMINARY FINDINGS OF A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Obesity is a global public health priority with alarming prevalence and is a chronic, multifactorial disease that substantially increases the risk of numerous non-communicable diseases (NCDs). Notably, central obesity, characterized by the excess accumulation of adipose tissue in the abdominal region, has been shown to better discriminate the risk of excess adipose tissue on developing NCDs. Integral to the long-term management of obesity is lifestyle modification with physical activity being considered a cornerstone of obesity management. Despite regular physical activity being a key protective factor for the prevention and management of obesity, participation remains inadequate. Among physically inactive individuals, lack of time is the most commonly identified barrier to regular physical activity. High-intensity interval training (HIIT) consists of high-intensity exercise interposed with active recovery bouts and is considered a time-efficient exercise modality that may alleviate the 'lack of time' barrier to physical activity. In this study, we present the preliminary findings of a randomized controlled trial that aimed to examine the effects of once-weekly HIIT on reducing visceral adiposity in centrally obese adults.

METHODS: In this two-arm, assessor-blinded, randomized controlled trial, 150 adults (BMI: 29.95±3.95, Age: 46±10) with central obesity (defined as BMI≥25 and waist circumference of ≥80cm for women and ≥90cm for men) were randomly allocated in a 1:1 ratio to a HIIT (n=75) or usual care control group (n=75) for 12 months. Usual care control group (CON) participants attended a 70-min health education class every 2 weeks for 12 months. HIIT group participants attended a 35-min HIIT session once a week under the supervision of certified athletic coaches for 12 months. The training was performed on a treadmill using the 4x4-min HIIT protocol, whereby the participants ran for four 4-min bouts at 85-95% peak heart rate with a 3-min active recovery between each bout. Outcome assessments were conducted before and after the 12-month intervention. Visceral adipose tissue mass was assessed using dual-energy x-ray absorptiometry (DXA). Generalized estimating equation (GEE) was used to assess the treatment effects with baseline measurements used as covariates. A P value of <0.05 was considered statistically significant.

RESULTS: After 12 months of intervention, the visceral adipose tissue mass was significantly reduced in the HIIT group when compared to the CON group (HIIT: -54g -7.70% vs CON: +5g +0.72%, $P<0.05$).

CONCLUSION: These findings demonstrate that HIIT performed once-weekly for 35-min can effectively induce a substantial reduction in visceral adipose tissue mass. This suggests that low-frequency HIIT is a feasible, practical and effective approach to reduce visceral adiposity in centrally obese adults.

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A RANDOMIZED CROSSOVER TRIAL TO ASSESS THE EFFECT OF TIME-RESTRICTED EATING COMBINED WITH RESISTANCE TRAINING ON HIGH-SPEED STRENGTH AND BODY COMPOSITION IN HEALTHY MALES

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INTRODUCTION: Optimum nutrition is highly valuable for athletes aiming at maintaining or improving body composition and sports performance. Recently, intermittent fasting (IF) has gained popularity as an alternative to energy restriction (ER). IF is a dietetic approach that requires varying between fasting and feasting periods. Fasting typically extends beyond an overnight fast (≥ 12h), and feasting implicates feeding on limited time-windows (either with or without ER). There is preliminary evidence that IF may be an important strategy for improving exercise performance. To our knowledge, the impact of this specific dietary approach on high-speed strength (e.g. explosive strength) has not yet been examined. There is compelling evidence that RT is effective for enhancing high-speed strength over time. Yet, whether TRE affects the overall positive impact of resistance training (RT) on high-speed strength is presently unknown. We sought to examine the effects of four weeks of RT combined with time-restricted eating (TRE) vs. regular diet, on fat and fat-free massas well as maximum and explosive force production in healthy, trained participants (18 males, aged 23.7±2.6 years).

METHODS: The order of dieting was randomized and counterbalanced, and the participants served as their own controls. TRE involved an 8-h eating window and non-TRE involved a regular meal pattern. Participants completed performance strength tests (lower and upper body) and body composition scans at baseline and post-intervention. The participants followed a structured full-body RT routine during each dietary intervention (4 sets of maximum repetitions at 85% 1RM in 5 dynamic exercises, 3 times/week). Analysis of covariance (controlling for baseline values) was used for determining differences between both interventions.

RESULTS: Both interventions elicited deceases in fat mass ($p<0.05$), but not in fat-free mass. After training (controlling for baseline values as covariates), non-TRE was compatible with better lower-body jump performance than TRE (SJ peak force, CMJ peak force and CMJ height) ($p<0.05$). Conversely, training with TRE elicited higher values of peak force and dynamic strength index at the level of the upper-body ($p<0.05$).

CONCLUSION: It can be concluded that, when combined with RT, four weeks of TRE do not offer any benefit over a regular dietary pattern for improving fat or fat-free mass in already trained young males. In addition, while the combination of TRE and RT might be beneficial for individuals focusing on developing high-speed strength performance at the upper-body level, the exact opposite is applicable to those focusing on the training the lower-body.

THE EFFECT OF STATIC STRETCHING ON ILIOTIBIAL BAND STIFFNESS AND PATELLAR ALIGNMENT IN HEALTHY INDIVIDUALS

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INTRODUCTION: The risk factors for patellofemoral joint pain are excessive lateral tilt and shift of the patella in the extended knee position [Drew et al. 2016]. These patellar malalignments are influenced by the tension of the soft tissues attached to the lateral aspect of the patella, particularly the iliotibial band (ITB) [Herrington et al. 2012]. Static stretching (SS) is a common therapeutic intervention to reduce ITB stiffness and improve patellar malalignments [Pourahmadi et al. 2016]; however, it has not been confirmed whether SS could improve ITB stiffness and patellar alignments. Therefore, this study aimed to examine whether SS could reduce ITB stiffness and change patellar alignment in healthy individuals.

METHODS: Seventeen healthy young males participated (23.8±3.8 years), and patellar alignment and ITB stiffness were assessed on their dominant leg before and after a 5-minute SS. The SS was performed in the supine position with 90° knee flexion, maximal hip extension, and maximal hip adduction. One examiner fixed the pelvis, and the other performed the SS. In addition, the participant held the contralateral lower extremity in a maximum hip flexion position to fix the pelvis. The patellar positions relative to the medial and lateral femoral condyles were captured three times each using B-mode ultrasound. Indicators of lateral tilt and shift of the patella were calculated following the same procedures as our previous study. In addition, the shear wave velocity of the ITB was measured twice by ultrasound shear wave elastography as an indicator of the ITB stiffness. Patellar alignment and shear wave velocity were measured at two postures, 5° knee flexion with 0° or 70° hip flexion. A paired t-test was used to compare shear wave velocity and indicators of lateral tilt and shift of the patella before and after SS for each measurement posture, with a significance level set at 5%.

RESULTS: In both measurement postures, the shear wave velocity of the ITB decreased significantly after SS (at 0° hip flexion, 12.2±1.5→10.3±1.6m/s, $p<0.01$; at 70° hip flexion, 9.8±1.8→8.7±1.5m/s, $p<0.01$). In addition, indicators of lateral patellar tilt decreased after SS in both postures (at 0° hip flexion, 2.0±0.5→1.8±0.4., $p<0.01$; at 70° hip flexion, 2.0±0.5→1.8±0.4., $p<0.01$). Furthermore, indicators of lateral patellar shift decreased after SS stretching in both postures (at 0° hip flexion, 34.1±9.0→28.7±7.2°, $p<0.01$; at 70° hip flexion, 31.5±8.4→26.8±7.1°, $p<0.01$). These findings indicated a reduction in lateral tilt and lateral shift of the patella.

CONCLUSION: In healthy individuals, 5-minute SS reduced not only ITB stiffness but also lateral tilt and shift of the patella. The results suggest that SS may be a useful therapeutic intervention to improve ITB stiffness and patellar malalignments.

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BIOMECHANICAL RESPONSE TO ACUTE STATIC STRETCHING IN BALLET DANCERS AND NON-DANCERS

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INTRODUCTION: Increased range of motion after static stretching is attributed to decreased passive torque and/or stiffness and increased stretch tolerance [1]. More flexible individuals, such as ballet dancers, have less passive torque and/or stiffness and greater stretch tolerance than normal or less flexible individuals [2, 3]. Therefore, ballet dancers may have smaller changes in stiffness and stretch tolerance due to static stretching. The purpose of this study was to examine the acute effects of static stretching on range of motion, stiffness, stretch tolerance, and muscle strength for ballet dancers and non-dancers.

METHODS: Thirteen female ballet dancers with at least 5 years of ballet experience were compared to a control group of 13 female university students with no exercise habits. After measuring the muscle thickness of the medial head of the gastrocnemius muscle and Achilles tendon thickness of the right lower limb, passive dorsiflexion measurements of the right lower limb were performed before and after 5 minutes of static stretching. Maximal dorsiflexion angle, passive torque, and deformation of the muscle-tendon junction were measured during the passive dorsiflexion test which the right ankle joint was passively dorsiflexed at 1°/s. The relative stretching intensity was calculated by dividing the angle of the stretching board (absolute stretching intensity) by the angle of maximum dorsiflexion angle. After completion of the measurement on the right lower limb, ankle maximal voluntary plantar flexion torque on the left leg was measured before and after 5 minutes of static stretching to the left leg.

RESULTS: The present study revealed that gastrocnemius muscle thickness was higher in ballet dancers, whereas there was no significant difference in Achilles tendon thickness. Although there was no significant difference in absolute stretching intensity, the relative stretching intensity was higher in the control group than in the ballet dancers. Static stretching increased the maximum dorsiflexion angle, maximum passive torque, and maximum deformation of the muscle-tendon junction in both groups, while submaximal passive torque and maximal plantar flexion torque decreased. However, there was no difference in the amount of change in any of the measures between the ballet dancers and the control group.

CONCLUSION: These results indicate that there is no difference in the effect of 5 min static stretching between the ballet dancer and the control groups.

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EFFECT OF DIFFERENT TYPES OF AEROBIC EXERCISE ON HUNGER, FOOD CHOICES, AND AD LIBITUM POST-EXERCISE FOOD INTAKE

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INTRODUCTION: Exercise modulates, hunger, food choices, and energy intake both acutely and chronically. However, these effects are highly variable and are affected by both individual characteristics and exercise-dependent factors (i.e., intensity, duration). It is unknown if the effects on hunger, food choices, and energy intake differ by type of aerobic exercise. Therefore, the present study aimed to investigate the acute effects of duration- and energy expenditure (EE)-matched running vs. cycling on subjective hunger and hypothetical food choices before and after exercise as well as on post-exercise food intake.

METHODS: In a three-way crossover study, eight healthy participants (24.0±2.1 years, 21.2±1.4 kg/m2, 5 women) completed three exercise conditions at 60% VO2peak in randomized order and on separate days following a standardized breakfast: (1) 45min bike ergometer (Bike), (2) 45min treadmill running (Run), (3) and bike ergometer until reaching EE of Run (Bike_adusted). Before (pre), immediately after (post), and 30min after (post30) each condition, participants rated their subjective hunger (condensed visual analog scale from 0 to 10) and hypothetical food amount preferences for both immediate and delayed (+4h) consumption via electronic questionnaires with visual food cues. Additionally, 30min after each condition, participants completed a single-item (cheese pizza) ad libitum test meal.

RESULTS: EE during the exercise sessions was 492±114 (Bike) and 479±96 (Run and Bike_Adjusted). Food intake during the post-exercise test meal (Bike: 1134±419 kcal vs. Run: 1112±495 kcal vs. Bike_adjusted: 1162±486 kcal) did not differ between conditions (p=0.98). Similarly, changes in subjective hunger ratings from pre to post (Bike: −0.1±1.6 vs. Run: 0.5±1.6 vs. Bike_adjusted: 0.8±1.3; p=0.51) and pre to post30 (Bike: 1.0±2.1 vs. Run: 1.4±1.4 vs. Bike_adjusted: 2.3±2.4; p=0.47) did not differ between conditions. Changes in food amount preferences for immediate consumption did not differ between conditions from pre to post (Bike: 16±67 kcal [+7%] vs. Run: 52±58 kcal [+25%] vs. Bike_adjusted: 56±70 kcal [+26%]; p=0.43) or from pre to post30 (Bike: 68±86 kcal [+29%] vs. Run: 112±91 kcal [+52%] vs. Bike_adjusted: 113±102 kcal [+52%]; p=0.55). Likewise, changes in the amount selected for delayed consumption did not differ between conditions at any time point (all p≥0.78). The proportion of food selected for immediate vs. delayed consumption was significantly greater at post30 compared to pre (80±21% vs. 45±31%, p=0.03) only in Bike_adjusted. For all other conditions and time points, intertemporal food preferences did not differ (all p≥0.08).

CONCLUSION: Our results suggest that subjective hunger and ad libitum post-exercise food intake do not differ between acute bouts of duration- and EE-matched running and cycling. There may be differences in intertemporal food preferences, though more research with larger samples is needed to corroborate these findings and explore more longitudinal effects.

IS PICKLEBALL A VALUABLE ACTIVITY FOR PREMENOPAUSAL/MENOPAUSAL WOMEN TO MAINTAIN GRIP STRENGTH?

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INTRODUCTION: Menopause is a critical time for women with heightened risks related to musculoskeletal health. Growing evidence suggests that objective measures of physical performance such as grip strength not only accurately describe physical capability but also act as indicators of current and future musculoskeletal health [1]. Kurina et al. highlighted the decreased in grip strength in post-menopausal women [2]. Pickleball is a fast-growing sport in the US that combines great physical activity with entertainment. The popularity of the sport has sky rocketed, during the COVID crisis among the 55 years old and older, reaching about a third (32.7%) of 65-plus. This study investigated the grip strength of pre-menopausal and menopausal women engaging in pickleball in a rural setting.

METHODS: 17 Women (63.76±8.45 years) from a Southwest US rural area were recruited for this study. All participants were healthy with no injuries within the last 3 months. All participants reported playing pickleball regularly during the week (Mean=326.5min/week). Participants were tested on bilateral grip strength. Hand dominance as well as years of pickleball play were collected. Grip strength was measured according to the standard arm position as recommended by the American Society of Hand Therapists [3] using a hand dynamometer. Maximal effort was expected in each 3 trials of the test for each hand. The results were compared to the normative value for their age range.

RESULTS: An one sample t-test between the dominant hand grip strength and the age/gender normative data showed a significant difference (t(25)=2.059, p=0.001). The non-dominant hand grip strength, when compared to the normative data

showed a significant difference as well (t(27) =2.051, p<0.001). A paired t-test between the dominant and non-dominant grip benefits recorded no significant differences (t(16)=0.368, p<1.746). A large effect was detected (Hedges g=1.22).

CONCLUSION: This study investigated the grip strength of pre-menopausal/menopausal women engaging in the sport of pickleball. Significant greater grip strength was recorded in the dominant as well as non-dominant hands in that population compared to the normative data. This could suggest that the involvement in pickleball may provide a way for older women to increase or maintain their grip strength, thus display better musculoskeletal health.

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EFFECTS OF COMBINING MICROCURRENT THERAPY WITH RESISTANCE EXERCISES ON BODY COMPOSITION IN MIDDLE-AGED ADULTS: A PILOT STUDY

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INTRODUCTION: Microcurrent therapy (MT) is a non-invasive treatment modality that transmits extremely small currents (<1 mA) through the skin. It has been shown that MT can maximise training outcomes when combined with resistance exercise.

METHODS: This study involves a double blind randomised controlled design. Eight participants (mean ± SD: BMI 23.1 ± 3.8 kg/m2, age 54.4 ± 7.4 years, height 168.7 ± 12.3 cm) were randomly assigned to either microcurrent (MC, n = 4) or sham (SH, n = 4) groups (1 male and 3 females per group). After completing two in-person supervised resistance training familiarisation sessions, the participants performed a 6-week home-based resistance exercise programme using resistance bands. Participants were provided with a pre-recorded copy of the session and were asked to perform 2 weekly sessions. The programme involved 8 multi-joint and single-joint exercises targeting the whole-body musculature (squat with shoulder press, biceps curl, squat, lateral pull down, deadlift, triceps extension, lunge, and upright row). Participants were required to perform 3 sets of 12-15 repetitions per exercise with 1.5 to 2 min rest between sets. The rating of perceived exertion (RPE) was determined by the OMNI-Resistance Exercise Scale (OMNI-RES) for elastic bands (0-10 scale) to determine the increasement of the training load over the intervention period. Participants wore a microcurrent or a sham device for 3-h post-workout and in the morning on non-training days. The microcurrent was delivered at a frequency of 1.03 kHz, at an intensity between 50 and 400 μA in a ratio of 2:1 (on:off), to induce a flow of electrons into the tissue. Measurements (body mass, BMI, waist circumference, and percent (%) body fat) were taken pre- and post-intervention. Body composition was determined using air displacement plethysmography (BodPod). Raw changes in all dependent variables were calculated by subtracting pre- from post-intervention values and compared to examine effect sizes.

RESULTS: Neither the MC, nor SH groups showed statistically significant differences for any of the analysed variables: body mass (mean change ± SD; MC = -0.70 ± 1.36 vs. SH = 0.48 ± 1.13 kg, p = 0.233, d = 0.937), BMI (MC = -0.20 ± 0.42 vs. SH = 0.13 ± 0.41 kg/m2, p = 0.313, d = 0.778), waist circumference (MC = -1.45 ± 1.37 vs. SH = -1.30 ± 3.02 cm, p = 0.931, d = 0.064), and % body fat (MC = -1.90 ± 2.96 vs. SH = -0.35 ± 3.82 %, p = 0.545, d = 0.453). However, the analysis of the effects size (d) showed more favourable changes for MC compared to SH.

CONCLUSION: Adding a 3-hr microcurrent therapy post resistance training programme may provide further improvements in body composition in middle-aged adults.

Conventional Print Poster

CP-AP10 Fatigue

EXPERIMENTAL TESTING OF METHODS TO MONITOR FATIGUE AMONGST ROYAL NAVY CLEARANCE DIVERS

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INTRODUCTION: Chronic sleep restriction (SR) contributes to fatigue and impairs performance. To reduce human error, maximise safety, and optimise performance, Defence and Security organisations require reliable fatigue monitoring methods to identify fatigued individuals. This exploratory study investigated the use of the psychomotor vigilance test (PVT), oculography, and a subjective fatigue rating to identify fatigue amongst Royal Navy Clearance Divers (RN-CD) during a training course, which replicated certain operational demands, including SR.

METHODS: Seven male trainee RN-CDs (mean ± SD; age 29 ± 3 y; height 1.82 ± 0.06 m; body mass 81.8 ± 4.8 kg) undertook two consecutive, 5-day (Monday-Friday) scheduled phases of the RN-CD training course. A typical week (CON) was followed by a high fatigue (HF) week. Sleep was monitored throughout using actigraphy. Fatigue measures were recorded twice daily (AM and PM) using the 10-minute PVT (PVT-10), oculography tests (horizontal precision, tangential variance test, and radial variability), and the Samn-Perelli fatigue scale (SPFS). All dependent variables between CON and HF were compared using a paired samples t-test. Additionally, fatigue thresholds were calculated at a group level (using the 75th percentile above the baseline median) and individual level (1 SD above the baseline mean). These thresholds were used to classify observations as 'fatigued' or 'non-fatigued' (binary outcome) for each variable and participant.

RESULTS: Mean sleep duration was longer during CON (303 ±71 minutes) versus the HF (217 ± 39 minutes) week ($p < 0.001$). Median PVT-10 lapses (CON 1.0 vs HF 3.0) and median reaction times (CON 270.5 ms vs HF 309.5 ms) increased between CON and HF conditions ($p < 0.001$), with no difference in false starts ($p = 0.243$). Fatigue (75th percentile above baseline median) was detected most frequently by reaction time (43 of 63 test results), followed by lapses (35 of 63 test results). Group level subjective fatigue ratings were significantly different between CON (2.5) and HF (3.5) conditions (<0.001). Oculography variables were not different between CON and HF weeks (Radial: p=0.395; Tangential: p=0.667; Horizontal: p=0.144).

CONCLUSION: This exploratory study indicates that PVT-10 derived reaction times were most responsive to sleep loss, and were more likely to classify a participant as fatigued compared to oculography measures and subjective ratings. Further data are needed to support these findings.

THE ASSOCIATION BETWEEN SLEEP AND PERFORMANCE IN FEMALE ATHLETES: A SYSTEMATIC REVIEW

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INTRODUCTION: Sleep is fundamental to health and recovery and inextricably linked to sports performance. Females may have a different subjective sleep quality to men, as well as potential barriers to optimal sleep such as menstrual cycle (MC) symptomology. The aim of this study was to systematically review the existing literature examining the association between sleep and performance parameters in female athletes.

METHODS: The protocol for this review was registered on PROSPERO (CRD42022297974). Peer-reviewed studies were systematically searched via PubMed, and Web of Science, from inception up to September 2022. Studies had to contain primary data and examine any relationship between sleep and performance in female athletes over the age of 18 years and with their level of competition described.

RESULTS: The search returned 3007 records. After inclusion and exclusion criteria were applied, thirty-two studies remained for review. These studies were separated into four categories: sport-specific performance; cognitive performance; physical performance, readiness and availability; and mood and wellbeing. Only two studies were of high-quality according to a modified Newcastle-Ottawa Scale, indicating a lack of high-quality evidence in the reviewed literature. Lack of control for sleep, athletic population and MC phase or hormonal contraceptive use in females was particularly apparent. The majority of selected studies examined physical performance, readiness and availability, whereas cognitive performance was the least studied aspect of performance.

CONCLUSION: This review highlights that lower sleep duration and/or quality has a detrimental impact on sport-specific performance; cognitive performance; physical performance, readiness and availability; and mood and wellbeing of female athletes. However, high-quality research is needed to describe sufficiently the relationship between sleep and performance in female athletes. Researchers must ensure that study in this area is of methodological suitability for the examination of female athletes and is of an appropriate study duration to account for both chronic sleep as well as physiological processes unique to females such as the MC.

EFFECT OF MMP3 GENE POLYMORPHISM AND SEX DIFFERENCE ON RATE OF RECOVERY OF MAXIMAL VOLUNTARY MUSCLE CONTRACTION TORQUE AFTER ECCENTRIC EXERCISE

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INTRODUCTION: Muscle damage due to maximal eccentric exercise can result in reduced muscle strength (Chen and Li, 2020). Recently, it has been reported that muscle strength after eccentric exercise is influenced by sex and genetic factors (Baumert et al., 2016, Sewright et al., 2008). Matrix metalloproteinase 3 (MMP3) gene polymorphisms, whose expression is affected by sex, are among the polymorphisms associated with reduced muscle strength due to muscle damage (Fang et al., 2007). The aim of this study was to investigate the effect of MMP3 gene polymorphism and sex differences on muscle strength after eccentric exercise.

METHODS: A total of 101 participants, including 52 men (age: 22.8 ± 2.9 years, height: 171.2 ± 5.5 cm, weight: 67.8± 9.8 kg) and 49 women (age: 21.6 ± 1.6 years, height 160.4 ± 5.6 cm, weight: 56.2 ± 6.4 kg), who had not previously participated in daily biceps resistance exercise were enrolled in the study. Participants performed five sets of six maximal eccentric elbow flexion exercises in the non-dominant arm. Maximum voluntary contraction (MVC), range of motion (ROM), muscle soreness, and serum creatine kinase (CK) concentration were assessed immediately before and after, as well as 1, 2, 3, and 5 days after, eccentric exercise. The recovery rate of MVC was calculated by subtracting the %MVC measured imme-

diately after exercise from the %MVC measured on day 5 after exercise. MVC, ROM, muscle soreness and CK over time were compared groups between genotype and sex by a two-way repeated measure analysis of covariance (ANCOVA)with %MVC at immediately as a covariate.

RESULTS: There was no difference between males and females in the change in MVC torque after exercise (p = 0.945). We found significant MMP3 polymorphism - sex interaction in the recovery rate of MVC at 5 days after exercise between two genotype groups in men and women (p = 0.026). G-allele carriers in men had significantly lower recovery rates of MVC (p = 0.041) after exercise. On the other hands, there was no significant difference in women. There was no significant genotype – sex interaction in CK, ROM and muscle soreness.

CONCLUSION: In the present study, MMP3 polymorphism - sex interaction was found to correlate with the recovery rate of MVC, particularly, in men.

TAKING THE HORIZONTAL FORCE COMPONENT OF THE 90:20 IPC TEST INTO ACCOUNT INCREASES SENSITIVITY TO DETECT MUSCLE FATIGUE OF THE POSTERIOR CHAIN, AND LIMB ASYMMETRIES.

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INTRODUCTION: Lateral deficit and fatigue [1] favor the risk of hamstring strain and can increase the risk of ACL ruptures. Instead of using high-end methods like an isokinetic device, recent literature shows that tests like the 90:20 isometric peak force (IPF) test of the posterior chain (PC) [2] are alternatives to detect e.g. muscle fatigue by just using a regular force plate. A possible problem associated with these tests is that only the vertical component (Fz) is considered for data analysis. Different pushing techniques can result in meaningful posterior-anterior forces (Fx), leading to wrong conclusions due to an underrepresentation of the PC capabilities. Therefore, the aim of this study is to evaluate if the resultant force (Fx+Fz = Fres) of the posterior force component shows an increased sensitivity to detect muscle fatigue and limb symmetries of the PC using the 90:20 test.

METHODS: The IPF of 16 subjects from a semi-professional soccer team was measured 1 h prior to a soccer match and repeated immediately after the match or their substitution, respectively. For the measurements, subjects stood against a wall and placed one leg (randomized order) with the heel onto a force plate (1000Hz), placed on a height adjustable table. Hence hip and knee joints were flexed to 90° and 20°, respectively, as proposed by [2]. First, subjects' leg weight was measured to account for gravitational forces. Second, participants were then asked to apply force as quickly and hard as possible onto the force plate for 5 s using two different verbal instructions which were randomized:

1: "Press as hard as you can onto the force plate."

2: "Press as hard as you can onto the force plate and pull it towards you."

They carried out the procedure with the other leg and made a total of two trials of IPF with each leg with 30 s break between trials. Then, they carried out the same procedure under the other instruction. Unlike [2], not only peak Fz was analyzed but also the peak resultant force. In addition, limb asymmetries were calculated from both analysis procedures. Paired samples t-tests (alpha = 0.05) evaluated the sensitivity (= ES [Cohen's d]) of the Fz and Fres pre vs. post-match and the respective limb asymmetries.

RESULTS: Due to the postponement of the soccer club's match schedule, data acquisition took place four days after the submission deadline of this abstract on February 18th. However, piloting (n = 4) shows a larger effect size of the peak Fres (d = -0,58) compared to the peak Fz (d = -0,42). On top of that, peak Fres detects an increased limb asymmetry compared to only using Fz (d = 0,32 or 11.3 %).

CONCLUSION: Piloting results show that using Fres in combination with verbal instruction 2 gives a better representation of the PC capabilities. Hence using such a setup might lead to an increased sensitivity in terms of detecting risk factors associated with hamstring strain injuries.

1. McCall et al. (2014) 2. Matinlauri et al. (2019) 3. Rasp and Gabriel (unpublished)

ASSESSING INDICES OF AEROBIC FITNESS WITH DETRENDED FLUCTUATION ANALYSIS OF HEART RATE VARIABILITY DATA

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INTRODUCTION: Accurate identification of the gas exchange threshold (GET) and the respiratory compensation point (RCP) is important for effective exercise prescription and fitness assessment [1]. Categorized into one of three intensity domains, the GET and RCP can be used to separate moderate from heavy exercise intensities, and heavy from severe exercise intensities, respectively. Recently, a non-linear measure of heart rate (HR) variability (HRV), known as detrended fluctuation analysis (DFA a1), emerged as a tool to identify exercise thresholds, where DFA a1 values of 0.75 and 0.5 reportedly represent GET and RCP, respectively [2]. The aims of this study were to i) assess the suitability of DFA a1 values of 0.75 and 0.5 to evaluate GET and RCP, (ii) evaluate possible sex differences in DFA a1 threshold values, and iii) determine whether DFA a1 values during low-intensity exercise can predict aerobic fitness.

METHODS: Twelve (6M, 6F, 31±9 yrs) recreationally active participants performed 10-min of cycling at 75W followed by a 25W/min ramp incremental test until failure to determine GET, RCP, and VO2max. RR intervals (H10; Polar Electro Oy, Kempele, Finland) were recorded continuously during the exercise trial. RR data were preprocessed prior to quantifying DFA a1 using a modified Python script [3]. DFA a1 measurements at GET and RCP were compared to reported threshold

values of 0.75 and 0.5, respectively, using dependent sample t-tests. DFA a1 measures at GET and RCP were compared between males and females using independent sample t-tests. Correlations were performed between DFA a1 values between minute 7-9 at 75W and absolute VO2max values. Statistical significance was set at $p<0.05$.

RESULTS: DFA a1 values at GET (1.28±0.43) and RCP (0.79±0.39) were significantly different from 0.75 (t=3.879, p=0.004, n=10) and 0.5 (t=2.370, p=0.04, n=10) respectively. At GET, DFA a1 values were not significantly different between males (1.39±0.45) and females (1.18±0.44, p=0.48). At RCP, DFA a1 values were also not significantly different between males (0.93±0.52) and females (0.66±0.16, p=0.30). When normalized to fat free mass (FFM), VO2max was not different between males (58.7±7.8 ml/kg FFM/min) and females (56.6±13.3 ml/kg FFM/min, p=0.75). The correlation between DFA a1 values and absolute VO2max was not significant (r=-0.15, p=0.65).

CONCLUSION: Despite previous studies reporting that DFA a1 may be useful to measure exercise thresholds, our data suggest that DFA a1 values of 0.75 and 0.5 do not coincide with GET or RCP. Therefore, the proposed DFA a1 threshold values may not properly demarcate the exercise intensity domains. Additionally, there were no sex differences found with DFA a1 threshold values. Lastly, DFA a1 at a moderate exercise intensity was not a strong predictor of aerobic capacity.

1. Iannetta (2020) 2. Rogers (2021) 3. Altini (2020)

RATING OF PERCEIVED EFFORT BUT RELATIVE TO WHAT? A COMPARISON BETWEEN IMPOSED AND SELF-SELECTED ANCHORS

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INTRODUCTION: Collecting reliable and valid rating of perceived effort (RPE) data requires properly anchoring the scales' upper limits (i.e., the meaning of 10 on a 0–10 scale). Yet, despite their importance, anchoring procedures remain understudied and theoretically underdeveloped. Here we propose a new task-based anchoring procedure that distinguishes between imposed and self-selected anchors. In the former, researchers impose on participants a specific task as the anchor; in the latter, participants choose the most effortful task experienced or imaginable as the anchor. We compared the impact of these conceptually different anchoring procedures on RPE.

METHODS: Twenty-five resistance-trained participants (13 females) attended a familiarization and two randomized experimental sessions. In both experimental sessions, participants performed non-fatiguing and fatiguing isometric maximal voluntary contraction (MVC) protocols with the squat followed by the gripper or vice versa. After each MVC, participants reported their RPE on a 0–10 scale relative to an imposed anchor of the performed task (e.g., gripper MVCs anchored to a gripper MVC) or to a self-selected anchor.

RESULTS: In the non-fatiguing condition, imposed anchors yielded greater RPEs than self-selected anchors for both the squat [on average, 9.4 vs. 5.5; Δ(CI95%) = 3.9 (3.2, 4.5)] and gripper [9.4 vs. 3.9; Δ = 5.5 (4.7, 6.3)]. Similar results were observed in the fatiguing condition for both the squat [9.7 vs. 6.9; Δ = 2.8 (2.1, 3.5)] and gripper [9.7 vs. 4.5; Δ = 5.2 (4.3, 5.9)].

CONCLUSION: We found large differences in RPE between the two anchors, independent of exercises and fatigue state. These findings provide a basis for further development and refinement of anchoring procedures and highlight the importance of selecting, justifying, and consistently applying the chosen anchors.

PLAYING POSITION EFFECTS ON BIOMARKERS IN MALE FUTSAL PLAYERS

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INTRODUCTION: Currently, studies focusing on the effects of playing position in futsal (five-a-side indoors soccer) are limited, while there is sparsity of information regarding inflammatory and antioxidant responses. The aim of the current study was to investigate the effects of playing position on the time-course of oxidative stress, muscle damage markers, as well as inflammatory and antioxidant responses for a period of five days following a futsal match.

METHODS: Sixty-two futsal players were randomly allocated into four groups: control group (n=16, age: 23.6±0.7 y), wingers (n=18, age: 23.1±0.5 y), defenders (n=16, age: 22.4±0.4 y) and pivots (n=12, age: 24.1±0.5 y). The following variables were measured before, immediately after, and 24h, 48h, 72h, 96h, 120h, and 144h post-match: creatine kinase (CK), lactate dehydrogenase (LDH), interleukin-6, (IL-6), tumor necrosis factor alpha (TNF-a), complete white blood cell count (WBC), C-reactive protein (CRP), Fibrinogen (FIB), soluble vascular cell adhesion molecule-1 (sVCAM-1), sP-Selectine, thiobarbituric acid reactive substances (TBARS), protein carbonyls (PC), Uric Acid (UA), oxidised glutathione (GSSG) and catalase (CAT). A two-way mixed ANOVA was used for all dependent variables.

RESULTS: CK and plasma LDH peaked at 24h and remained elevated for 144h and 96h respectively in all active groups. LDH remained elevated for 120h in defenders and 144h in wingers. IL-6 and TNF-a peaked immediately after and returned to baseline at 24h in all groups apart from wingers where IL-6 returned to baseline levels at 48h. WBC count peaked immediately after and returned to baseline at 48h in defenders and pivots and at 96h in wingers respectively. CRP and fibrinogen peaked at 24h and returned to baseline at 72h in most groups. CRP and FIB returned to baseline at 96h in wingers, whereas in pivots it returned to baseline much faster (48h). sVCAM-1 peaked at 24h and returned to baseline at

72h in all groups, whereas sP-Selectine peaked immediately after and returned to baseline at 72h, apart from the wingers group that returned to baseline levels at 96h. Both TBARS and PC peaked at 24h and retuned to baseline levels at 120h post-match. GSSG peaked at 24h and returned to baseline at 96h in all groups whereas CAT peaked immediately after and returned to baseline at 48h post-match. UA peaked at 24h and remained elevated 120h for Wingers and defenders and 96h post-match for pivots respectively.

CONCLUSION: Immediate and short-term changes are induced by a single futsal match on oxidative, inflammatory, muscle damage and antioxidant markers. The magnitude and time-course of these changes depend on playing position, with wingers showing the greater responses. These findings may be used to assist recovery practices and to prescribe appropriate training following intense futsal games.

PUPILLOMETRY: DETECTION OF VARIATIONS IN AUTONOMIC NERVOUS SYSTEM ACTIVITY IN HIGH LEVEL YOUNG ATHLETE.

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INTRODUCTION: The pupil light reflex (PLR) is a reliable physiological mechanism which lasts 3.5 seconds [1]. It's based on a strength equilibrium mathematical model whose fitting with real data is almost perfect. These components are viscous, elastic, sympathetic and parasympathetic [2]. The autonomic nervous system (ANS) activity is commonly modulated with clinostatism and orthostatism positions. These ones are used to appreciate activity variations through the monitoring of heart rate variability (HRV) in elite sport [3]. We assume the PLR which reports the ANS activity is susceptible to being impacted by these positions and could complete HRV analysis.

METHODS: Seventeen subjects, handball and basketball players (respectively n=10, n=7), aged 16±0.87, who were in a pathway to high level access were exposed to light flashes which were produced using a screen (Samsung QB50R LED, 50 inchs - Vietnam). Subjects wore glasses equipped with two cameras (Pupil core by Pupil Labs – Berlin, Germany) to record PLR at 120hz sampling frequency. Ten flashes lasting 200ms, interspaced by 30 seconds, were produced in each position with a 2 minute rest period before the beginning of each analysis. Throughout the whole protocol, athletes wore a cardiofrequencemeter (Polar H9 by Polar - Malaysia) to collect HRV data. A principal component analysis was done to characterize the nature of the data given by pupillometry and HRV respectively. Student paired T tests were done after application conditions were verified to appreciate the PLR sensitivity and its model of the study [2] at changing positions. Significance was set at $P<0.05$.

RESULTS: The model showed a high quality degree of fit with the measured PLR ($r2=0.99\pm0.01$). In clinostatic condition, the basal pupil diameter was significantly smaller than in orthostatic condition ($p=0.002$). The constriction has a shorter duration and the parasympathetic strength was reduced (respectively $p=1.25*10-11$, $p=0.03$) in clinostatic condition compared to in orthostatic. The redilation and the concomitant impulse of both sympathetic and parasympathetic systems were significantly higher compared to in clinostatic condition (respectively $p = 1.03*10-7$, $p = 0.03$). The principal component analysis showed that information given by pupillometry and HRV analysis were distinct and complementary.

CONCLUSION: Raw pupillometric data and those from the tested model appears sensitive to the changing position. Pupillary and cardiovascular responses do not seem redundant but can give complementary information about ANS. The HRV provides information transmitted by baroreceptors while pupillometry would deliver more general indications about ANS state. The pupillometry could constitute a complement to appreciate the ANS state in regard to training load in high level athletes.

1.Wang et al. (2018) 2. Yan et al. (2021) 3. Schmitt et al. (2015)

Conventional Print Poster

CP-MH32 Orthopedics

SPORTS INJURY SURVEILLANCE PRACTICES AND METHODS IN UNIVERSITY STUDENT-ATHLETES: A SYSTEMATIC REVIEW

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INTRODUCTION: Injury surveillance and epidemiology studies are essential components of protecting athletes' health. In recent years, university sports have grown globally in popularity and professionalism. This has been reflected in the continuous increase in student-athlete participation, which has also increased the burden of sports injuries. In general, universities struggle to adequately implement standardized surveillance methods and safety measures within university sports. Therefore, this systematic review aims to identify injury surveillance practices and methods used in the recording and reporting of sports injuries in university student-athletes.

METHODS: Prospective cohort studies investigating sports injuries in university student-athletes were included to identify surveillance methods used for recording and reporting sports injuries. The systematic review methodology was performed per the PRISMA guidelines. Databases (PubMed, SPORTDiscus, Scopus, and Web of Science) from 2000-2022 were

searched for relevant articles. Two reviewers independently selected and screened articles using Covidence open-source software and assessed the risk of bias through the Newcastle Ottawa Scale. Data from the included studies were analyzed descriptively, synthesized, and summarized.

RESULTS: A total of 47 studies were included. Four injury surveillance systems and five injury surveillance guidelines were identified across 31 university sports codes. Three different definitions of injury were used. Student athletic therapists, qualified athletic therapists, athletes, physiotherapists, physicians, and course instructors mostly recorded the data, and the duration of surveillance ranged from one tournament to one university career. The exposure and injury data were recorded either via an electronic web-based system (24 studies) or physical paper (8 studies).

CONCLUSION: This review identified injury surveillance systems and guidelines using a variety of different practices and methods across different university sports codes, including the injury definition, who records the data, and the direct method of data collection. Only one study followed the IOC consensus statements on injury and illness definitions and data collection procedures for use in epidemiological studies in sports. In addition, six studies did utilize sport-specific consensus statements on injury and illness definitions and data collection procedures. Future studies should utilize a consistent definition of sports injuries, qualified medical personnel to record the data, and an electronic web-based system to collect the data. This will enable the development of a standardized methodological strategy for future studies on sports injuries in university student-athletes. This provides a unique opportunity to introduce standardized injury surveillance systems that could lead to a better understanding of sports-related injury and support the implementation of injury prevention measures within university sports.

INJURY PATTERNS IN ELITE GERMAN SOCCER PLAYERS: INJURY HISTORY, TYPOLOGIES, AND IMPLICATIONS

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INTRODUCTION: Injuries & infections in soccer are commonly associated with prolonged periods of downtime for players as well as financial costs for clubs. However, the origin and time period of downtime can vary greatly. Among others, muscle injuries have been reported to be a major reason for absence in soccer players. The aim of the present study was to compile the injuries of an elite German soccer club to see if different injury patterns regarding the affected structures can be identified.

METHODS: Total injuries of 49 first league german soccer players (23.6 ± 4.4 years) were collected and analyzed over the course of 14 consecutive seasons (07/08 – 22/23). All presented data were obtained from a publicly accessible database (transfermarkt.de). Injuries were categorized regarding their type (muscle, infect, joint, tendon/ligament, back, others), and days of absence were screened.

RESULTS: In total, 573 injuries occurred, including 183 muscle injuries (31,9%). This accumulated in 13590 days of absence for all players; 2790 days could be attributed to muscle injuries. There was a great variance regarding muscle-related absence, ranging from 0 – 383 total days (mean: 56.5 ± 78.8 days). On average, 16% ± 18.4% of all injuries were muscle-related, with accumulations of up to 65% in individual players.

CONCLUSION: The results of this study show that muscle injuries were a major cause of prolonged periods of absence in the tested elite german soccer players. Furthermore, it appears that both the absolute muscle injuries and the relative distribution among players varies greatly and there may be players who are more susceptible to injuries of a muscular origin than others. Knowledge of such individual injury profiles is important to enable physicians and coaches to manage individual loading to minimize the risk of injury and infections.

PREVALENCE RATES OF SHOULDER AND ELBOW OVERUSE INJURIES AMONG COMPETITIVE OVERHEAD YOUTH ATHLETES IN SINGAPORE

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INTRODUCTION: High prevalence rates of shoulder and elbow overuse injuries have been reported among overhead youth athletes in various populations. However, there is a dearth of such epidemiological evidence among Asian overhead youth athlete populations. Therefore, the aim of this study was to determine the prevalence rates and severity of shoulder and elbow overuse injuries, and its associated factors among competitive overhead youth athletes in Singapore.

METHODS: An online survey was distributed among 532 overhead youth athletes (12- to 18-years old) in Singapore, who were recruited from various youth sports clubs and training centres. Participants' gender, age, years of experience, and weekly training hours were collected. The survey included four multiple-choice questions and one open-ended question. Presence of an overuse injury was determined based on participants' response to Question 1, concerning their ability to participate in training and competition. Severity scores were tabulated from the scores of Questions 1 to 4, which were each scored on a scale of 0-8-17-25. The association between participants' demographics and presence of shoulder and elbow overuse injuries was determined using the Chi-square Test. Crude Odds Ratios and 95% confidence intervals were also calculated.

RESULTS: A total of 434 surveys were found complete and included for analysis. Badminton, cricket, softball, swimming, and volleyball were some of the sports studied. The prevalence rates of shoulder and elbow overuse injuries were 31.3% and 9.2%, respectively. The respective severity scores were 30.4 ± 14.4 and 38.4 ± 22.4. Age was associated with the

presence of both shoulder (P = .016) and elbow overuse injuries (P = .037). Years of experience was associated with the presence of substantial elbow injuries (P = .049). Weekly training hours was associated with the presence of shoulder (P = .016) and substantial shoulder injuries s (P = .020). Being 15- to 18-years old increased the odds of shoulder (OR = 1.65, 95% CI 1.10 to 2.49) and elbow overuse injuries (OR = 2.04, 95% CI 1.03 to 4.01). Having more than 8 years of experience increased the odds of substantial shoulder (OR = 2.71, 95% CI 1.01 to 7.29) and substantial elbow overuse injuries (OR = 3.92, 95% CI 1.01 to 15.24). Training more than 11 hours per week increased the odds of shoulder overuse injuries (OR = 2.64, 95% CI 1.31 to 5.30).

CONCLUSION: Shoulder overuse injuries are more prevalent but elbow injuries tend to be of greater severity among competitive overhead youth athletes in Singapore. Coaches working with older and experienced youth athletes training long hours every week should be cognizant of the risk of shoulder and elbow overuse injuries and consider the implementation of injury prevention programs.

TRAINING LOAD AND INJURIES IN LEINSTER SCHOOLBOY RUGBY PLAYERS; THE SCRUM STUDY

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INTRODUCTION: Rugby Union has seen increasing participation worldwide, which in turn increases exposure and potential for sport-specific injuries. Rugby specific reporting procedures provide guidance for injury surveillance research [1]. The management of training loads has been highlighted to help minimize risk of injury [2]. The SCRUm study aimed to investigate training loads and describe injury incident in Leinster schools' senior rugby squads.

METHODS: This prospective cohort study monitored training loads and injuries during a senior schoolboy's rugby season 2019-20. Informed consent and/or assent was obtained from participants and guardians. School nominated personnel recorded injuries (site, mechanism, severity) using the World Rugby Injury Surveillance System (ISS) web-portal. Individual players recorded training load (intensity, type, duration) using The Sports Office app via personal smartphone devices.

RESULTS: 463 participants in 16 schools provided data over 20 weeks (partial season) with rolling recruitment and early end to season due to Covid19 restrictions. 84 injuries were reported (61 match and 23 training). Injury incidence per 1000 player hours was 19.9 (95% CI 152-256) match injuries and 0.7 (95% CI 0.4-1.0) training injuries. Median time loss was 22 days (95% CI 16-27). Most frequent injury sites included shoulder (n=23, 27%), head (n=22, 26%), wrist/hand (n=9, 11%), ankle (n=8, 10%), and knee (n=5, 6%). The tackle was cited in 49% of injuries; tackling (n=25, 30%) and tackled (n=16, 19%). Low player data reporting led to estimated total training exposure of 31141 hours; with schools ranging from 365 to 4879 hours. Match exposure was calculated as 3063 hours: schools ranged from 123 to 385 hours. 500 training sessions were reported, including conditioning (weights, n=155, 31%; non-weights, n=22, 4%), rugby skills (non-contact, n=139, 28%; semi-contact, n=118, 24%; contact, n=54, 11%), and other (n=12, 2%).

CONCLUSION: Match activity and tackle event cited most injuries. Head and shoulder injuries occurred more often, with knee and ankle injuries causing longer time loss. The match injury incidence is lower in comparison to similar schoolboy cohorts; Ulster 29/1000 match hours and Munster/Connacht 54/1000 match hours [3, 4]. Training exposure varies widely across schools. Low player engagement limited individual level data analysis in this cohort.

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LACK OF PROPRIOCEPTIVE PLASTICITY IS ASSOCIATED WITH AT-RISK BIOMECHANICS FOR ANTERIOR CRUCIATE LIGAMENT INJURY.

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INTRODUCTION: Anterior cruciate ligament (ACL) injuries are frequent in team sports, especially during side-cutting manoeuvres (1). Altered sensory integration contributes to increased injury risk (2) and several biomechanical determinants have been previously associated with the occurrence of ACL ruptures (3). Recent data has shown that proprioceptive postural control strategies differ between athletes (4), with decreased postural performance and aberrant hamstring recruitment in young individuals with a more ankle-steered proprioceptive strategy. Since postural control during complex tasks requires adequate sensory integration and somaesthetic reweighting (5), we aimed to investigate the relationship between proprioceptive strategies and biomechanics during side-cutting manoeuvres in the context of ACL injuries.

METHODS: 47 handball players performed unanticipated (CUTunant) and unanticipated (CUTunant) cutting tasks. Their ability to reweight somaesthetic signals during postural perturbations on various surfaces was assessed using the centre of pressure displacements generated by the muscle vibration on a firm and foam surface. Two opposing behaviours were observed: a "rigid" strategy in which reliance on ankle proprioception increased on the foam, and a "plastic" strategy that involved a proximal shift of proprioceptive reliance ($p<.001$). Statistical Parametric Mapping analysis was used to compare

pelvic and lower limb side-cutting kinematics, kinetics and electromyography activity from 7 muscles 200ms before and after initial contact (IC) using a two-way Analysis of Variance (strategy×condition).

RESULTS: 20 athletes (11 females and 9 males, 18.5 years) were characterized as plastic and 20 (12 females and 8 males, 18.9 years) as rigid. No interaction between condition and proprioceptive profile was observed. More ipsilateral pelvis inclination prior IC and lower vastus lateralis (VL) activity immediately after IC was observed during CUTant. When comparing proprioceptive strategy, rigid individuals exhibited less pre-activity of the semitendinosus ($p<0.001$) and higher VL activity ($p=0.032$). Conversely, they showed higher gluteus medius pre-activity ($p<0.05$) and higher VL activity 100ms after IC ($p<0.001$). Ankle was also more internally rotated before and during the stance phase ($p<0.05$) among rigid athletes.

CONCLUSION: Lower ST pre-activity, higher foot internal rotation and VL overactivation were previously associated with an increased risk of ACL injury (4). Decreased proprioceptive plasticity is linked with at-risk biomechanics for Anterior Cruciate Ligament injury during side-cutting manoeuvres.

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Conventional Print Poster

CP-AP11 Winter Sports

INFLUENCE OF PHYSICAL QUALITIES ON GAME PERFORMANCE, ACUTE PHYSIOLOGICAL RESPONSES AND POST-GAME RECOVERY IN ICE HOCKEY

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INTRODUCTION: Understanding the effects of physical qualities on game performance, loading and post-game recovery are needed in professional team sports in order to optimize physical training. Despite the growing number of scientific research in ice hockey during the past couple of decades, there is still lack of knowledge in this area. Therefore, the purpose of the present study was to examine the influence of physical qualities on game performance, acute physiological responses and post-game recovery in ice hockey.

METHODS: Thirty-eight male professional ice hockey players (age 26.2 ± 4.6 years; height 181.9 ± 5.9 cm; body mass 85.6 ± 6.5 kg) from two different teams participated in the study. Aerobic (maximal oxygen uptake [VO2max]) and anaerobic (Wingate 30 s peak power [PP]) bicycle ergometer tests were executed during the pre-season five weeks prior to an official ice hockey game played against the teams at the beginning of the regular season of the Finnish Elite League. Neuromuscular performance (countermovement jump [CMJ]), hormonal responses (testosterone [T]; cortisol [C]) and immunological markers (interleukin-10 [IL-10]) were assessed before (pre-9h; pre-2.5h) and after (post-0h; post-12h) the game. During the game, skating volume and intensity were recorded using a Local Positioning System. Players were divided into high- and low-groups based on their level of physical qualities.

RESULTS: VO2max correlated with the skating volume, amount of high intensity skating and repeated high intensity sprints during the game ($r=0.33$-0.44; $p<0.05$). CMJ height increased from pre-9h to post-0h in the lower PP group (5.7%; $p<0.05$), whereas the opposite was found in players with higher PP (-2.2%; $p<0.05$) despite no differences in game load were observed between the groups. The higher PP group maintained CMJ height from post-0h to post-12h, while there appeared a significant reduction in the lower PP group (0.5% vs. -4.4%; $p<0.05$). Additionally, a greater reduction in T:C-ratio and T were noticed immediately after the game compared to the pre-values, and more pronounced recovery 12 hours after the game in players with higher VO2max and PP. Furthermore, IL-10 increased more in the higher VO2max group from pre-9h to post-0h (128% vs. 43%; $p<0.05$) and recovered to a higher extent from post-0h to post-12h (38% vs. 13%; $p<0.05$).

CONCLUSION: Aerobic endurance capabilities and ability to produce high amount of high intensity skating during official ice hockey game appear to be related. In addition, players with well-developed physical qualities, particularly higher aerobic power, seem to generate higher external, hormonal and immunological load during the game but also recover more rapidly after the game. Given the level of physical qualities related to differences in loading and recovery, the individual physical profile should be taken into account when designing physical training for ice hockey players in relation to their playing schedule.

PREDICTION OF MAXIMUM LACTATE CONCENTRATION DURING AN ALL-OUT ANAEROBIC TEST IN ELITE ICE HOCKEY PLAYERS

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INTRODUCTION: Maximum lactate concentration is an important measure in the development of hockey players and is typically performed using a lactate analyzer. However, this procedure may become cumbersome and costly when attempting to evaluate large groups of hockey players. Thus, the aim of this study was to develop an equation allowing an indirect assessment of the maximum lactate concentration produced from an all-out on-ice skating effort in elite adolescent ice hockey players.

METHODS: Twenty elite male ice hockey players participated in this study (age=15.7±1.0 years). The lactate anaerobic skating test (LAST) consisted of skating back and forth on an 18.2 m (60 ft) course at maximal speed with abrupt stops at each end for a total of 6 shuttles (total distance=218.2 m; average time=52.0±2.0 s). The maximum post-exercise lactate concentration was measured using a Lactate Pro analyzer and heart rate with a Polar chest strap. The variables used to estimate lactate concentration were time (s), heart rate (bpm), number of skating strides during the last shuttle (6th) and the skating stride index (SSI, number of skating strides during the last back and forth shuttle, divided by the average speed (strides/(m/s)) to complete the LAST course).

RESULTS: The average maximum lactate concentration was 14.3 mmol·L-1, which is consistent with the values found in adult elite players. No significant difference was observed in lactate production between younger and older individuals (P=0.248). The regression equation showed a strong correlation (r=0.929) with a standard error in the estimate (SEE) of 0.69 mmol·L-1, indicating an excellent accuracy of the equation. By removing variables directly related to skating efficiency in the lactate prediction equation, the correlation coefficient dropped to r = 0.49 and the SEE increased to 1.5 mmol·L-1, indicating 10.5% SEE that is 117% greater than the SEE obtained with the equation incorporating skating variables. Equation: Lactate (mmol·L-1) = - 161.88 + (Time 218.2 m×3.10) + (stride_6×8.36) + (HR×0.064) + (SSI×-34.51).

CONCLUSION: This study allows coaches to associate a metabolic estimation during an on-ice test that involves the solicitation of the anaerobic lactate system. The inclusion of skating variables significantly improves model accuracy and confirms the relevance of including skating economy variables for estimating maximum lactate level. Its validity and reliability make the prediction equation a tool of choice for noninvasively evaluating the metabolic expenditure of players. The maximum lactate concentration estimation has been automated using an Excel file where only the total time, the number of skate strides during the last shuttle (6th) and the maximum heart rate at the end of the test need to be entered. The estimation of lactate concentration will allow coaches to better target the needs of their elite players and thus improve their specific physical preparation.

PERFORMANCE-DETERMINING VARIABLES OF A FULL SPRINT CROSS-COUNTRY SKIING COMPETITION

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INTRODUCTION: Sprint cross-country skiing involves repeated ~3 min efforts during a ~3-4 h competition, starting with a qualifying time-trial (TT) followed by three subsequent knock-out heats (quarterfinals [QF], semifinals [SF], and final [F]). Although the physiological demands and performance-determining variables of time-trials have been investigated in detail, there exist limited data on how the relationship between performance-determining variables and the different efforts evolve throughout a sprint competition. Therefore, this study investigated lab-derived performance-determining variables and the relationship with performance during a full sprint cross-country skiing competition.

METHODS: Eighteen national-level male junior skiers performed a simulated on-snow sprint competition in the skating technique consisting of an individual TT followed by 3 heats (QF, SF, and F) for a total of four efforts. A promotion-relegation system was used instead of the regular elimination system so that each skier completed all heats. Within ~3 weeks from the competition, the skiers performed laboratory tests of performance and physiological variables in roller-ski skating, including sub-maximal efforts and an incremental test to exhaustion as well as upper- and lower-body strength and power tests.

RESULTS: We found longer time spent during the QF compared to the SF (2.6±3.2 seconds $p < 0.01$) and shorter time spent during the SF compared to the F (-6.8±9.5 seconds $p < 0.05$). Peak velocity and peak oxygen uptake (VO2peak) achieved during the incremental test, showed increasing correlations with performance as the sprint competition progressed. Correlation coefficients (r-values) for peak velocity and VO2peak were -0.73 and -0.51, -0.80 and -0.68, -0.82 and -0.73, and -0.86 and -0.77 in the TT, QF, SF and F, respectively (all $p < 0.05$). Gross efficiency demonstrated consistently large correlations with performance across all efforts (average r: -0.58±0.09), while 30-second poling-ergometer sprint power output demonstrated moderate correlations with performance (r: -0.37±0.22).

CONCLUSION: The gradually increasing correlations observed between peak velocity, VO2peak and performance in the subsequent efforts of a simulated sprint cross-country skiing competition indicate that aerobic power is increasingly important as the competition day progresses.

CRITERION VALIDITY OF PERFORMANCE TESTS AND PHYSIOLOGICAL CHARACTERISTICS IN ELITE CROSS-COUNTRY SKIERS

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INTRODUCTION: Performance testing is an integral component of the training process for elite cross-country skiers. The performance determinants should demonstrate high criterion validity and reflect the physiological demands of on-snow competitions. This study investigated the validity of three aerobic-based laboratory performance tests utilized by Swiss national team athletes.

METHODS: Twenty-nine elite cross-country skiers of the Swiss national team (19 men and 10 women, age: 24 ± 5 and 22 ± 3 years, VO2max: 72.2 ± 2.2 and 60.8 ± 3.8 ml/kg/min, respectively) performed an incremental test to task failure in the classic diagonal technique to measure maximal oxygen uptake (VO2max), a graded exercise test skating (GXT) to assess the second lactate threshold (LT2), and a 24-min double poling time-trial (24-min DP) all on a motorized treadmill using roller skis. Fat-free mass (FFM) was assessed using Dual-energy X-ray absorptiometry. Pearson's product-moment correlations were calculated to assess the relationships between laboratory performance determinants and on-snow sprint and distance performance as measured by FIS points (5th FIS points list 2022/23), with lower points indicating better performance. Correlation coefficients were categorized according to Hopkins (2002).

RESULTS: Large and extremely large associations were found between 24-min DP performance and distance performance in men ($r = -0.55$, $p = 0.022$) and women ($r = -0.91$, $p < 0.001$), respectively. Moderate and very large correlations were observed between absolute VO2max and sprint performance in men ($r = -0.49$, $p = 0.023$) and women ($r = -0.85$, $p = 0.003$), respectively. Relative VO2max and distance performance showed a small correlation in men ($r = -0.28$, $p = 0.111$) and a large correlation in women ($r = -0.66$, $p = 0.268$). LT2 and distance performance demonstrated large to very large correlations in both sexes (men: $r = -0.55$, $p = 0.023$; women: $r = -0.74$, $p = 0.038$). FFM and sprint performance showed a moderate correlation for men ($r = -0.49$, $p = 0.021$) and a very large correlation for women ($r = -0.84$, $p = 0.008$). At the same time, FFM and distance skiing demonstrated a moderate, positive correlation in men ($r = 0.48$, $p = 0.030$) and a moderate, negative correlation in women ($r = -0.41$, $p = 0.403$).

CONCLUSION: Laboratory-derived performance determinants and physiological characteristics such as 24-min DP, VO2max, LT2, and FFM were associated with on-snow distance and sprint performance in male and female elite cross-country skiers, with generally larger correlations in women than men and stronger relationships with distance compared to sprint race performance. Furthermore, the scaling of VO2max (absolute vs. relative) influences the predictive value for on-snow sprint and distance performance and could be utilized to distinguish typical sprint and distance skiers. Our results support the use of the current testing procedures for elite skiers.

PERFORMANCE, PHYSIOLOGICAL, AND PERCEPTUAL RESPONSES OF A FULL SPRINT CROSS-COUNTRY SKIING COMPETITION

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INTRODUCTION: Sprint cross-country skiing involves ~3 min efforts in undulating terrain, starting with a qualifying time-trial (TT) followed by three subsequent knock-out heats (quarterfinals [QF], semifinals [SF], and final [F]) separated by ~15-90 min recovery periods. However, the actual physiological responses during a full sprint competition, including warm-up, recovery between heats, and cool-down has not yet been investigated. Therefore, this study investigated performance, physiological, and perceptual responses of a full sprint cross-country skiing competition.

METHODS: Eighteen national-level male junior skiers performed a simulated sprint competition in the skating technique consisting of an individual TT followed by 3 heats (QF, SF, and F). A promotion-relegation system was used instead of the regular elimination system so that each skier completed all heats. The skiers were monitored by heart rate (HR) and global navigation satellite system (GNSS) sensors. Perceived readiness (RED, 1-10), rating of perceived exertion (RPE, 6-20), and blood lactate concentrations [La-] were taken at different time points during the competition.

RESULTS: The total time and distance covered during the full sprint competition were 03:30±00:06 h and 25.2±2.9 km, respectively. The skiers spent 02:19±00:27 h between 60-85% of maximal HR (HRmax) and 00:16 ± 00:04 h above 85% of HRmax. Average speed in SF was higher than TT, QF, and F (2.2±2.6%, 1.5±1.8%, 3.9±5.3%, respectively, all $P<0.05$). Average HR was reduced from TT to F (90.5±2.2% vs. 88.0±1.8% of HRmax, $P<0.01$) while [La-] was higher after F compared to TT, QF and SF (10.9±1.4 vs. 9.8±1.6, 9.1±19, and 8.8±1.8 mmol·L-1, respectively, all $P<0.05$). [La-] before F was also higher compared to TT, QF and SG (4.5±2.1 vs. 2.9±1.3, 2.7±1.4, and 2.2±0.6 mmol·L-1, respectively, all $P<0.01$). RED was lower before F compared to TT, QF and SF (6.7±1.3 vs. 8.0±1.0, 7.6±1.2, and 7.4±1.4, respectively, all $P<0.05$) while RPE was highest after TT compared to QF, SF, and F (17.7±0.9 vs. 15.5±1.1, 16.6±1.2, and 16.8±1.8, respectively, all $P<0.01$).

CONCLUSION: This study provides new insight into the physiological demands of a full sprint cross-country skiing competition, emphasizing the need for maintaining high physiological and perceptual effort throughout the competition. The relatively long competition day consisting of repeated efforts of high intensity interspersed with periods of low intensity is unique for sprint cross-country skiing and should be considered while designing corresponding training programs.

COMPARISON OF THE EFFECTS OF HIGH-LOAD VERSUS LOW-LOAD RESISTANCE TRAINING ON SPORT-SPECIFIC PERFORMANCE PARAMETERS IN YOUTH CROSS-COUNTY SKIERS AND BIATHLETES: A PILOT STUDY.

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INTRODUCTION: In sports practice, cross-country ski athletes often incorporate maximum strength- or explosive strength training to their work-out routine. Hypertrophy training, especially in the upper body is generally recommended to be avoided, as increased bodyweight is thought to be detrimental for endurance performance. However, some authors indicated that peak oxygen uptake (VO2peak) is considerably influenced by the active muscle mass during exercise (Larsen et al., 2016). Therefore, it seems reasonable that upper-body hypertrophy could increase VO2peak double poling. The aim of the present pilot study was to compare the effects of two hypertrophy training regimes with high volume on sport-specific performance parameters in elite youth cross-county skiers and biathletes, one with high-load resistance and one with low-load resistance.

METHODS: Fifteen elite youth cross-country skiers (16±2 years, VO2max: 59±7 mL*kg-1*min-1) were assigned either to a high-load resistance training group (HL; n=9) utilizing a 10x 6-12 repetition protocol or a low-load resistance training group (LL; n=6) utilizing 10x 15-20 repetitions. Both groups performed upper body resistance training twice a week for 10 weeks in addition to their regular training routine. The effects on double poling (DP) peak oxygen uptake (VO2peak), on DP power output, on VO2max, and 1-repetition maximum (1RM) for bench pull and bench press were investigated. A two-way ANOVA with repeated measures was performed for data analysis.

RESULTS: T-Test analysis showed significant differences ($p<0.05$) in pretest for maximum strength performances only. ANOVA with repeated measures showed significant increases for nearly all variables (except for VO2max [Eta=0.052, p=0.415]) with a time effect of $p<0.001$, Eta=0.594-0.775 (HL d= 0.42 to 1.02 vs. LL d= 0.05 to 0.73). In both groups the ratio between VO2peak and VO2max was improved (HL: 0.76 to 0.86 and LL: 0.80 to 0.87). However, only for bench press a significant interaction effect [group*time] with larger improvements for HL was calculated (p=0.044, Eta = 0.276).

CONCLUSION: Since no significant differences between the HL and the LL group could be observed, the presented results relativize the defensive position regarding hypertrophy training in elite cross-country skiing. In accordance with Larsen et al., 2016, a high-volume strength training routine led to a significant increase in the VO2peak without a significant increase in VO2max, independent on the intensity (HL vs. LL). The presented results indicate a beneficial influence on sport-specific performance parameters in both groups. However, studies with more participants are necessary to be conclusive.

References:

Larsen, R. T., Christensen, J., Tang, L. H., Keller, C., Doherty, P., Zwisler, A. D., Taylor, R. S., & Langberg, H. (2016). A Systematic Review and Meta-Analysis Comparing Cardiopulmonary Exercise Test Values Obtained from the Arm Cycle and the Leg Cycle Respectively in Healthy Adults. Int J Sports Phys Ther, 11(7), 1006-1039.

ASSOCIATIONS BETWEEN FORCE-VELOCITY PROFILE, ANAEROBIC CAPACITY AND REPEATED SPRINT ABILITY OF ADOLESCENT ICE HOCKEY PLAYERS.

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INTRODUCTION: Anaerobic capacity and repeated sprint ability are key components of performance in ice hockey [1]. Off-season training regularly includes sprint training focusing on the neuromuscular component of theses physiological abilities [2]. Horizontal force-velocity profiling (FVP) has gained popularity as a mean to individualise strength training programs by identifying if an athlete is more "force" or "velocity" oriented [3]. Yet, it remains unclear if a specific profile is favorable to enhanced anaerobic performance. Therefore, this study aimed to explore associations between FVP variables, anaerobic capacities and repeated sprint ability of adolescent ice hockey players.

METHODS: Recruited players were part of the selection process for Hockey Quebec's teams (Male: n = 36, mean age = 15.7 yrs; Female: n=35, mean age = 16.5 yrs). FVP and anaerobic capacity were assessed before the at the early phase of off-season training. FVP was measured during 30-meter sprints. Anaerobic capacity was measured with 2 tests: 1) Wingate test (WAnT30) and 2) repeated sprint test (RAST). Pearson's correlations were computed to explore associations between FVP variables (F0, V0, Pmax, Sfv, Rfmax¬ and Drf), WAnT30 and RAST variables.

RESULTS: F0 had small to moderate associations with anaerobic power indicators (r ranging from 0.28 to 0.49, $p < 0.05$) and moderate associations with anaerobic capacity indicators of both tests (r ranging from 0.31 to 0.36, $p < 0.01$). A small association with the RAST fatigue index ($r = 0.28$, $p = 0.019$). V0 and Pmax had strong associations with anaerobic power indicators (r ranging from 0.50 to 0.78, $p < 0.05$), strong associations with anaerobic capacity indicators (r ranging from 0.54 to 0.81, $p < 0.001$) and no significant associations with fatigue indexes of both tests. Sfv had a moderate association with the RAST fatigue index. Rfmax had moderate to large associations with anaerobic power indicators (r ranging from 0.30 to 0.56, $p < 0.05$), moderate associations with anaerobic capacity indicators of both tests (r ranging from 0.39 to 0.49, $p < 0.001$). Drf had a moderate association with the RAST fatigue index ($r = 0.376$, $p = 0.001$).

CONCLUSION: FVP's strong associations with performance in the RAST (principally V0 and Pmax) suggests that FVP has good predictive validity for the ability to repeat sprints. These associations were weaker with the WAnT30 variables and attributed to natural differences between running and cycling tasks. FVP mechanical components (F0, V0 and Pmax) were

moderately associated with better anaerobic power and capacity in both tests. Mechanical effectiveness (Rfmax¬ and Drf) did not translate to more efficient movement and recovery. An evaluation of athletes' mechanical capabilities through the FVP and anaerobic capacity and resistance to fatigue through the WAnT30 should give a broader view of athlete's physical capacities.

1. Brocherie et al. (2018) 2. Lagrange et al. (2020) 3. Jiménez-Reyes et al. (2017)

Conventional Print Poster

CP-MH02 Adapted Physical Activity

PATIENTS SUFFERING FROM MYOTONIC DYSTROPHY TYPE 1 SEEMS TO TOLERATE RESISTANCE EXERCISE WELL COMPARED TO HEALTHY CONTROLS

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INTRODUCTION: Patients suffering from most myopathies are recommended to stay active to delay declines in functional capacity and stay ambulatory for as long as possible. Still, a 9-year follow-up study showed that patients suffering from myotonic dystrophy type I (DM1) reduced muscle strength by 25-53% (1). Resistance exercise can be an effective countermeasure against loss of muscle function, but little is known about how intense exercise DM1 patients tolerate. To prescribe optimal dosing of resistance exercise, muscle stress and recovery must be considered. Therefore, the aim of this study was to investigate recovery after moderate-heavy load resistance exercise in DM1 patients compared to healthy controls.

METHODS: DM1 patients (DM1, n=10, 36±12 yrs) and healthy controls (Ctrl, n=10, 27±5 yrs) underwent one bout of unilateral resistance exercise (RE). The exercise consisted of 3 x 6-8 repetitions in leg press and knee extension at 75-85 % of 1 RM. Maximal force-generating capacity (MVC) of the knee extensors was measured prior to and 5 minutes, and 3, 24, 48, and 72 hours after exercise. Blood samples were drawn directly prior to MVCs to measure myoglobin levels. M. vastus lateralis was electrically stimulated with a max twitch contraction before and one hour after exercise. A week before testing, participants were familiarised with testing procedures and scanned using dual X-ray absorptiometry to measure lean leg mass. Analysis of variance using a mixed model was performed to investigate effect of time and disease. Data are expressed as mean ± standard deviation.

RESULTS: At baseline, MVC was significantly lower in the DM1 group compared to the Ctrl group (p=0.04), but there was no difference when strength was normalized to leg lean mass. There was a tendency towards higher myoglobin levels in the DM1 group at baseline (p=0.06). Total load lifted during RE by the DM1 group and the Ctrl group was 1479±730 kg and 2054±893 kg, respectively (p=0.07). The DM1 group experienced an acute decline in MVC of 12±9% five minutes after RE (p=0.01), but at the following timepoints MVC was not significantly different from baseline. The Ctrl group showed no significant decline in MVC following RE. The electrically induced torque was lower in the DM1 group one hour after exercise (p=0.03), while the Ctrl group was unchanged. The myoglobin levels were elevated and peaked 3 h after RE (DM1, 100±69 µg/L; Ctrl, 43±19 µg/L), and the groups differed significantly at 24 h and 72 h after RE.

CONCLUSION: The DM1 group had an acute reduction in both voluntary and electrically evoked force after resistance exercise, but the course of recovery was not different from controls, and the small rise in myoglobin levels excludes severe muscle damage. The present data indicate that well-functioning DM1 patients tolerates moderate-heavy resistance exercise well.

(1) Gagnon et al., 2018

RESTING HEART RATE AND CARDIOVASCULAR MORTALITY IN KOREA: THE MODIFYING EFFECTS OF PHYSICAL ACTIVITY

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INTRODUCTION: Resting heart rate (RHR) is known as an independent risk factor of cardiovascular diseases (CVDs), and elevated RHR has been associated with various CVDs and related mortality. RHR is determined by numerous factors, including physical activity level. The current World Health Organization (WHO) physical activity guidelines recommend that adults should engage in at least 150 minutes/week of moderate to vigorous physical activity (MVPA). However, it is not clear whether meeting the minimum level of recommended MVPA can modify the association between RHR and CVD mortality. The aim of this study was to examine the combined effect of RHR and MVPA on CVD mortality.

METHODS: This study included 31,698 adults from the 2007-2013 Korea National Health and Nutrition Examination Surveys (KNHANES) who provided data on self-reported physical activity and were linked to the Cause of Death Statistics through December 31, 2019. Multivariate cox proportional hazard models were used to estimate the adjusted hazard ratio (HR) of CVD mortality associated with RHR and MVPA. In combined analysis, participants were classified into 8 categories according to level of RHR (<60bpm, 60-69bpm, 70-79bpm, >=80bpm) and MVPA (<150min/week, >=150min/week). This study used participants in RHR of 60-69bpm with MVPA of >=150min/week as a reference group.

RESULTS: During 9.2 years of follow-up, 311 CVD deaths occurred. Among physically inactive adults compared to the reference group, the adjusted HR (95% CI) for CVD mortality was 2.41 (1.42-4.09) for RHR of <60bpm, 1.59 (1.01-2.50) for RHR of

60-69bpm, 1.98 (1.23-3.20) for RHR of 70-79bpm and 2.41 (1.50-3.89) for RHR of >=80bpm. Among physically active adults, there were no significant associations between RHR and CVD mortality. The results indicate that, regardless of RHR, participants who performed at least 150min/week of MVPA tended to have a lower risk of CVD mortality compared to those who did not meet WHO recommendations.

CONCLUSION: This study suggests that engaging in even the minimum recommended level of physical activity may substantially reduce the risk of RHR-related CVD mortality. The physically inactive group should be the target of preventive health strategies, as supported by this study.

THE EFFECT OF HEALTH PROVIDER'S FEEDBACK ON PHYSICAL ACTIVITY SURVEILLANCE USING WEARABLE DEVICE-SMARTPHONE APPLICATION FOR RESOLUTION OF METABOLIC SYNDROME; A 12-WEEK RANDOMIZED CONTROL STUDY

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INTRODUCTION: Metabolic syndrome is characterized by the co-existence of several major risk factors for cardiovascular disease, high blood pressure, hyperglycemia, and dyslipidemia (reduced high-density lipoprotein cholesterol [HDL-C] or raised triglycerides). Therefore, appropriate prevention and intervention are required in all related fields. The worldwide increase in recent mobile devices and wearable health work suggests the possibility to overcome the limitations of conventional physical activity healthcare programs. But further research is needed to better understand how or why they work and what factors can mitigate the impact of other groups. This study aimed to evaluate the effect of feedback on clinical indicators in patients with metabolic syndrome on activities measured using wearable devices, such as smartphone apps.

METHODS: In this study we included a total of 67 men and women aged 58.2±10.7 years. Patients with metabolic syndrome were recruited and prescribed to live for 12 weeks using a wrist-wearable device (B.BAND, B Life Inc., Korea). A block randomization method was used to distribute participants between the intervention (n=35) and control groups (n=32). In the intervention group, an experienced study coordinator provided feedback on physical activity to individuals through telephonic counseling every other week. Through the wearable device, it is possible to measure daily physical activity, and it is possible to obtain the values of physical activity time, number of steps, and calorie consumption. Blood pressure, body composition, fasting blood glucose, and lipid profiles were recorded.

RESULTS: The mean number of steps in the control group was 8892.86 (4473.53), and those in the intervention group was 10129.31 (4224.11). After 12 weeks, metabolic syndrome was resolved. Notably, there were statistically significant differences in the metabolic composition among the participants who completed the intervention. The mean number of metabolic disorder components per person remained at 3 in the control group, and decreased from 4 to 3 in the intervention group. Additionally, waist circumference, systolic and diastolic blood pressure, and triglyceride levels were significantly reduced, while HDL-cholesterol levels were significantly increased in the intervention group.

CONCLUSION: Overall, 12 weeks of telephonic counseling intervention using wearable device-based physical activity confirmation improved the damaged metabolic components of patients with metabolic syndrome. Telephonic intervention can help increase physical activity and reduce waist circumference, which is a typical clinical indicator of metabolic syndrome.

EFFECTIVENESS OF PHYSICAL ACTIVITY INTERVENTIONS ON ALLEVIATING PERCEIVED FATIGUE AMONG ADULTS WITH CHRONIC CONDITIONS: A SYSTEMATIC REVIEW AND META-ANALYSIS OF RANDOMISED CONTROLLED TRIALS

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INTRODUCTION: Adults with chronic conditions often experience significant fatigue, which is a barrier to physical activity participation and negatively impacts their health-related quality of life and physical function. Studies have found that physical activity might alleviate perceived fatigue symptoms after exercise in these individuals; however, the findings are conflicting, and no clear recommendations have been given to individuals who experience fatigue. This systematic review and meta-analysis aimed (1) to overview the physical activity interventions of randomised controlled trials (RCTs) aiming to alleviate perceived fatigue symptoms across many chronic conditions using a transdiagnostic approach and (2) to evaluate the effectiveness of physical activity interventions in alleviating perceived fatigue after exercise.

METHODS: Five databases were searched up to November 2021 and two reviewers independently conducted study screening and selection, extracted data, and assessed the risk of bias. The outcome was the standardised mean difference (SMD) with 95% confidence intervals in perceived fatigue between experimental and control groups.

RESULTS: A total of 27 articles met the inclusion criteria. The findings indicated that physical activity interventions alleviated perceived fatigue after exercise symptoms in adults with chronic conditions (SMD=0.61; 95% CI= 0.87 to 0.34; p<0.00001). No effect was found on perceived fatigue of post-trial follow-up. No activity pacing strategies were incorporated into any physical activity interventions.

CONCLUSION: Physical activity interventions were found to have a moderate effect on perceived fatigue reduction among adults with various chronic conditions. Our transdiagnostic approach highlights the important role of physical activity in alleviating the feelings of daily life fatigue in individuals with chronic conditions. We also observed that most physical

activity interventions did not include post-trial follow-up measurements, which are considered essential for identifying potential risks that might not be evident during the trial period as well as to explore sustained effects. After the standardised intervention length, adults with chronic conditions might not be able to keep up with the exercise training program. Activity pacing, which is the process of self-regulation of physical activity levels, has been proposed to be a key factor in fatigue management and exercise engagement. Incorporation of activity pacing into physical activity interventions could result in sustained effects reducing perceived fatigue in daily life and enhancing sustained physical activity engagement.

SPECIFIC EXERCISE IS MEDICINE – PHYSICAL ACTIVITY IS CURRENTLY THE MOST EFFECTIVE TREATMENT OPTION FOR NEUROPATHIES

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INTRODUCTION: Neuropathies are a prevalent, heterogeneous group of diseases of the peripheral nervous system. Symptoms are often debilitating, difficult to treat, and usually become chronic. Not only do they diminish patients' quality of life, but they can also affect medical therapy and lead to complications. To date, for most conditions there are no evidence-based treatment options available. Specific exercise interventions have proven beneficial to reduce and even prevent a neuropathy. We therefore performed a systematic review with meta-analysis to analyse the potential benefits of exercise interventions for neuropathies of different origin that can then be translated into practice.

METHODS: Two independent reviewers performed a systematic review with meta-analysis according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Inclusion criteria according to the PICOS approach were: neuropathic patients, exercise interventions only, an inactive or non-exercising control group, and solely randomized controlled trials with the following outcome parameters: neuropathic symptoms, balance parameters, functional mobility, gait, quality of life, and HbA1c (glycated hemoglobin).

RESULTS: A total of 41 randomized, controlled trials met all inclusion criteria, 20 could be included in the quantitative analysis. Study quality varied from moderate to high. Current data further supports the hypothesis that exercise is beneficial for neuropathic patients. This is best documented for patients with diabetic peripheral neuropathy (DPN) (27 studies) and for chemotherapy-induced peripheral neuropathy (CIPN) (nine studies), while there are only few studies (five) on all other causes of neuropathy. We found standardized mean differences in favor of exercise of 0.27–2.00 for static balance, Berg Balance Scale, Timed-up-and-go-test, nerve conduction velocity of peroneal and sural nerve as well as for HbA1c in patients with DPN, and standardized mean differences of 0.43–0.75 for static balance, quality of life, and neuropathy-induced symptoms in patients with CIPN. Furthermore, we have meanwhile completed a further RCT study that reveals a significant preventive effect of exercise on CIPN by 50-70%: (SMT 30% (95%CI 17·9-42·1%) and WBV 41·2% (27·9-54·5%) vs. TAU 70·6% (58·0-83·2%); pITT<0·0016). This also had a clinical impact, leading to less dose reductions and less mortality in the group that performed sensorimotor training concomitant to therapy.

CONCLUSION: Specific exercise can reduce and even prevent the symptoms of a neuropathy. For DPN, evidence-based recommendations can now be made, suggesting a combination of endurance and sensorimotor training. For CIPN, sensorimotor training remains essential. For all other neuropathies, more high-quality research is needed to derive evidence-based recommendations. Overall, it seems that sensorimotor training has great potential to target most neuropathies and is therefore currently the best treatment option for neuropathies.

MULTIPLE CHRONIC DISEASE CHARACTERISTICS OF THE MIDDLE-AGED SOUTH KOREANS BY A LIFESTYLE USING DATA MINING

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INTRODUCTION: he term "multiple chronic diseases" (MCD) describes a patient with two or more chronic conditions simultaneously at the same time. Compared with prevalent chronic diseases, it is linked to poorer health outcomes, more difficult clinical management, and higher medical expenses. Several existing MCD guidelines support a healthy lifestyle, including regular physical activities but do not include specific exercise therapy recommendations. This study aimed to understand the prevalence and model of MCD in middle-aged and elderly South Koreans by comparing MCD characteristics with exercise habits to provide a theoretical basis for implementing exercise therapy in these patients.

METHODS: This study was based on data from the "Korean Health Panel Survey" (KHPS). The KHPS is a government-approved statistical survey that has been distributed annually since 2008 to generate national-scale data on healthcare use, medical costs, health levels, and health behaviors. Through rigorous screening of 14 741 participants, 8477 participants, aged > 45 years, with a complete set of exercise-related data and chronic disease data were included in this study. Statistical analyses were performed using IBM SPSS Statistics, version 26.0, and IBM SPSS Modeler, version 18.0. Statistical significance was set at a two-tailed p-value of <0.05. Comparing the MCD characteristics of the participants, the chi-square test for categorical variables and the t-test for continuous variables were used.

RESULTS: In this study, the morbidity rate of MCD was 39.1%. Those with MCD were more likely to be female (p<0.000), seniors over 65 years of age (p<0.000), those with low education level, more than eight h of daily sedentary time (p<0.000), no regular exercise behavior (p=0.001), no sports-related expenses (p<0.000), and no weight management behaviors (p<0.000). Chronic renal failure (93.9%), depression (90.4%), and cerebrovascular disease (89.6%) were the top

three diseases identified in patients with MCD. A total of 37 association rules were identified for the individuals who did not exercise regularly. This equated to 61% more than the regular exercise group, which showed only 23 association rules. In the extra association rules, cardiovascular diseases (150%), spondylosis (143%), and diabetes (125%) are the three chronic diseases with the highest frequency increase.

CONCLUSION: Association rule analysis effectively studies the relationship between various chronic diseases in patients with MCD. It also effectively helps identify chronic illnesses more sensitive to regular exercise behaviors. The findings from this study may be used to formulate more appropriate and scientific exercise therapy for patients with MCD.

INSPIRATORY MUSCLE TRAINING IN THE TRAINING PROCESS OF DISABLED SWIMMERS.

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INTRODUCTION: The purpose of this study was to evaluate the effects of inspiratory muscle training attached to standard swimming training on lung ventilation, inspiratory muscle strength and aerobic endurance levels, as well as the training status of athletes with disabilities participating in swimming.

METHODS: The study was performed in 16 athletes of the Polish Disabled Sports Association "Start". The subjects were divided into 2 groups, allocation to groups was randomized according to the distribution table: group I (IMT group) - athletes performing standard swimming training with attached inspiratory muscle training of medium intensity at a load level of 50% MIP; group II (sham-IMT group) - athletes performing standard swimming training with attached inspiratory muscle training of low intensity at a load level of 15% MIP. All subjects received eight weeks of inspiratory muscle training on personal PowerBreath KH1 devices. The following tests were performed on each athlete: spirometrics, maximum inspiratory pressure (MIP), expiratory pressure (MEP), T-30 test; step test - progressive test 8 x 100. All tests were performed 3 times: I - before the start of IMT, II - after of IMT, III - follow – up after 8 weeks. The results of the study were statistically analyzed using STATISTICA PL V.12.0.

RESULTS: Significant increases in FVC, FEV1, as well as MIP and MEP values were obtained only in group I after applied inspiratory muscle training. In this group, maintenance of the results was observed at follow-up. Also in group I, there was a significant increase in the distance swum during the T-30 test after IMT and a significant maintenance of the effect at follow-up. A significant reduction in lactic acid concentration was also observed in this group and a significant reduction in heart rate at 88% and 93% of maximum speed.

CONCLUSION: 1. Inspiratory muscle training with 50% MIP load significantly increased pyrometric parameters and respiratory muscle strength in disabled swimmers. The disabled swimmers showed maintenance of training effects over a longer period of time at a high level.

2. There were positive distal effects of using training with 50% MIP load in maintaining the achieved levels of respiratory functional parameters.

3. Training of inspiratory muscles at a higher intensity significantly improved the training level of the tested athletes, which was associated with an increase in swimming distance. The use of medium-intensity inspiratory muscle training significantly reduced lactic acid levels in the progressive test. Higher intensity training significantly lowered the heart rate in the 8x100 progressive test at 88% and 93% of maximum speed improving the athletes aerobic endurance.

4. The use of medium-intensity inspiratory muscle training effectively improved the training level and physiological parameters of the swimmers effort. This indicates the need to include this type of training in the standard of competitive preparation of athletes with disabilities.

MOTOR AND MUSCLE ACTIVATION RESPONSES DURING STANDING WITH SENSORY RESTRICTIONS IN CHILDREN WITH CEREBRAL PALSY

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INTRODUCTION: Cerebral palsy (CP) is a brain disorder resulting in motor disability due to impaired muscle coordination [1], which often leads to increased imbalance and risk of falls. Integration of visual, proprioceptive, and vestibular inputs with motor output is crucial for controlling upright standing [2]. Studying posture by excluding or limiting sensory information helps to understand the dependency of an individual on restricted sensory sources. Knowing that children with CP have a deficit in processing sensory information [3], restriction of sensory sources may further deteriorate their balance control. Therefore, the purpose of this study was to examine the influence of visual and proprioceptive restrictions on balance and muscle activation during upright standing, in children with CP compared with typically developed (TD) children.

METHODS: Ten children with CP (13.0±1.7 yrs, 147.3±0.5 cm, 48.1±0.9 kg) and 16 TD children (14.0±3.8 yrs, 161.2±1.2 cm, 54.8±0.9 kg) were asked to stand on a force platform, in four conditions, with eyes open (EO) or eyes closed (EC), on a rigid (R) or foam (F) surface. The standard deviation (SD) of the center of pressure (CoP) on the anterior-posterior (AP) and mediolateral (ML) direction, the SD of trunk acceleration (TrA), as well as the electromyogram of the soleus (Sol), gastrocnemius medialis (MGas) and tibialis anterior (TA) muscles, were recorded in three 60-s trials in each balance condition. The rate of change for ECR, EOF, and ECF was expressed as the log2 ratio relative to EOR. A linear mixed model was used to compare the differences between conditions, groups, and interactions.

RESULTS: According to the CoP and TrA data, children with CP were less stable than TD children in all 4 conditions. Regarding the relative changes, CoP-AP, CoP-ML, and TrA increased significantly in EOF and ECF compared to EOR, but this increase was less evident in children with CP (interaction p=0.002, p=0.006, and p=0.002). The activation of Sol and MGas significantly increased to a similar extent in both groups at ECR, EOF, and ECF relative to EOR (p<0.05). TA did not demonstrate any significant change (p>0.05).

CONCLUSION: The sensory restrictions applied in children with CP induced a lesser deterioration of their balance compared to TD children. This could be attributed to their greater instability in EOR, compared to TD children. However, the muscle activity changed similarly between the two groups, suggesting a preserved ability of the children with CP to adjust motor command depending on sensory conditions. This could open new directions for training and rehabilitation.

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EEG DELTA AND THETA OSCILLATIONS ON PROPRIOCEPTIVE-MOTOR DYSFUNCTIONS IN YOUNG ADULTS WITH A PROBABLE DEVELOPMENTAL COORDINATION DISORDER

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INTRODUCTION: Individuals with a probable developmental coordination disorder (pDCD) are known to exhibit proprioceptive dysfunctions that result in abnormal motor execution. To date, no neural mechanism has been identified that underlies brain processes related to proprioceptive-motor dysfunctions in these individuals. This study aims to investigate, via the use of limb proprioceptive motion detection task and time-frequency analysis of EEG, if the neural oscillations in responding to passive limb motion might reveal differences between young adults with pDCD and controls, and to what extent the EEG data is linked to motor performances in young adults with and without pDCD.

METHODS: Thirty-four adults aged between 18-23 years were recruited and categorized into either pDCD group (M ± SD: 21.20 ± 1.17) and control group (M ± SD: 21.30 ± 1.10) based on the results of Bruininks-Oseretsky Test of Motor Proficiency 2nd edition long-form (BOT-2-LF). Participants placed their dominant foot on the paddle of the ankle apparatus that passively moved the ankle at constant velocities of 22°-1 while the EEG was simultaneously recorded. Participants were required to 1) attend to the passive movement and press the button held by the dominant hand once they sensed the ankles motion as fast as possible (voluntary response, VR), or 2) receive purely passive movement (without voluntary response, NVR). The reaction time to passive motion (RT), standard deviation across all reaction time (RT-SD), and EEG power of delta/theta oscillations were obtained in all participants.

RESULTS: In comparison to the control group, young adults with pDCD performed longer RT ($p < .001$) and larger RT-SD ($p = .004$) during the VR condition. Mixed model Analysis of variance (ANOVA) on EEG measures showed a significant interaction effect of Group x Condition ($p = .007$) for delta power. The subsequent post hoc analyses indicated that the VR condition showed higher delta ($p < .001$) and theta ($p < .001$) activities in both groups. Notably, the pDCD group revealed stronger delta power than the DCD group in the VR ($p < .001$), but not the NVR condition. Further correlation analysis indicated that delta oscillation over fontal and premotor cortices was significantly correlated with the RT ($r = -.454$, $p = .001$), RT-SD ($r = -.472$, $p = .005$), body coordination ($r = -.425$, $p = .012$) and strength and agility ($r = -.439$, $p = .009$) of BOT-2-LF.

CONCLUSION: This study demonstrated for the first time that delta power in response to lower limb proprioceptive stimuli is reduced in young adults with pDCD. Such reductions in delta power are significantly correlated with poorer behavioral performance on proprioceptive-motor tasks and lower scores on standardized clinical motor measures. These findings offer the first EEG evidence of proprioceptive-motor function and suggest that delta power might serve as an electrophysiological marker for motor deficits in young adults with pDCD.

KINEMATIC ANALYSIS OF ROWING IN A CHILD WITH CEREBRAL PALSY: A PRELIMINARY STUDY

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INTRODUCTION: Hemiplegia is a pathological condition that affects one side of the body and it is associated with disorders of the upper and lower limbs caused by muscle spasticity. Such disorders are usually remedied by rehabilitative treatments aimed to improving function and aesthetics by correcting rigid deformities [1]. However, therapy alone is not enough to achieve the desired effects. Recent studies have found that increasing patient motivation and focusing on daily activities and participation are the most effective ways to help children with unilateral cerebral palsy recover their function [2].

The aim of the study is to use biomechanical kinematic assessment to determine the rehabilitation impact of rowing on children with unilateral cerebral palsy.

METHODS: The study was approved by IRCCS Eugenio Medea ethics committee and focused on a case study of one child with left hemiplegia. Data was collected using Xsens Awinda and an indoor rowing ergometer connected with ErgData app and with a heart rate monitor. After an initial familiarization, the child was asked to perform the following protocol: 15-stroke trial using (i) only arms and shoulders (AS), (ii) upper limbs and trunk (TA); (iii) legs, arms and shoulders (LTA) and "the

fish game". The whole body kinematic in the sagittal plane, the heart rate during the protocol, the number of stroke per minute, the power the time duration were obtained and processed in an ad hoc Matlab script. The statistical analysis was performed through statistical parametrical mapping [3]. The data normality was verified and a two-tailed paired t-test (α = 0.05) was used to compare the right and left side kinematics.

RESULTS: The child performed the protocol without any interruption. In the LTA, we found statistical differences between the two sides in all joints. The shoulder flexion-extension differed from 63-99% of the stroke cycle, the elbow from the 30-78% of the stroke cycle, the wrist throughout the stroke cycle. As for the lower body, however, the hip did not differ, instead the knee from 0-16%, 85-99% stroke cycle and finally the ankle of the affected side differed from the less affected side from 0-20% and from 73-99% of the stoke cycle.

CONCLUSION: The most significant findings relate to the presence of asymmetry in the sagittal plane of both the shoulders, elbows, wrists, knees and ankles joints at different stages of the rowing cycle. This speculation may be a helpful aid for the clinician to understand whether rowing can be used as a rehabilitation tool in children with unilateral cerebral palsy.

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CP-BM03 Motor Learning and Motor Control

CHANGES IN THE MECHANISMS OF CONTROL OF POSTURE DEPENDING ON TASK DIFFICULTY: EFFECT OF DIFFERENT PROPRIOCEPTIVE STIMULATION

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INTRODUCTION: Proprioception allows us to know at any moment the position of our body and guides our movements. During these movements, the sensorimotor integration allows the link between the sensory integration (like proprioceptive information) and the motor command in the central nervous system (CNS). Proprioception can malfunction, leading to an alteration in balance and walking. To prevent such alteration, it is possible to specifically solicit proprioceptive receptors via local vibration (LV) applied to the postural muscles while performing balance exercises. While this presents promising clinical perspectives, LV perturbates postural control, and could make postural exercises more difficult. Conversely, transcutaneous electrical nerve stimulation (TENS) can also solicit proprioceptive receptors and may favor postural control during postural exercises so that combining LV and TENS may be further relevant for their synergic effects. We therefore investigated how stimulating the proprioceptive system by LV, TENS or their combination may affect balance during postural tasks of increasing difficulty.

METHODS: We calculated the center of pressure velocity (CoP) in both axis of 14 healthy participants for three postural tasks of increasing difficulty: 2-feet eyes closed (1), 1-foot eyes opened (2) and 1-foot eyes closed (3). Each task was performed three times for 20sec in four randomized conditions: no stimulation, LV, TENS and LV+TENS. Two sessions were performed by each participant, with stimulation targeting either the triceps surae or the tibialis anterior muscle.

RESULTS: For LV and LV+TENS there was an increase in CoP speed in both axes compared to no stimulation in task 1, while no differences were observed for tasks 2 and 3. TENS caused no differences in CoP speed for all tasks.

CONCLUSION: This show that proprioceptive stimulation through LV may perturbate balance during easy postural exercises but not when task difficulty increases. This task difficulty-dependent results suggest that the CNS is saturated during difficult tasks by proprioceptive afferences due to mechanical constraints and the increase of proprioceptive afferences this already generates. Moreover, we showed a greater increase of CoP speed in the ML axis compare to the AP for LV and LV+TENS conditions, only for task 1 suggesting that to compensate proprioceptive afferences perturbation the CNS increases the ML oscillations to stabilize and/or gather sensory information. This could imply that proprioceptive afferences from LV is integrated by the CNS as a perturbation in task 1. In task 2 there is a decrease of ML CoP speed compare to AP for LV and LV+TENS, a more classical behavior of standing with no perturbation which could suggest that LV is no more integrated as a perturbation. For task 3 no more difference between both axes probably because participants already are in their limit of stability.

MAGNETIC RESONANCE IMAGING COMPATIBLE ROBOTIC DEVICE FOR EXPLORING THE SUPRASPINAL CONTROL OF GAIT: A SYSTEMATIC REVIEW

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INTRODUCTION: The locomotor control of gait is essential for daily activities and athletic performance, which depends upon both peripheral musculoskeletal and supraspinal elements (e.g., brain cortical network). Therefore, the explicit characterization of supraspinal elements can provide critical knowledge to optimize rehabilitative strategies for people suffering from athletic injuries, as well as neurodegenerative diseases.

Magnetic resonance imaging (MRI) is one widely-used neuroimaging technique that can provide sophisticated measurements of the structure and functions of supraspinal neural regions. However, people are required to stay motionless during MRI scan, largely limiting the feasibility of studying the supraspinal networks pertaining to gait. To overcome this, researchers have developed MRI-compatible devices to apply the stimulation mimicking the locomotor control of gait without interfering with the imaging quality. However, large variance in the design and functionalities of these devices existed, leading to uncertainty of the interpretation of the observations, and implementation of these devices.

OBJECTIVES: We here performed a thorough systematic review to review and summarize the research and development progress of these devices.

METHODS: Seven electronic databases PubMed, Web of science, EBSCO MEDLINE, SPORT Discus, Psych-Info, Cocaine Library and Scopus were searched (until 27 August 2022). The information related to device structures and functionalities, study protocols, and observations from MRI, was extracted.

RESULTS: Twenty-six studies were included, including 13 types of devices from 12 groups and 371 participants across nine countries. Three devices applied only somatosensory stimuli to foot soles, eight only motion stimulation to lower-extremities, and two both types of stimulation. The MRI compatibility (n=7) and the validity of device performance (e.g., head motion) (n=9) were reported. It was observed that the primary and secondary sensorimotor cortex, prefrontal cortex, and the cerebellum were activated in response to gait-related stimulations.

CONCLUSION: All these devices were successfully implemented during MRI scan and reliable data were obtained, suggesting it is feasible to implement these devices to characterize supraspinal networks pertaining to locomotor control of gait in different populations. However, inconsistent observations were presented, potentially stemming from varied designs of devices or study protocols (e.g., relatively small sample sizes). The following aspects are thus needed to be carefully considered and focused on: (1) to improve the quality of gait simulation using for example, independently-controlled pneumatic actuators to smooth the force control over with individualized shaped surface; (2) to simultaneously measure the muscular characteristics during the stimulation using electromyography, enabling the characterization of the supraspinal and peripheral coupling related to locomotor control.

MOTOR-COGNITIVE STRATEGIES TO INFLUENCE THE NEURAL CONTROL OF BALANCE: AN FNIRS STUDY.

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INTRODUCTION: With age, postural control deteriorates because of changes in the sensory and motor systems (da Silva Borges et al., 2021). Results of behavioral and neuroimaging studies have also shown that not only subcortical structures such as the brainstem, cerebellum, and spinal cord (Sherrington, 1910; Takakusaki, 2017) but also sensorimotor areas influence postural control (Mihara et al., 2008; Lin et al., 2017). Furthermore, there is a scientific consensus on the functional reciprocal link between language processing and motor actions. For instance, reading or listening to words that refer to bodily actions elicits activity in brain motor areas involved in action production (see Pulvermüller & Fadiga, 2010 for a review). Because increases in measured cortical activity compensate for sensorimotor deficits and thus maintain postural stability (St George et al., 2021), we hypothesized that motor-cognitive processes exhibit reduced body sway with concomitant increased brain oxygenation. Here, functional near-infrared spectroscopy (fNIRS) allows us to analyze brain oxygenation during both cognitive tasks and postural control (Helmich et al. 2015, 2016, 2020).

METHODS: The sample includes 43 active and healthy (no neurological or orthopedic diseases) athletes (39 men; 31 right-handed, 12 left-handed) mean age: 21.8 ± 4.11 years). Postural control was assessed using a pressure distribution measurement system (type FDM XS from zebris Medical GmbH) during (I) eyes open/closed; (II) standing on a stable/unstable surface; and (III) with/without cognitive priming task. Tasks were divided into a motor-cognitive (taskmotor: reciting motor actions) and non-motor-cognitive (tasknon-motor: reciting numbers) task. Neuronal activation of postural control was derived using mobile fNIRS (NIRSSport2, NIRx GmbH, 8 sources, 8 receivers, 18 channels) over sensorimotor areas of the left and right hemispheres.

RESULTS: The results of postural control of taskmotor on an unstable standing surface and with eyes closed show a significant reduction of body sway [smaller area of the confidence ellipse in mm²] compared to postural control without a task. Results with fNIRS show a significant increase in brain oxygenation [ΔHbO] in a left hemisphere channel localized in the premotor cortex during taskmotor compared to measurement without a task.

CONCLUSION: Results show reduced postural sway using motor-cognitive acquisition during postural control with eyes closed and unstable standing surface. The associated increase in brain oxygenation shows that motor action can be initiated by motor-cognitive tasks, thereby improving postural control. These findings can be used to optimize rehabilita-

tion interventions for diseases with balance impairments and to improve the understanding of postural control mechanisms, which has important implications for exercise science and rehabilitation.

ACTIVATION OF ABDOMINAL MUSCLES DURING FORCED EXPIRATION AT VARIOUS EXPIRATORY MOUTH PRESSURE LEVELS

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INTRODUCTION: During forced expiration, active muscle contraction of the rectus abdominis (RA) and the oblique externus abdominis (OE) is required to reduce intrathoracic volume rapidly. Considering the origin and insertion of the RA and OE, it is clear that active contraction of these muscles contributes to forced expiration. However, if these muscles are not actively contracting during forced expiration, they will not be able to contribute to forced expiration. Therefore, this study measured the activation of the RA and OE during forced expiration at various expiratory mouth pressure levels by surface electromyography (EMG).

METHODS: Twelve healthy male participants performed forced expiration at 30%, 50%, 75%, and 100% of the maximal expiratory mouth pressure (PEmax). During forced expiration, the EMG activity of the upper RA, the lower RA, and the OE was measured by surface EMG. The root mean square (RMS) amplitude of the EMG activity during the forced expiration was calculated and normalized to the RMS amplitude during the maximal voluntary contraction (MVC) in an isomeric abdominal crunch (for the upper and lower RA) or twist crunch (for the OE).

RESULTS: The PEmax was 128 ± 9 cmH2O, corresponding to 107.2 ± 21.5% of the PEmax predicted by sex, age, height, and weight. The EMG activity during forced expiration was clearly lower than that during MVC in isomeric abdominal (twist) crunch and greatly varied with participants: the EMG activity during forced expiration at 100% of the PEmax was 16.0 ± 18.4% of the MVC (Coefficient of Variation: CV = 115.3%) for the upper RA, 14.2 ± 12.6% of the MVC (CV = 88.6%) for the lower RA, and 28.2 ± 14.2% of the MVC (CV = 50.2%) for the OE. The EMG activity during forced expiration tended to increase with increasing expiratory mouth pressure levels. A two-way analysis of variance revealed a significant interaction between muscle and mouth pressure levels. Post hoc multiple comparisons revealed that the EMG activity of the upper RA was significantly different among the mouth pressure levels except for between 30% and 50% of the PEmax and between 75% and 100% of the PEmax. In the EMG activity of the lower RA, significant differences were found only between 30% and 100% of the PEmax and between 50% and 100% of the PEmax. In the EMG activity of the OE, significant differences were found among the mouth pressure levels except for between 30% and 50% of the PEmax. The EMG activity at 100% of the PEmax was significantly higher in the EO than in the lower RA.

CONCLUSION: The finding that the EMG activity of the RA and EO was clearly lower during forced expiration than during abdominal (twist) crunch and the EMG activity during forced expiration greatly varied with participants shows the difficulty of using abdominal muscles for forced expiration.

MOTOR IMAGERY SPEEDS IN THE FOOTBALL DRIBBLING TASK: AN EEG STUDY

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INTRODUCTION: Motor imagery (MI) is a mental process to rehearse or simulate a given action (Guillot & Collet, 2008). MI is also described as explicit and implicit mental representation of an action with or without concomitant movements (Ruffino, Papaxanthis, & Lebon, 2017). The following factors should be considered when performing MI: Timing (Holmes & Collins, 2001), and temporal characteristics or temporal equivalence (Guillot & Collet, 2008). However, Louise et al. (Louis, Guillot, Maton, Doyon, & Collet, 2008) and Boschker et al (Boschker, Bakker, & Rietberg, 2000) showed that voluntarily increasing or decreasing the movement speed during MI impacted the actual movement speed. With this in mind, two types of imagery were examined in this study, slow-motion imagery and fast-motion imagery. Therefore, in order to know about the neurological basis of different modes of MI, we decided to examine the activity of alpha and beta waves at the brain cortex regions in these two types of imagery.

METHODS: To this end, participants were asked to imagine a football dribbling task at rest state, slow and fast speeds, while their neuronal activities were registered via brain electroencephalography (EEG). 10 healthy adolescent athletes took part in the study. Participants' neuronal oscillations were recorded using an international 10–20 electro-encephalogram (EEG)-system to assess alpha (8 Hz – 12 Hz) and beta (18 Hz – 28 Hz) frequency bands.

RESULTS: Alpha wave activity was higher at frontal, temporal, and occipital regions; beta wave activity was higher at frontal and temporal regions. Compared to the default mode resting state, during the fast motor imagery, alpha wave activity was higher at Fp2, F3, F8, C3, P3, and O2; and beta wave activity was higher at O1 and O2. During the slow imagery, only beta wave activity was higher at P3 and Pz. Slow imagery further activated the left areas of the brain (frontal, temporal, and parietal), while fast imagery further activated the fronto-central and posterior sections. In addition, alpha/beta ratios showed higher activity in the rest state than in slow (Pz) and fast (O1) states.

CONCLUSION: The present study adds to the current literature in the following ways: generally, more activation of brain regions was found in the fast-motion imagery than in slow-motion imagery. Slow imagery was associated with increased beta activity; while, fast-speed imagery was associated with increased alpha activity compared to the rest state. As well,

the representation of EEG activity during slow-motion imagery was consistent with previous findings about more attention during motor learning. In addition, the activity of the alpha band was very widespread in fast-motion imagery at the prefrontal, frontal, central, parietal, and also occipital regions of both sides of the cortex. In contrast, beta-band activity was more in the posterior regions of the brain.

INTERPERSONAL SYNCHRONIZATION BETWEEN SPRINTERS: AN OBSERVATIONAL STUDY OF THE JAPANESE 100-M RECORD RACE

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INTRODUCTION: Athletes' performances are determined not only by individual ability but also by environmental states, especially the behavior of competitors. Previous studies suggest that spontaneous interpersonal synchronization occurs when individuals can see and hear each other's action. One study reported interpersonal synchronization between Usain Bolt and Tyson Gay in the 100-m race in which Bolt broke the world record and Gay broke the U.S. record (Varlet & Richardson, 2015). This report suggests that interpersonal synchronization may, in some cases, enhance an athlete's performance. In this study, we report a new case of the potential positive effect of interpersonal synchronization on athletes' performances.

METHODS: In the men's 100-m final at the Fuse Sprint (Tottori, 2021) in Japan, the first-place sprinter broke the Japanese 100-m record, and the second-place sprinter set his new personal record. These two sprinters ran side-by-side throughout the race. We analyzed the video of this race using deep learning-based estimation of human joint coordinates (OpenPose) (Cao et al., 2021). First, we obtained time series data of ankle joint coordinates for each sprinter. Then, to examine the degree of synchronization between two sprinters, the relative phase between their steps was then calculated using the negative peaks of the time series data. We also analyzed the video data of preliminaries in which the sprinters ran in different races to determine the chance level of synchronization.

RESULTS: Our results showed that the difference in cadence between the two sprinters was smaller and the relative phase between the two sprinters was more synchronized (inphase) in the final race compared to the chance level of synchronization determined by the preliminary races.

CONCLUSION: These changes in cadence or relative phase could not be explained by the difference in running speed between the final and the preliminaries because the time difference between them was the same (0.06 seconds) in the final and the preliminaries. This result supports the hypothesis that spontaneous interpersonal synchronization can occur between the two sprinters running side by side. It is noteworthy that both the world and Japanese 100-m records were set in races in which the first- and second-place sprinters synchronized their running movements. Our study provides additional evidence to suggest that interpersonal synchronization can influence the cadence of sprinters and enhance their performance.

HOLD YOUR FIRE! EFFECTS OF MENTAL FATIGUE ON MOTIVATION, EXECUTIVE FUNCTION, EYE-MOVEMENTS, AND SIMULATED GUN-SHOOTING PERFORMANCE.

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INTRODUCTION: Mental fatigue (MF) is a psychobiological state characterised by feelings of tiredness and lack of energy and caused by prolonged and demanding cognitive activity. There is evidence that MF can affect physical performance through impaired cognitive control; however, most studies have focused on endurance and strength in sports. In this study, we used a psychomotor shooting task requiring attentional control and response inhibition and measured behavioural performance and concomitant visual behaviour as an index of visual attention. We also evaluated mental fatigue-induced changes to the capacity to inhibit selective information.

METHODS: Sixteen participants visited the lab on two different days. On the experimental day, they completed a 50-minute computer task requiring selective visuospatial inhibition (Flanker task) to induce mental fatigue. On the control day, they viewed a 50-minute documentary. Before and after the fatiguing protocol (or the documentary), we assessed self-report MF (VAS and Fatigue-Fatigability) and inhibition performance at two computer tasks (Stop-Signal and Simon tasks). After the fatiguing protocol (or the documentary), we measured self-control capacity (State Self Control Capacity Scale), self-report motivation as the willingness to engage in more of the computer tasks or more of the shooting task (bespoke questions), and psychomotor shooting performance as the number of civilians-casualties (on whom firing should have been inhibited) along with the visual behaviour through mobile eye tracking (EyeLink® II).

RESULTS: After the fatiguing protocol, self-control capacity was lower ($p=0.020$), fatigability was higher ($p=0.015$), motivation to engage in more of the computer task was lower ($p=0.029$), and the pre-to-post drop in energy level was more pronounced ($p=0.014$) compared to the control documentary. Despite these self-report differences, shooting performance, fixation, and saccade parameters did not differ between the fatiguing protocol and the documentary ($p>0.05$), nor did the pre-to-post changes in inhibition task performance ($p>0.05$).

CONCLUSION: Despite the participants feeling more fatigued after the fatiguing protocol as expected, their inhibition capability, shooting performance, and visual attention were not impaired compared to the control documentary condition. These null effects might be due to the participants' eagerness to engage in anything else (but especially in such an attractive task as simulated shooting) after performing nearly 1 hour of the same activity (Flanker task or documentary). It may

also be that the documentary induced boredom, and that prolonged engagement with it required participants to exercise self-control, which in turn could have produced mental fatigue. Finally, the participants may have exerted greater effort to compensate any detrimental effect of mental fatigue on cognitive and psychomotor performance. We encourage future research to test these interpretations.

TWO-DIMENSIONAL TRIAL-BY-TRIAL ERROR CORRECTION FOR ACCURACY IN HIGH-SPEED PITCHING TASK

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INTRODUCTION: Accurately and repeatedly controlling a ball to a target position in high-speed is one of the human specific motor skills. This can be observed as various sports-related skills, such as pitching, kicking, and batting. The arrival position of the ball can be approximately determined by its physical state at the release or impact. In high-speed baseball pitching, reducing the variability of the ball's release angle is known to be necessary to reduce the variability of arrival position. However, as there is always variability in human movements and it increases as the speed increases, how to decrease the variability is one issue. This study focused on one strategy; trial-by-trial error correction, which is to correct movements in the following trials facing an undesirable outcome. We developed a new method to clarify the error correction in two-dimension and performed on the intertrial changes of the elevation/azimuth release angle in skilled baseball pitchers.

METHODS: Two synchronized high-speed cameras (960 fps) were used to capture the 30 fast balls each for 14 college pitchers aiming a target at 18.44m away. 3D positions of the ball were obtained from the camera images digitized by an automatic image recognition based on deep learning (DeepLabCut). Speed was defined as the magnitude of velocity vector at the ball release. The release angle was given by the elevation and azimuth angle of velocity in polar coordinates. Two-dimensional (elevation/azimuth) release angles were divided into four states according to whether they are larger or smaller in each direction than the average value of each pitcher, and the transition probability from each state to state was calculated. The transition probabilities were summed according to the direction of the transition as the frequency of error correction, and whether each of them was greater or less than the chance level was tested. In addition, the correlation between each of probabilities and the variability of release angle was investigated.

RESULTS: Bootstrap test using surrogate data showed that the transition probability of elevation direction was larger than the chance level with a significant tendency, while that of any other direction was not. In addition, the grater the transition probability to the same state, the grater the variability of azimuth release angle (and the ratio of variability of azimuth release angle to elevation release angle).

CONCLUSION: The skilled baseball pitchers tended to correct elevation error most frequently. In addition, the pitchers who made no error correction frequently had more variability of azimuth release angle (and the ratio of variability of azimuth release angle to elevation release angle). These findings suggest that trial-by-trial error correction can be one strategy to decrease the variability in high-speed motor tasks. Furthermore, the result that it can influence on the shape of the two-dimensional variability indicates the importance of analyzing error correction in two-dimension.

MODULATING AROUSAL VIA PUPIL-BASED NEUROFEEDBACK: A POTENTIAL MENTAL TRAINING APPLICATION IN SPORTS?

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INTRODUCTION: A growing body of evidence suggests that intermediate arousal levels are essential for optimal performance. Self-regulation of the brain's arousal state can be particularly challenging in high pressure competition settings. The locus coeruleus (LC) is the principal source of noradrenaline in the brain and is one of the key regulators of the brain's arousal level. Additionally, it modulates autonomic arousal, marked by heart rate variability (HRV) changes, via projections to the brainstem and spinal cord. Interestingly, there is ample evidence for a link between LC activity and non-luminance dependent pupil size changes. Building on this evidence, we investigated whether changes in pupil size (i) can be volitionally induced via pupil-based neurofeedback (pupil-NF) training and are linked to changes in (ii) autonomic nervous system functioning as indexed by HRV.

METHODS: In experiment I, 54 healthy volunteers (19-47 years) received 3 days of pupil-NF training to learn to volitionally up- and downregulate pupil size. 28 control participants (19-40 years) received the same amount of training and instructions on mental strategies but no veridical pupil-NF. To explore the link between pupil size changes and cardiovascular function, 25 pupil-NF participants underwent follow-up sessions combining pupil-NF with pulse oximetry to measure heart rate and HRV. In a replication experiment, 23 participants (21-41 years) completed a slightly adapted pupil-NF training with simultaneous electrocardiography (ECG) recordings.

RESULTS: Participants of the pupil-NF group were able to successfully self-regulate their pupil size (pupil modulation index after the final day of training $M = 0.34 \pm 0.28$). Such self-regulation was significantly reduced in control participants (pupil modulation index $M = 0.09 \pm 0.12$; main effect of group: $F(1,21.58) = 21.49$; $p = .001$). Pulse oximetry and ECG analyses revealed that pupil self-regulation was linked to changes in cardiovascular measures: we found higher heart rate during blocks of volitional pupil size up- than downregulation in the main experiment ($Mup = 76.92 \pm 7.67$; $Mdown = 70.18 \pm 8.03$; $t(23) = 6.644$; $p < .001$) and replication experiment ($Mup = 76.44 \pm 9.82$; $Mdown = 73.28 \pm 9.71$; $t(21) = 3.97$; $p < .001$). In contrast, we observed a trend towards higher HRV during pupil size down- than upregulation in the main exper-

iment (Mdown = 54.58 ± 35.51; Mup = 47.78 ± 28.29; Z = 1.91, p = .056) and a significantly higher HRV during down- than upregulation in the replication experiment (Mdown = 64.91 ± 71.18; Mup = 54.24 ± 63.84; Z = 2.97, p = .003).

CONCLUSION: This proof of concept study provides evidence that pupil-NF makes the brain's arousal system accessible to volitional control. This finding has tremendous potential for translation to pupil-NF-guided mental training applications in the sports domain, by enabling athletes to volitionally control their arousal state in situations of high performance and recovery.

PRELIMINARY FINDINGS OF HIGH-DENSITY EEG SOURCE IMAGING DURING INCREMENTAL CYCLING TASK

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INTRODUCTION: Understanding brain dynamics under natural conditions remains a challenge due to the technical limitations of brain imaging techniques. Advanced processing procedures for artifact removal enabled high-density mobile electroencephalography (EEG) to be used in dynamic settings. Previous EEG studies on cycling showed that primary motor cortex activity increases with the duration and intensity of cycling [1,2]. In contrast, when Fontes et al. [3] compared low to high intensity cycling they observed that the activation of the motor cortex remained similar throughout the duration while activation of the prefrontal cortex decreased in both intensities. In addition, the cerebellum was activated at lower intensities. The aim of this study was to replicate the design used by Fontes et al. [3] while using high-density source imaging.

METHODS: 14 subjects aged 19 to 35 years performed incremental exercise on a cycling ergometer. After a 5-minute warm-up cycling all participants started to cycle at 50 watts, which was increased in 25-watt increments. Each intensity block consisted of cycling four times with a 30-second rest. Participants cycled until they reached a score of 17 on a Borg scale of 6-20. Low and high intensities were pooled from 50 to 100 and 125 to 200 watt, respectively. Before, during, and after cycling a 64-channel EEG (Brain Products, GmbH) was used to record electrocortical activity. Data were preprocessed with EEGLAB (Delorme and Makeig, 2004) and imported into Cartool 3.8 (Brunet et al. 2011) to localize sources within the cortex.

RESULTS: All subjects successfully completed cycling tasks with 271 ± 65 W of maximal cycling intensity (Borg scale = 17). Preliminary results show consistent activation of the cerebellum and motor cortex at both low and high intensity of cycling

CONCLUSION: Although EEG seems promising for source localization in such a design, several more subjects may need to be analysed and presented to draw generalizable conclusions. A direct comparison with Fontes et al. [3] revealed that our subjects reached higher maximal intensities and similar brain areas were involved. Finally, discussion about the most optimal EEG cleaning procedures for source imaging will be provided.

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Conventional Print Poster

CP-AP12 Health and fitness

THE EFFECT OF BODY COMPOSITION ON SHORT AND LONG SPRINTS, AND ENDURANCE RUNNING PERFORMANCE IN MALE AND FEMALE STUDENTS

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INTRODUCTION: Intersex differences in performance are the result of lifelong interactions between genetic inheritance and environmental factors (e.g. balanced nutrition, prevention against infectious diseases, level of physical activity...). Thus, during the 20th century, the improvement of living conditions for most humans has led to anthropometric changes (i.e. mainly an increase in height and weight) in both sexes. However, technology and its consequences on the mechanization of our lifestyles (e.g. travel, mechanical handling, etc.) has drastically decreased our level of daily physical activity, which in turn has lowered the physical performance of adolescents and has led to the development of noncommunicable diseases in older adults (cf. "epidemiological transition")

METHODS: 72 male and 64 female students aged 20 to 23 years participated in this study.

After assessing their morphological characteristics (body mass, percentage of fat mass), running performances during 30 m and 400 m, and maximum aerobic velocity (MAV) and maximal oxygen consumption (VO2max) during a 20 m shuttle running test have been estimated for each subject.

Male students were re-tested after being overweighed down with a weight equivalent to the mean differences in body fat recorded between the two sexes in the form of a loaded worn vest.

RESULTS: Male are 15,7% heavier and 7,4% taller ($p < 0.001$) and presented a percentage of fat mass (17.2 ±2%) significantly ($p < 0.001$) lower than that of women subject (25.0 ±2.5%) (difference male vs female for body fat mass: 45.34%).

Running performances during 30 m and 400 m, MAV and VO2max were significantly ($p < 0.001$) better in males (4.81 ± 0.11 sec, 61.97 ± 2.63 sec, 12.53 ± 0.54 km/h and 49.67 ± 3.3 ml/min/kg, respectively) than in females (5.58 ± 0.31 sec, 87.95 ± 8.93 sec, 10.38 ± 0.57 km/h and 37.22 ± 3.31 ml/min/kg, respectively)

In the weighted condition, male performances during 30 m and 400 m, MAV and VO2max were attenuated by 6.89%, 14.16%, 6.48% and 10.07%, respectively) but remain significantly better than those of female students.

Cancelling the intersex difference in body fat mass by overweighting male subjects reduced by to 57.14%, 66.22%, 62.21% and 59.84% the intersex difference for performances during 30 m and 400 m, MAV and VO2max, respectively.

CONCLUSION: Speed performance over 30 and 400 m (i.e. short and long sprints, respectively) and SRT are significantly better in male subjects compared to female one. Relative differences represented -16,1%, -41,92%, -17.15% and -25.08% of the male performances for 30 m, 400 m, MAV and VO2max, respectively.

The persistence of intersex differences after overweighting male subjects indicates that other factors than body fat mass could be responsible for only 9.2%, 27.8%, 10.67% and 15.01% of observed intersex differences for 30 m, 400 m, MAV and VO2max performances, respectively.

BREAKING DOWN THE CROSSFIT GAMES: A 10-YEAR ANALYSIS OF THE COMPETITION AND TOP ATHLETES. ARE THEY THE FITTEST ON EARTH?

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INTRODUCTION: This study aimed find exercise type and distribution patterns within the CrossFit Games, a seemingly random competition, where participants are challenged through a wide range of functional movements that involve lifting large loads and covering long distances as fast as possible with the goal of finding "the fittest man and woman on Earth"®

METHODS: Information was gathered from a publicly accessible website (www.games.crossfit.com/games). Data analysed includes The CrossFit Games workouts from 2011 until 2021. Every WOD was broken down by gender and target, which included rounds for time (RFT), for time (FT), repetition maximum (RM) and as many reps/rounds as possible (AMRAP). Exercises were classified into 3 main groups Metcon, Gymnastics and Weightlifting. Additionally, the Weightlifting category was subdivided as follows: Olympic Weightlifting (OW), Barbell Weightlifting (BW) and Object Weightlifting (OBW).

RESULTS: 150 WODs were analysed, which included 68 different exercises and 94 exercise variations. 57% of the exercises fell into the Weightlifting category, from which 44% corresponded to OBW, 7% to OW and 6% to BW. 26% of the exercises were classified as Gymnastics and the remaining 16% fell into the Metcon category. Each year averaged 13.6 ± 2.4 events per year. Each day of competition averaged 3.3 ± 0.9 WODs, with no differences between competition days (day 1, 2, 3 or 4; $p=0.546$). Within WOD exercise number averaged 2.5 ± 1.5 exercises per WOD, ranging from 1 to 7 exercises. When rounds were included into the workout, they averaged 4.5 ± 2.2 rounds per event. Among event goals, FT and RFT represented 85% of the total, whereas RM and AMRAPs were 9% and 3%, respectively. We found no differences between the load lifted throughout the years ($p=0.530$). We found no differences between the exercise classification and day of competition among years ($p=0.317$), nor between exercise classifications and days of competitions. 79% of the WODS lasted less than 20 min, 16% lasted more than 30 min and barely 5% lasted between 20 and 30 min. On day 1, there seemed to be an even distribution among shorter (<11' and ≥11'-≤20') and longer (<20'-≤ 30' and >30') WODs. On day 4, 90% of the WODs lasted less than 20 min (70% last less than 11 min) and only 3% of them lasted more than 30 min.

CONCLUSION: Despite CrossFit®s self-implemented philosophy of randomness, according to our analysis, athletes at the CrossFit Games can expect a reduction in the number of longer events (>30') and an increase in the number of shorter ones (<11') as competition days pass and expect heavy events on day 3 of competition. Athletes should also expect Metcon type WODs to be the most frequent, being running, muscle-ups, rowing, snatch, and pull-ups the most frequent exercises. This highlights the combination of endurance, strength and skill that athletes need to display in this competition

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HEART RATE-BASED ESTIMATES OF METABOLIC INTENSITY OF AEROBIC EXERCISE IN POST-MENOPAUSAL WOMEN: APPLICATION AND PERFORMANCE.

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UNIVERSITY OF GHENT

INTRODUCTION: Regular aerobic exercise maintains fitness and counters the detrimental effects of ageing on health and function, in an intensity-dependent manner. Accurately monitoring exercises metabolic intensity (MET) is crucial to reach these goals. However, its implementation is constrained by expensive equipment and trained staff. Heart rate (HR) is a simple, low-cost alternative for MET estimation but its accurate implementation still requires a preliminary lab test. To overcome this limitation, HR equivalents (absolute HR, HRnet, HRindex) may be used, yet the validity of these indexes of

MET in specific populations is unclear. This investigation aims to verify the existing relationships between HR equivalents and MET and test their performance at different intensities in postmenopausal women.

METHODS: 14 postmenopausal women (59±6 years, menopause: 4±3 years, VO2max 34±9 ml/min/kg-1) performed a cycling ramp incremental test aimed at verifying the relationships between MET and absolute HR, HRnet and HRindex. Then, both general and population-specific equations were tested in a second group of 10 postmenopausal women (54±3 years, menopause: 3±2 years, VO2max 35±5 ml/min/kg-1) who performed six constant work exercises of 10 min between 40% and 90% of the VO2max. Breath-by-breath pulmonary gas exchange and HR were continuously measured using a metabolic cart. General and population-specific equations for post-menopausal women were compared on the agreement between the coefficients. Estimated and measured MET were compared using correlations, Bland-Altman analysis and two-way RM ANOVA.

RESULTS: Strong linear relationships were found between absolute HR (r = 0.90), HR net (r = 0.93), HR index (r = 0.92) and MET. The ones of absolute HR and HRnet were found to differ from the general relationships, while the relationship of HRindex did not differ. When population-specific equations were applied to estimate MET, measured and estimated MET were medium to highly correlated and showed acceptable precision and non-significant biases (absolute HR r=0.74, imp=21.6%, z=0.25; HRnet r=0.88, imp=14.7%, z=0.12; HRindex r=0.89 imp=14.0%, z=-0.48), with better performance displayed by both HRnet and HRindex compared to absolute HR. Statistical differences between measured and estimated MET was found only at 80% VO2max for absolute HR at 90% VO2max for HR. General HR equations displayed similar correlations coefficients with MET than population-specific equations, but also larger biases and imprecision (absolute HR r=0.75, imp=23.3%, z=-0.89; HRnet r=0.89 imp=15.4%, z=-1.50; HRindex r=0.89, imp=14.9%, z=-1.25) and statistical differences were detected at all the trial intensities investigated.

CONCLUSION: Our results support the need for, and provide, population-specific equations to estimate MET in postmenopausal women using HR. HRnet and HRindex show superior performance than absolute HR in estimating MET. Between the general equations of HR, HRindex shows a slightly superior performance.

THE INFLUENCE OF AGE ON PHYSICAL FITNESS, OCCUPATIONAL PERFORMANCE AND EXERCISE HABITS (PHYSICAL ACTIVITY) IN PORTUGUESE ELITE MALE POLICE OFFICERS

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INTRODUCTION: Physical fitness and occupational performance are crucial requirements for police officers, especially those in elite units [1,2,3,5]. As such, physical activity and exercise habits are critical factors in maintaining fitness levels. However, the impact of age on these factors in Portuguese elite male police officers is not fully understood. This study aims to investigate the influence of age on physical fitness, occupational performance, and exercise habits in this population.

METHODS: Forty-two trained male elite police officers in Portugal completed a timed occupational-specific circuit, the On-Duty Task (ODT) [4], and a physical fitness assessment, which included shuttle runs, agility T-test, sit-ups, handgrip strength, horizontal and vertical throwing of a 3kg medicine ball, flexibility, and pull-ups. Additionally, the level of physical exercise was assessed using the International Physical Activity Questionnaire (IPAQ), and the importance of characteristics necessary to carry out occupational tasks, simulated through the simplified Borg scale, was also recorded. Elite police officers (CI) were stratified into cut-offs, younger (≤ 38 years; n = 20) and older (≥ 39 years; n = 22) based on the sample mean age. Independent-sample t-test was used to analyze differences in outcome measures between the cutoff values of younger and older officers.

RESULTS: Older elite police officers took 19.5% longer to complete the ODT circuit compared to younger officers (younger: 210.0 s ± 26.7 vs. 251.6 ± 38.8 s; p = 0.001). Both groups reported similar frequencies of vigorous physical activity and showed comparable cardiovascular levels (younger: 50.78 ± 7.18 ml.kg-1.min-1 vs. older: 44.80 ± 6.92 ml.kg-1.min-1, p = 0.065) and handgrip strength (HGS) levels (younger: 54.74 ± 4.70 kg vs. 52.66 ± 10.67 kg; p = 0.391). However, significant differences were found between the two age groups indicating that the younger officers had superior agility (10.83 ± 0.89 vs. 11.67 ± 0.98 s; p = 0.04), abdominal strength (number of repetitions, 52.65 ± 4.86 vs. 43.5 ± 7.34; p = 0.01), arm strength (number of pull-ups, 15.3 ± 5.03 vs. 10.5 ± 3.87; p = 0.001), and arm power (throwing a 3kg medicine ball, 6.29 ± 0.78 m vs. 5.46 ± 0.94 m; p = 0.002). The police officers had some similar aptitude characteristics, but in terms of power and agility, these negatively influenced occupational performance.

CONCLUSION: The study results suggest that age-related declines in physical fitness and occupational performance occur in Portuguese elite male police officers, despite their similar levels of physical activity and training. Law enforcement professionals need to be aware of the potential negative impact of aging on physical performance and adjust training programs accordingly. Further research in this area is necessary to develop effective strategies to mitigate these age-related declines.

1. Marins et al. (2021); 2. Araújo et al. (2020); 3. Lockie et al (2019); 4. Teixeira et al. (2019); 5. McGill et al. (2013)

PHYSIOLOGICAL CHARACTERISTICS OF THREE LEVELS OF MALE JUDO ATHLETES

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INTRODUCTION: Judo is a combat sport that relies on anaerobic abilities such as strength, power and anaerobic capacity, in addition to grip strength and specific judo technique. The aim of this cross-sectional study was to evaluate the physiological profile of judo athletes from various levels and to identify physiological determinants for judo success.

METHODS: 38 athletes of the men's national judo team, from 3 levels, various weight classes and ages (cadets + Juniors [CJ]: n=14, age=17.04±1.4; Non-Olympic seniors [NOS]: n=20, age=21.6±1.9; Olympic seniors [Oly]: n=4, age=28.6±2.7) were tested for various anaerobic physiological qualities.

The selected tests were: countermovement jump (CMJ), drop jump from a 40 cm box (DJ), maximal grip strength (Grip) and upper body Wingate anaerobic test with a resistance of 6% of bodyweight (WIN). In addition, 5 RM strength measures of 3 exercises (squat, hang power clean and bent-over row) were gathered from the athletes' ongoing strength program.

All measures were normalized for body mass or competition weight class. The dependent variables were world judo ranking and an internal quality ranking based on success in national vs. international competitions.

For CJ, a coach estimated their level (high vs. low level) based on success in national competitions alone since these young athletes were yet to compete at international level. A comparison was also made between the three age categories.

RESULTS: While some significant differences were found between groups (CMJ peak power, grip strength, WIN peak power [PP], WIN mean power [MP] and strength levels), most between-group differences disappeared when normalized. The only remaining significant differences were WIN test relative PP (p=0.022) and relative MP (p=0.001). Post hoc analysis revealed a significant difference in relative WIN PP between CJ and NOS (p=0.027) but not between NOS and OLY, and in relative WIN MP between CJ and NOS (p=0.001) and CJ and OLY (p=0.039), but not between NOS and OLY. No differences were found in any of the variables between success levels in CJ. Since OLY contained only 4 athletes, this comparison was made for all seniors (NOS + OLY), with no differences found between national and international level senior athletes.

CONCLUSION: It was not possible to differentiate high vs. low level athletes in our cohort. When comparing the three groups, only WIN relative PP and relative MP were significantly different between groups while other measures lost significance when normalized. This strengthens the notion that anaerobic power and capacity are relevant to judo. Success in Judo is multifaceted. Future studies should further explore relevant judo physiological tests, including aerobic capacity, with a greater sample of elite athletes, while considering non-physiological factors (e.g. psychological and technical) as significant determinants of success.

EFFECT OF FITNESS ON TIME COURSE OF RECOVERY FOLLOWING ACUTE STRENGTH AND AEROBIC CONDITIONING TRAINING

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INTRODUCTION: Contemporary athletes are dealing with highly congested training and competition schedules. Therefore, their ability to recovers as fast as possible is a crucial component for performance enhancement and maintenance. Multiple factors have been proposed to modulate the time-course of recovery following a single training session with fitness being an important one. Currently, the majority of athletes are required to develop multiple physical capacities in order to compete at high level. In this instance, to successfully evaluate fitness, we may need the creation of a of a metric incorporating multiple physical performance qualities. The primary aim of this study was to examine the impact of fitness described by a total fitness score (TFS), which was defined as the average score of maximal aerobic capacity, handgrip strength score and 10 repetition maximum score, on the time-course of recovery following acute bouts of resistance (STR) and high-intensity interval training (HIIT) training.

METHODS: Twenty-eight resistance-trained males and females participated in a randomised cross-over designed intervention to examine the time course of recovery following acute STR and HIIT sessions, where on separate occasions participants undertook either a STR or HIIT session divided into 8 testing sessions across 14-17 days. The isometric mid-thigh pull (IMPT), countermovement jump (CMJ) and modified Wingate test (WINmod) were performed at baseline, immediately post-exercise, as well as at 6- and 24-hours post-exercise. Total work was calculated by multiplying the force applied by the distance over which the force was applied.

RESULTS: Following a resistance training session, it was reported that jump height was significantly supressed for up to 24 hours compared to baseline (p=0.0012). However, when participants were grouped based on their TFS there was a main effect of group (F2,15=5.27, p=0.02). Specifically, it was found that people possessing a higher fitness score were had a lower decrease in jump height immediately post-exercise compared to both medium (p=0.018, g=-0.67 [-1.62,0.28]) and low group (=0.011, g=-0.64 [-1.56, 0.28]). Additionally, people in the high TFS group had a significantly higher jump height compared to people in the low group 6-hours post-exercise (p=0.018, g=0.85 [-0.09, 1.80] and they slightly surpassed their baseline performance, but it was not statistically significant (g=0.10 [-0.82, 1.03]).

CONCLUSION: Based upon the current findings, it seems that higher fitness levels, as described by the current composite score used may prevent acute fatigue following a resistance training session. Additionally, it may speculated that people with higher fitness scores may be able to potentiate their explosive strength within the first 6-hours following a resistance

training session, as depicted in changes in jump height, further supporting the hypothesis that fitness may be an important regulator of time-course of recovery but more research is warranted.

Conventional Print Poster

CP-MH04 Cardiovascular diseases I

COMBINED EFFECTS OF ACUTE AEROBIC EXERCISE BEFORE OR AFTER STRETCHING ON ARTERIAL STIFFNESS

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INTRODUCTION: Increased arterial stiffness enhances cardiovascular disease risks. Aerobic exercise or stretching generally decreases arterial stiffness, but resistance exercise does not. Arterial stiffness changes are also affected by the exercise order in combined exercise. For instance, aerobic exercise after resistance exercise improves arterial stiffness, but resistance exercise after aerobic exercise didn't. Although both aerobic exercise and stretching improve arterial stiffness, the exercise orders and combined effects on arterial stiffness are still unclear. Thus, this study aimed to investigate the combined effect of aerobic exercise before and after stretching on arterial stiffness.

METHODS: Fourteen healthy young males (21 ± 1 years) participated in five trials in random order on different days; 1) seated resting trial (REST); 2) aerobic exercise-stretching trial (AERO-ST); and 3) stretching-aerobic exercise trial (ST-AERO); 4) aerobic exercise trial (AERO); 5) stretching trail (ST). A cycling ergometer exercise of 20 min at the intensity of 120 beats/min of heart rate levels was performed as an aerobic exercise, and four types of stretches of 20 min focusing on the lower limbs were performed. Before (Pre) and immediately (Post) after trials, cardiac ankle vascular index (CAVI) and carotid-femoral pulse wave velocity (cfPWV) were measured to evaluate arterial stiffness.

RESULTS: CAVI and cfPWV were not significantly different in the comparison of Pre in each trial. Pre and Post1 of CAVI values were compared for each trial; REST and ST showed no significant differences, whereas AERO-ST, ST-AERO, and AERO showed significant reductions (AERO-ST, Pre, 6.2 ± 0.5; Post1, 5.5 ± 0.6 %, ST-AERO, Pre, 6.1 ± 0.5; Post1, 5.6 ± 0.6 %, AERO, Pre, 6.3 ± 0.5; Post1, 5.6 ± 0.4 %, both $P<0.01$). However, the reductions in these trials were comparable. The cfPWV results showed a significant decrease in AERO-ST, ST-AERO, and AERO from Pre to Post1 change and no difference among these trials as well as CAVI results. (AERO-ST, Pre, 5.9 ± 0.3; Post1, 5.7 ± 0.3 %, ST-AERO, Pre, 6.0 ± 0.5; Post1, 5.7 ± 0.3 %, AERO, Pre, 6.0 ± 0.4; Post1, 5.8 ± 0.3 %, both $P<0.01$).

CONCLUSION: Our findings indicate that both single aerobic exercise and combined aerobic exercise before or after stretching would acutely reduce arterial stiffness. However, exercise order and combined effects of aerobic exercise and stretching would not differ among degrees of arterial stiffness reduction.

SCREENING YOUNG ATHLETES – CAN WE IGNORE THAT A NEGATIVE STANDALONE HISTORY & PHYSICAL EXAMINATION COULD SKIP HIGH RISK CARDIAC CONDITIONS ?

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INTRODUCTION: Pre-Participation (PPE) cardiovascular (CV) screening in young athletes is the cornerstone of any evaluation for detecting high-risk CV (hrCV) conditions responsible for sudden cardiac death (SCD) linked with exercise.(2,5) Sometimes, the PPE-CV protocols rely on the standalone History&Physical (H&P),such as the 14-Element AHA Recommendation.(4) Less apparent hrCV conditions may not be readily evident by standalone H&P (1); the association with resting electrocardiography (ECG) and echocardiography (ECHO) is mandatory for the correct diagnosis.

Retrospective study of PPE-CV athletes:To compare the standalone H&P (14-Element) with ECG and ECHO results, recorded for each athlete, according to the protocol. To evaluate the incidence of false positive (positive: >/equal 1 of the 14-Elements) (4) and false negative H&P vs ECG/ECHO data.

METHODS: Retrospective 6-year (2016-2021) study of 385 highly trained athletes (ath)-football .

Study Group:211 ath (100% males;17-37 yo); 178 (84.4%) caucasians, 33 (15.6%) afroamericans. All underwent PPE before competitions. Standard PPE included H&P, ECG (3) and ECHO (5).

RESULTS: Height 174+/-2 cm; Weight 78+/-1 kg; BSA 1.94 m2;BP 125+/-5 mmHg.

211 ath: 191 (90.52%),normal H&P and ECG; 4(1.89%) positive H&P; 16(7.6%) normal H&P and borderline ECG (in time,1 Brugada type I, 3 WPW). ECHO:200(94.7%) normal with normal H&P and 11 (5.3%) abnormal with 4 positive H&P: 2 hypertrophic cardiomyopathy, 2 right ventricular dilation, 1 abnormal origin of coronary artery, 1 dilated cardiomyopathy, 3 stenotic bicuspid aortic valve, 2 mitral prolapse. Coronarography, cardiac MRI indicated accordingly.

CONCLUSION: In most cases, standalone H&P correlated with ECG and ECHO , but failed to identify hrCV entities responsable for SCD in 11(5.31%; 1 Brugada, 3 WPW, 7 abnormal ECHO). No false positive H&P. Asymptomatic rare cardiac conditions are sometimes overlooked by standalone H&P.

Conclusions. PPE-CV screening for identifying hrCV conditions shall include ECG/ECHO.

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THE ROLE OF PHYSICAL ACTIVITY PROGRAM IN ANTIHYPERTENSIVE DRUG CONSUMPTION: A RANDOMIZED CONTROL TRIAL

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INTRODUCTION: Physical activity (PA) improves hypertension control and may reduce the consumption of antihypertensive drugs. However, the effect of exercise training on systolic blood pressure remains under- studied especially among hypertensive populations in relationship to commonly used antihypertensive drugs. Aim of the study was to evaluate the effect of a 24 months supervised program of PA on drug load in hypertensive subjects without previous major cardiovascular diseases (CVDs).

METHODS: A randomized controlled, parallel-group, observer-blinded clinical trial has been designed. Hypertensive subjects at risk of CVDs taking at least one drug were enrolled. A total of 180 participants were randomized and 111 participants completed the 24-month assessment. Participants were randomly allocated to an intervention group (EG) (n=90) that underwent to a 24-month supervised program of physical activity or to a control group (CG) (n=90). The EG underwent a PA program of increasing intensity, duration and frequency 3 times/week. The CG followed a program of postural PA. Outcome measures were evaluated at 0, 6, 12, 18 and 24 months. The drug load in each participant was calculated by summing the ratios between the prescribed daily dose (PDD) and the defined daily dose (DDD) for all antihypertensive drugs taken by the participants.

RESULTS: At baseline, the two groups were homogeneous in terms of age, diastolic and systolic pressure, and PDD/DDD. At 24-month assessment, Repeated Measures Analysis of Variance (RM-ANOVA) showed significant differences between the two groups in PDD/DDD ($p < 0.05$).

CONCLUSION: We demonstrated that a PA program supervised by personal trainers reduces drug consumption in elderly with hypertension with or without previous CVD.

HEAT THERMOTHERAPY TO IMPROVE CARDIOVASCULAR FUNCTION: A SYSTEMATIC REVIEW AND META-ANALYSIS

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INTRODUCTION: Heat thermotherapy (HT) is a passive heating intervention that is associated with reduced cardiovascular disease (CVD) risk and improved cardiovascular (CV) function. Despite several mechanistic reviews, longitudinal and experimental studies, it is unclear whether HT consistently improves CV function. This systematic review and meta-analysis aimed to determine the efficacy of HT to improve CV function.

METHODS: In a registered systematic review (CRD42020193669), databases (Embase, Medline and Web of Science) were searched up to March 2022 for HT studies investigating CVD-related outcomes, including systolic (SBP), diastolic (DBP) and mean arterial (MAP) blood pressure, flow-mediated dilation (FMD), peripheral artery shear rate (SR) and arterial stiffness. Study inclusion criteria was adults aged >18yrs, a passive heating stimulus with no exercise involved and a control group comparison. Of 3074 papers screened, 41 papers were included in the meta-analysis. Studies were separated into two categories, acute (1 heating bout) and chronic perturbation (>1 heating bout), permitting examination of physiological changes immediately after a single HT bout vs possible functional and structural CV changes after multiple HT bouts. Effect estimates were calculated using generic inverse variance and random effect models with pooled effects presented with 95% confidence intervals. Estimated significance (α>0.05) and heterogeneity (I^2) were examined. Pre-planned subgroup analyses compared the effects of modality (sauna, water-perfused suit, hot water immersion), health status (healthy, unhealthy) and time (session duration × bouts).

RESULTS: Compared with control conditions, HT reduced DBP (acute: n=20, -2.2 mm Hg [-4.0, -0.5], I^2= 75%; chronic: n=7, -4.8 mm Hg [-7.2, -2.4], I^2= 33%), MAP (acute: n=16, -4.9 mm Hg [-7.5, -2.3], I^2= 53%), FMD (acute: n=12, 0.3 g [0.1, 0.6], I^2=0%) and SR (acute, n=14, 3.7 g [2.3, 5.2], I^2=0%; all p<.05). There was no difference in arterial stiffness (p>.53; I^2=0%). Subgroup analysis indicated an acute heating modality effect for FMD (p=0.01; I^2=22%) and DBP (p<0.01; I^2=96%), such that DBP was reduced to a greater extent by sauna, followed by hot water immersion (-6.9 mm Hg [-15.9, 2.1] vs -4.3 mm

Hg [-9.2, 0.5]). There were insufficient studies to conduct subgroup analyses on the chronic effect of heating modality. Subgroup analysis for participant health status or time showed no acute or chronic HT effects for CV outcomes (all p>.05). Risk of bias assessment indicated that 35/41 papers had some concerns, and 6/41 papers have a high risk of bias.

CONCLUSION: This meta-analysis indicates that HT provides clinically meaningful improvements in CV outcomes both acutely and chronically. Such CV improvements appeared unaffected by an individual's health status or HT intervention duration. Acutely, sauna may be the most effective HT modality to elicit CV changes. These data support evidence for HT as a method to improve CV health.

ACUTE RESPONSES AND CHRONIC ADAPTATIONS ON CARDIOVASCULAR AND NEUROMUSCULAR OUTCOMES OF ENDURANCE AND RESISTANCE EXERCISE WITH BLOOD FLOW RESTRICTION IN PEOPLE WITH HYPERTENSION: A SYSTEMATIC REVIEW.

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INTRODUCTION: Regular phsical exercise is an effective strategy for reducing blood pressure (BP) with similar efficacy to medication. Recently, exercise with blood flow restriction (BFR) has emerged as a potential therapeutic tool for individuals with hypertension (HT) [1]. However, is needed to establish the FITT-VP (frequency, intensity, type, time, volume, progression) parameters that lead to a balance between minimizing risks and maximizing gains, such as improvements in cardiovascular (CV) and neuromuscular (NM) health. This review aimed to synthesize the available scientific evidence concerning the cardiovascular and neuromuscular responses and adaptations from endurance (EE), resistance (RE), and combined exercise with BFR in individuals with HT. The secondary objective was to describe the technical aspects of BFR and FITT-VP parameters that may impact the outcomes observed.

METHODS: A systematic search using terms as exercise type, BFR, and HT in PubMed, Web of Sciences, SPORTDiscus, Scopus, CINAHL, and MEDLINE databases was completed in June-2022 according to PRISMA statement. We selected quasi-experimental, randomised, and non-randomised control trials, that assessed the acute or chronic effects on CV and NM outcomes. The protocol was registered at PROSPERO (ID: CRD42022338515)

RESULTS: In total, 536 articles were identified, of which 11 studies (134 participants) were included. Specifically, 8 articles evaluated the acute CV effects of BFR, with 6 studies involving BFR applied to RE (20-80% 1-RM), and 2 studies incorporating BFR with EE (30-40% of VO2max). BFR interventions showed not statistically significant differences in the increments of heart rate and BP during exercise and returned to pre-exercise values in the post-exercise phase (i.e., after 60 min), compared to non-BFR interventions.

Regarding chronic effects of BFR applied to RE, 3 studies showed significant reductions in systolic blood pressure (SBP) (~12 mmHg) when utilizing BFR with low-intensity RE. However, no studies investigating adaptations from BFR with EE, or the response/adaptation of NM outcomes were found. Information regarding the progression parameter was not available.

Occlusion pressure was established based on either arterial occlusion pressure (AOP) (40-100%), or SBP (70-130%). Studies lacked sufficient information respect to the measurement position of AOP or cuff characteristics.

CONCLUSION: Our findings indicate that short-term exercise with BFR appears to be safe and may confer potential long-term benefits for individuals with HT. Nevertheless, to ensure accurate and reproducible results, detailed descriptions of the FITT-VP parameters and the methodology of BFR application, should be provided.

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A CONSUMER WEARABLE ACTIVITY TRACKER-BASED BEHAVIOUR CHANGE INTERVENTION IMPROVES SEDENTARY BEHAVIOUR AND CARDIOVASCULAR HEALTH IN SEDENTARY ADULTS: A RANDOMISED CONTROLLED TRIAL

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INTRODUCTION: To investigate the effectiveness of consumer wearable activity trackers (CWATs) as self-monitoring tool (CWAT-only) and as part of a multiple behaviour change technique (self-monitoring + motivational counselling) to reduce sedentary behaviour and improve cardiovascular health in sedentary adults.

METHODS: In a three-armed randomised controlled trial, 59 (male/female: 21/38) sedentary adults (sitting time of ≥ 9h/day; age: 53.3 ± 8.7 years; BMI: 26.0 ± 4.1 kg/m2) were randomly allocated to a control group, a CWAT-only group or the CWAT+ group (CWAT + motivational interviewing) for 12 weeks. Physical activity (PA) and SB were assessed using the activPAL3™ accelerometer. In addition, anthropometrics, plasma lipids, systemic inflammation and markers of microvascular endothelial function, blood pressure, heart rate variability (HRV) and vascular endothelial function were assessed at baseline and after the 12-week intervention period.

RESULTS: As compared with the control group, the CWAT+ group significantly reduced time spent in sedentary behaviour (-81 min/day confidence interval [CI; 95%]: [-151, -12] min/day; p = 0.021) and significantly increased step count (+3117 [827, 5406] steps/day; p = 0.036), standing time (+62 [14, 110] min/day; p = 0.015), light intensity PA (LPA; +28 [5, 50] min/day; p = 0.040) and moderate-to-vigorous PA (MVPA; +22 [4, 40] min/day; p = 0.005). Measurements of were all significantly increased, compared to the control group.

CONCLUSION: A 12-week multiple behaviour change intervention (self-monitoring + motivational interviewing) is effective to significantly reduce sedentary time and increases physical activity. These changes in sedentary behaviour and physical activity improve triglyceride concentrations and HRV in sedentary adults.

DOES UNDERWATER MASSAGE ENHANCE THE BENEFITS OF HOT WATER IMMERSION?

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INTRODUCTION: There is emerging evidence that demonstrates the health benefits of passive heating including improvements to cardiovascular health and reductions in stress and anxiety[1]. Many commercially available hot tubs offer underwater massage systems which purport to enhance any benefits of hot water immersion and increase enjoyment. However, the potential benefits of additional underwater massage have yet to be studied.

METHODS: Participants (16 male, 4 females) completed three, 30-minute sessions of hot water (39°C) immersion with underwater air jet massage (Air jet), water jet massage (Hydro jet) and no massage (Control) in a randomized and counterbalanced order on separate days.

Cardiovascular responses comprising; heart rate, blood pressure and femoral artery blood flow and shear rate were measured. Stress responses comprising; state trait anxiety, basic affect, and salivary cortisol were recorded before and after each trial. Enjoyment was assessed using a modified version of the physical activity enjoyment scale [2]. Data were analysed using a mixed effects model.

RESULTS: Post immersion, heart rate increased ($P<0.001$, mean difference 31bpm) with no difference between conditions. Systolic and diastolic blood pressure both decreased immediately post hot tub (approximately 9 and 19 mmHg respectively), with the decrease in systolic blood pressure being greater in the Air jet Vs Control condition ($P=0.007$, mean difference= 6.4 mmHg). Blood flow and total shear rate of the superficial femoral artery increased immediately following hot tub immersion ($P<0.0001$). The increase in blood flow was greater in the Control condition compared to the Air jet condition ($P=0.009$, mean difference 147 ml/min). Similarly, the increase in total shear rate was less in Air jet condition compared to the Control condition ($P=0.009$, mean difference 3380 s-1). Anxiety and salivary cortisol were reduced following hot tub sessions ($P=0.0035$, predicted difference 3.25 AU, 10.3% and $P=0.014$, predicted difference 3.02 nmol/L, 21.3% respectively) but did not vary between conditions. There was no effect on basic affect. Enjoyment did not vary between conditions.

CONCLUSION: These data confirm the positive acute responses to heat therapy by hot water immersion on markers of cardiovascular health, anxiety, and stress. However, there was no additional benefit of underwater massage irrespective of whether the massage was delivered by air or water jets.

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Conventional Print Poster

CP-BM04 Lower Extremity

QUANTITATIVE COMPARISON OF SPINAL KINEMATICS IN SQUAT WITH VARYING LOAD WEIGHT

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INTRODUCTION: The human spine, composed of 33 vertebral bones, has mobility, such as extension-flexion and rotation, similar to other joints. However, most biomechanical motion studies of squat simplify the human trunk to a single rigid-body segment, ignoring its range-of-motion (ROM). This study utilized a trunk model with six rigid-body segments and quantitatively compared spine extension movements during squat with varying load weight.

METHODS: Twelve healthy young males participated in this study. Each participant performed squat with varying load weight (60, 70, 80, 90%1RM: one repetition maximum). A three-dimensional optical motion capture system (VICON MX) with 12 cameras was used for the experiment. Twenty-seven reflective markers were attached to landmarks on the participants' bodies; six markers were located on the tips of specific spinous processes, thus creating a two-dimensional trunk model with six rigid-body-segments in the sagittal plane. Accordingly, the total and regional ROMs were evaluated using the angular displacement between each segment. A one-way repeated measure analysis of variance (ANOVA) was performed to detect differences in the total and local ROMs due to differences in load weight. Differences in the total and regional ROM between load weight were measured with Bonferroni's multiple comparison analyses.

RESULTS: Total ROM of spine in the squat was more flexed than at the neutral position (spine angle in the standing posture) in all load conditions. The one-way ANOVA test revealed that total ROM of spine in the high load conditions was

significantly more flexed position than in the low load conditions (at 60 to 100% normalized time, P <.05). The differences in regional ROM of spine, when varying load weight, were significant at the lower regions of the spine (T12: at 40 to 100% normalized time, L3: at 40 to 100% normalized time, respectively; P <.05).

CONCLUSION: Concerning spinal kinematics in squat, we conclude that (1) flexion ROM was larger with increasing load weight, and (2) the difference in regional ROM, with increased load weight, were especially remarkable around the upper lumbar spine.

HIP EXTENSION MOMENT IN BODYWEIGHT BULGARIAN SQUAT IS PREDOMINANTLY CAUSED BY PASSIVE REACTION MOMENT DERIVED FROM REAR FOOT GROUND REACTION FORCE NOT FROM UPPER BODY WEIGHT

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INTRODUCTION: The rear-foot-elevated split squat, usually called the Bulgarian squat (BSQ), is known to be useful for developing hip extensor muscles compared to conventional two-legged squat. A recent study suggested that in BSQ, the passive reaction moment derived from the rear foot ground reaction force (RFGRF) may contribute as resistance to hip extension moment of front leg. The aim of this study was to quantify the contribution of RFGRF to the resistance to hip extension moment in BSQ for different stance width and trunk angle conditions and compare them with the reaction moment derived from upper body weight.

METHODS: Thirteen young male participants performed bodyweight BSQ in total six conditions with two different stance widths (wide and narrow) and three different trunk forward lean angles. The trials performed voluntarily at each stance width were regarded as normal trunk lean angles, and the trials were also performed at each ± 10° trunk lean angles (trunk forward and upright). Feedback was provided to the subject to ensure that the amount of forward displacement of the knee during the BSQ was identical among the different trunk lean conditions. Prior to the data collection, a four-week familiarization period was conducted to allow subjects to familiarize with each condition. An optical 3-D motion capture system (VICON) and two force platforms (Kistler) for each leg were used for data collection. Based on the 2D inverse dynamics, net hip extension moment of front leg, reaction moment derived from RFGRF, and reaction moment derived from upper body weight were calculated using MATLAB (MathWorks). Each value at the lowest position of BSQ was used for evaluation.

RESULTS: The time course of net hip extension moment of front leg was approximately synchronized with the sum of reaction moments derived from RFGRF and upper body mass, demonstrating validity of the current biomechanical analysis. The mean values of reaction moment derived from RFGRF were 76 Nm, 79 Nm, and 86 Nm for wide stance, and 49 Nm, 67 Nm, and 71 Nm for narrow stance conditions (the orders were trunk forward, normal, and upright, respectively). Contribution ratio of the reaction moment derived from RFGRF to the sum of reaction moments (i.e., RFGRF and upper body mass) were 70%, 80%, and 96% for wide stance, and 59%, 78%, and 96% for narrow stance conditions (in the same order).

CONCLUSION: Resistance to hip extension moment in bodyweight Bulgarian squat is predominantly caused by passive reaction moment derived from RFGRF, not from upper body weight. The finding of this study suggests that more attention should be paid to the contribution of RFGRF when performing BSQ as a hip extensors dominant resistance exercise.

THE EFFECTS OF A 6-WEEK OF VELOCITY-BASED TRAINING ON RECREATIONAL LIFTERS

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INTRODUCTION: Recently, a new training method called velocity based training (VBT) has been introduced to compensate for the disadvantages of percentage-based training (PBT) [1,2]. VBT is a method of evaluating the velocity of concentric contraction through displacement and time by attaching an accelerometer to a barbell or body, and is known as a method of improving muscle power by objectively confirming the intensity and amount of training through velocity [3]. So far, various studies on VBT have been conducted, but only general 1RM measurements have been performed, and no study has verified the difference in kinetics and kinematics of the effect of VBT. Therefore, this study aims to further clarify the effect of training by verifying the differences in kinetics and kinematics during 6 weeks of velocity-based training.

METHODS: Eight recreational lifters who have more than 1 years athletic career and had no experience of musculoskeletal injuries on lower extremities in the last six months(age: 29±3.81 yrs., height: 174±3.83 cm., body mass: 74±11.63 kg.,) participated in this study. All subjects were asked to perform back squats with 1RM before and after a 6-week velocity-based training. Three-dimensional motion analysis with 8 infrared cameras (sampling rate: 100 Hz) and 3 EMG channels (sampling rate: 1,000 Hz) was performed to investigate the training effect. A paired t-test was used to find out the significances and the significance level was set at .05.

RESULTS: As a result of this study, significantly increased ankle and knee joint ROM were found in descending and increasing phase of sagittal plane, respectively (p<.05). In addition, significantly reduced quadriceps muscle activation was found in all phases (p<.05). Finally, there was increase in mass of back squat 1RM after the training.

CONCLUSION: The results of this study suggest that 6 weeks of velocity-based training allows recreational lifters to perform the efficient back squat with less agonist muscle activity.

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SECONDARY JUMP DIRECTION AFFECTS LOWER LIMB KINEMATICS IN LANDING TASK

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INTRODUCTION: ACL injury is one of the most burdensome injuries in sports [1]. Non-contact ACL injury mechanism includes extended knee, valgus stress, and anterior tibial shear forces [2]. To prevent these injuries, athletes' biomechanical deficits are often assessed through functional tasks. They often include a single-leg landing followed by secondary jumps [3]. This study aimed to analyze 3 tasks, comparing secondary jump's effects on the whole first-landing kinematic time series.

METHODS: 28 females and 29 males (18-30 years, 2+ weekly trainings, no lower limbs injuries in the last 6 months, no knee injury history) performed 3 unilateral drop-jump variations, with a secondary jump in vertical (DV), 45° medial (DM) or lateral (DL) direction, executed with the dominant limb. The box-target distance was 60% of the maximal forward jump, and the box's height was 20% of the subjects' height. A 9-camera optoelectronic system provided frontal and sagittal plane lower limb kinematics, from initial contact to maximum knee flexion (landing phase, LP). One-way ANOVA through SPM and post-hoc analyses (Bonferroni correction) were used to compare the task kinematics along the normalized LP curves (alpha=0.05).

RESULTS: ANOVA revealed significant differences among tasks in all kinematic variables. DL had the highest hip adduction and ankle eversion, while DM showed the lowest in the whole LP. DL required higher knee adduction, but only in 0-9% of LP. DL had the highest hip flexion for the whole LP, while DV had the lowest in the early LP stages. All tasks showed similar knee flexion, but DV presented slightly lower knee flexion than DM only in 0-18% and 75-100%. The ankle dorsiflexion was lower in DV than in the other tasks.

CONCLUSION: Hip and ankle frontal plane kinematics were highly task-dependent, most notably at early LP stages, the high-risk window for ACL injury. Moreover, the subjects exhibited a more flexed lower limb and dorsiflexed ankle in DL and DM, plausibly to move forward the body and promote the secondary 45° jumps execution. As expected, the secondary jumps affected the first-landing kinematics, even if subjects were instructed to land with the same technique in all tests. The present results demonstrated how different secondary jump strategies, applied to a standard drop jump task, may change lower limb kinematics in athletes.

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THE USE OF A CONVENTIONAL DROP LANDING TASK TO IDENTIFY STABILITY DEFICITS IN NETBALL PLAYERS WITH FUNCTIONAL ANKLE INSTABILITY.

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INTRODUCTION: A common practice to highlight deficits in postural stability associated with ankle injury, has utilised the forward vertical drop landing task. A systematic review of 149 drop landing studies indicated, more than 50% of drop landing tasks provided no specific rationale for the selection of a vertical drop-landing task, which challenges the validity in sport specific translation (1). Functional ankle instability (FAI) is associated with impaired postural control and may indicate deficits resulting in injury during landing tasks (2). The need to determine if dynamic postural stability indices (DPSI) are sensitive to functional ankle instability (FAI) during common landing tasks is warranted (3). The study aimed to determine possible differences in DPSI between an FAI group and healthy group, with a frontal and lateral 40cm landing task.

METHODS: A cross-sectional within-subjects repeated measures design was implemented on a purposive sample of twenty-one university league netball players. The sample included 9 FAI (age 20.68 ± 2.01 year, height 174.36 ± 4.72 cm, weight 67.17 ± 9.51 kg) and 12 healthy (age 20.34 ± 2.07 year, height 173.76 ± 5.72 cm, weight 68.12 ± 7.21 kg). Participants performed frontal and lateral drop landings from 40 cm box onto a 60 by 40 cm triaxial force-platform (Bertec Corp, Columbus, OH), sampling at 1000Hz. DPSI were calculated with a cut-off of 3 seconds after initial plate contact (4). The use of the idFAI questionnaire, categorized the participants into FAI and healthy groups (5).

RESULTS: The FAI group displayed the following stability indices for the frontal plane: ML indices: 0.05 ± 0.01; AP: 0.06 ± 0.2; Vertical: 1.27 ± 0.35; DPSI: 1.12 ± 0.14, peak BW force: 3.59 ± 0.87. Lateral plane indices presented: ML: 0.07 ± 0.03; AP: 0.05 ± 0.01; Vertical: 1.28 ± 0.16; DPSI: 1.18 ± 0.21, peak BW force: 4.62 ± 0.87. There were no significant differences in stability indices between the FAI and healthy groups for the frontal and lateral landing tasks.

CONCLUSION: The lack of significant differences between FAI and healthy group stability indices would suggest that the 40cm drop protocol may not be as translatable to sporting demands as previously thought. The intensity and reactive components experienced on the netball court is more likely to lead to stability deficits that are more noticeable . The need

for more dynamic protocols are warranted to ensure that no neuromuscular aspects are been overlooked by common landing tasks. The development of valid and reliable dynamic versions of the these tasks may yield results that are more representative. Furthermore, coping mechanisms in the lower kinetic chain may mask deficits in DPSI due to the controlled nature of the task.

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THE EFFECTS OF DIVIDED ATTENTION AND DECISION-MAKING ON SINGLE-LEG LANDING STABILITY IN ELITE YOUTH FOOTBALL PLAYERS

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INTRODUCTION: In football, athletes are required to quickly adapt their motor actions to the dynamics on the field. Previous studies have shown that athletic high-speed tasks (e.g., cutting or landing) involving either divided attention or time-constrained decision-making result in aberrant move-ment biomechanics associated with an increased risk for lower limb injuries. However, the effects of both cognitive components combined are largely unclear. Thus, the aim of this study was to investigate the effect of divided attention and decision-making on single-leg landing stability in elite youth football players.

METHODS: Twenty-one male elite youth football players (17.5±0.5years) performed a total of 24 counter-movement jumps with single-leg landings on a pressure plate. Of those, n=6 were anticipated without visual distraction (control condition 1), n=6 anticipated with visual distraction (control condition 2), and n=12 unanticipated with visual distraction (experimental condition). Jump order was randomized. During the flight phase, the participants had to perceive and react to a game situation (movement of two opponents, two teammates), which was displayed on a screen in front of them. In the unanticipated condition, the landing leg had to be selected based on the movement of the opponents. In the control conditions, the landing leg was indicated before the jumps. In the conditions with divided attention (control 2 and experimental), participants had to register the movement of teammates (visible only during flight phase) and report it after landing. Biomechanical stability outcomes were vertical peak ground reaction force (pGRF; [N]), time to pGRF [ms], and center of pressure path length (COP, [mm]). Recall error rate (incorrect perception of the teammate movements, [%]) was assessed to quantify divided attention performance. To test for differences between conditions, repeated measures ANOVA were used for landing stability outcomes and Wilcoxon-tests for recall error rates.

RESULTS: We found main effects (condition) for pGRF ($p<0.001$, eta2=0.37), time to pGRF ($p<0.001$, eta2=0.36) and COP ($p<0.001$, eta2=0.34). Post-hoc tests indicated significantly higher pGRF, and COP values as well as shorter time to pGRF in the unanticipated condition compared to the control conditions 1 and 2 ($p<.05$). However, visual distraction alone (control 2) did not result in differences in landing stability ($p>.05$). Finally, compared to the anticipated jumps, the unanticipated condition resulted in a higher recall error rate (z=-3,1; p =.002) indicating impaired divided attention perfor-mance under time constrains.

CONCLUSION: The combination of time-constrained decision-making and visual distraction may cause poten-tially harmful lower limb biomechanics and erroneous visual perception during jump-landings. These changes do not seem to occur with divided attention tasks only. This may have relevant implications for injury prevention in elite football players.

RELIABILITY AND KINEMATICS OF MOVEMENT CONTROL TEST IN THE HIP JOINT

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INTRODUCTION: Neuromuscular control of the hip joint has been linked to lower extremity alignment and injury. Neuromuscular performance can be examined clinically using physical examination or using laboratory tests such as electromyography or motion analysis systems. A series of kinetic control tests has been proposed in 2012 and widely used these days. However, measurement reliability and validity of these tests are still unclear. The aims of the study were to determine the reliability and the validity (using the kinematic data collected during the test) of the hip kinetic control tests.

METHODS: Asymptomatic adults were recruited for the study. Four testing tasks were performed including hip flexion control, adduction control, internal rotation control and external rotation control, and the movement was videotaped for scoring. During the task, kinematics data was also collected by VICON motion analysis system. The movement testing was scored by three trained therapists, and the patients were divided into pass or fail group based on the average score. The hip kinematics were then compared between the two groups. The measurement repeatability of kinetic control tasks was calculated using the kappa statistic and Fleiss kappa statistic, and the differences of kinematics data were assessed using the independent T test.

RESULTS: The intra-rater measurement reliability of the kinetic control testing was 0.333-1 and the inter-rater reliability was between -0.108-0.55. There was no significant statistical difference in kinematics data (0.07 CONCLUSION: Base on the

data so far, it indicated poor measurement reliability of the kinetic control tests and failed to validate the kinetic control testing results using the hip kinematics results. One possible reason for poor testing repeatability might relate to the multiple components of these tests. Poor measurement reliability and insufficient grouping level (only two groups in our design) might account for failure to show the validity of the kinetic control tests. In addition, we were unable to rule out possible influence from poor control of the trunk or other parts of the lower extremity such as ankle and knee joint. Future research should take into account these factors and re-assess the usefulness of the kinetic control tests as a neuromuscular control test battery.

KNEE AND HIP BIOMECHANICS IN SINGLE LEG HOP FOR DISTANCE IN HEALTHY AND ACL RECONSTRUCTED SOCCER PLAYERS: WHEN THE HOPPED DISTANCE IS NOT ENOUGH

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INTRODUCTION: A widely used test to determine readiness to return to sport (RTS) after ACL injury and surgery is the Single Leg Hop (SLH) (1). However, when proposing SLH, several works focus only on the knee, not considering a whole-body approach including the hip, which plays a key role. The aim of this study is twofold: to assess i) hip and knee differences in kinematic/kinetic parameters between healthy and ACL reconstructed soccer players, and, as consequence, ii) possible relations between SLH distance (performance-related indicator) and lower limb trend associated with poor neuromuscular control.

METHODS: Five healthy (27±6 y; 74.3±6.5 kg; 1.82±0.04 m) (HC) and three soccer players with ACL reconstruction (24±4 y; 83.6±7.6 kg; 1.83±0.04 m; 8-12 months post-surgery) (ACLR) participated in the study. Three SLH trials were performed for each limb [1], landing on a force plate (AMTI, USA, 1000 Hz). The 3D trajectories of 52 markers were measured by an optoelectronic system (Vicon, UK, 200 Hz) [2]. A time window of 100 ms after the foot landing was considered and joint kinematic and kinetic parameters were extracted together with the hop distance. To investigate the presence of asymmetries between injured and non-injured (or dominant Vs non-dominant in HC) sides, the Limb Symmetry Index (LSI) was calculated for each parameter. Significant differences between HC and ALCR were investigated using an unpaired t-test or the Mann-Whitney test, according to data distribution.

RESULTS: Internal knee extension moments were significantly lower in ACLR than HC (2.9±1.4 Vs 3.7±0.9 Nm/kg, $p=0.02$). In contrast, hip flexion moments were higher in ACLR than HC (9.2±2.2 Vs 6.9±1.6 Nm/kg, $p<0.001$). From a kinematics point of view, the two groups did not display significantly different strategies ($p>0.05$). Interestingly, when considering asymmetries between the two body sides, LSI values of the hop distance were the same for both ACLR and HC (97%), suggesting readiness for RTS in ACLR. Conversely, LSI values for knee adduction were doubled in ACLR than HC (211±2% Vs 102±42%), indicating a higher knee instability in the frontal plane for ACLR.

CONCLUSION: The results of this preliminary study confirm that considering only the between-side symmetry of the hop distance as a criterion for RTS clearance is not recommended. Symmetry in hop distance, in fact, can be reached even when a high asymmetry is displayed in the knee adduction movements, indicating that knee instability may still be an issue. The ACLR and HC soccer players implemented different landing strategies, especially from a kinetics point of view, at both knee and hip joints, suggesting a pre-planned protective strategy to decrease moments and loads on the injured knee and, possibly, compensate for knee instability at the hip joint [1,3].

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PERONEAL MUSCLE RESPONSE TO AN EXPECTED AND UNEXPECTED FALL IN YOUNG AND MIDDLE-AGED ADULTS BEFORE AND AFTER NEUROMUSCULAR TRAINING: A CROSS-SECTIONAL STUDY

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INTRODUCTION: During middle age (MA), balance and postural control may be affected by age-related changes in the nervous system and by a decrease in muscle mass, strength, and flexibility. The aim of this study was to investigate the anticipatory response of the peroneus longus muscle (PL) to landing after an expected fall (jump) and its postural response to an unexpected fall (perturbation) in MA and young adults. A second aim was to investigate the influence of neuromuscular training on PL postural responses in both age groups.

METHODS: Twenty-six healthy MA (55.3±4 years) and 26 healthy young adults (26.3±3.6 years) participated in the study. Assessments were performed before (T0) and after (T1) PL EMG biofeedback (BF) neuromuscular training. To assess the PL response to the expected fall, subjects performed a single-leg drop jump, and the PL EMG activity in preparation for landing (PL activity as % of jump time) was calculated. PL time to onset and time to peak were measured to assess PL response to an unexpected fall (perturbation). In this test, subjects stood on a custom-made trap door that produced a sudden 30° ankle inversion. For the excepted fall, repeated measures ANOVA was used to analyze PL EMG activity in preparation for

landing (% of jump time), and for the unexpected fall, MANOVA for repeated measures was performed to evaluate the effects of age and EMG-BF training on unexpected fall performance (PL onset time and time to peak).

RESULTS: Before training, the MA group showed significantly shorter PL activity in preparation for landing compared to the young adults (25.0% vs. 30.0%, p=0.016), while after training there was no difference between the groups (28.0% vs. 29.0%, p=0.387). There were no differences between groups in peroneal activity after the unexpected fall before and after training.

CONCLUSION: Our results suggest that automatic anticipatory peroneal postural responses are decreased at MA, whereas reflexive postural responses appear to be intact in this age group. A short PL EMG-BF neuromuscular training may have an immediate positive effect on PL muscle activity at MA. The results may highlight the need to examine both anticipatory and reflexive muscle responses when studying age-related changes and the necessity of studying middle-aged adults. Furthermore, this should encourage the development of specific interventions to ensure better postural control in this group.

Conventional Print Poster

CP-BM05 Team Sports

EFFECTS OF VARIOUS BAT WEIGHTS ON BAT SWING SPEED AND LOWER EXTREMITY MUSCLE ACTIVATION OF COLLEGIATE BASEBALL PLAYERS

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INTRODUCTION: Different bats may provide different batting performances, and improving swing speed is commonly considered to be the general consensus among outstanding hitters in baseball (1). Thus, the action of swinging a bat involves skill. In addition, to strengthen their muscles and be successful baseball players, athletes must train intensively. In terms of their joints, the player must coordinate the muscles of the entire body; muscle activation is crucial during the swing phase (2), which can help baseball players improve their batting performance. The purpose of this study was to investigate the swing process for different bat weights on the baseball field and analyze the bat speed and lower extremity muscle activation during the swing phase.

METHODS: The study participants included three university baseball players. The participants would hold 800, 850, 900, and 950g bats and swing at a ball on a tee. Every swing was performed three times, aiming to bat the ball from the tee into a net (87cm x 87cm). As experimental equipment, a Vicon motion analysis system, 9 wireless EMG, and 2 force plates were used. The swing action was divided into wind-up, stride, start-up, swing, contact, and follow-through. The statistical mused was One-way repeated measures ANOVA.

RESULTS: The results show that the swing speed with the 800g bat was significantly higher than with the 950g bat (P=.010). In terms of the characteristics of lower extremity muscle activation with different bat weights, the results show that gastrocnemius activation was significantly higher with the 850g bat than with the 800g bat (P=.043). Gastrocnemius activation with the 900g bat was significantly higher than that with the 850g bat (P=.038).

CONCLUSION: From the results, a significant difference was found between the swing speed of the 800g and 950g bats, indicating that, the higher the bat's mass and the further the bat mass is distributed from the rotation axis, the higher the resistance to angular acceleration, which reduces bat control (3). With a relatively lightweight bat, the resistance to angular acceleration is lower, so the bat is easier to control. A lightweight bat may require less muscle activation to control the swing motion. Regarding muscle activation according to swing phase, gastrocnemius muscle activation was significantly higher at start-up when the player was holding a 900g bat than with an 850g bat; gastrocnemius activation with the 850g bat was significantly higher than with the 800g bat, showing that baseball batting is a process of the continuous action of joints. They must add more power when swinging a heavier bat. In the rest of the swing phase, no significant difference was found between the different bat weights and the degree of muscle activation, indicating that when choosing a bat, the batter should choose the bat that is suitable according to their ability, function, and muscle strength.

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CAN INSTRUMENTED MOUTHGUARD BE USED FOR COMPUTING HEAD INJURY CRITERIA FOR RUGBY COLLISION INVESTIGATION OVER ELITE PLAYERS ?

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INTRODUCTION: Using instrumented mouthguards for quantifying head acceleration during rugby games is promising for better understanding concussion occurrence [1]. However, defining a threshold for rugby is an issue. Several criteria were proposed for several [2] purposes but none were defined for rugby. Thus the objective of this study was to investigate if classical injury criteria are of interest for collision investigation in rugby based on instrumented mouthguards (iMG) measurements.

METHODS: A call for volunteers was done over a male team of under 21 years old rugby players. They were equipped by instrumented mouthguards (boil and bite technology, Prevent biometrics) during their trainings. Collision selection threshold was set as 5g and then 10g over a 50ms window. Data were compared to video in order to eject false positive data. Eight different common injury criteria were computed on this dataset: GAMBIT, CP, HIC, RIC, PRHIC, HIP, BRIC and BrIC. Associated tolerance thresholds were computed.

RESULTS: Over the 16 players who were asked to be part of the study, 15 volunteered. iMG were used during 8 training sessions and 7 official matches, corresponding to 1169 collisions. With a threshold set as 5g, there was 81% of true positive, 13% of false positive and 6% undetermined. With a threshold set as 10g, results were 93%, 4% and 3% respectively.

Among those, 25 impacts were associated to at least over one injury criteria and 2 were over 2 injury criterias. The BrIC criteria was the one conducting to the highest percentages of severity overtaking.

CONCLUSION: Instrumented mouthguards seem to be a promising tool for measuring in-field head accelerations. Those may be of interest for coaches and medical staff to adapt players trainings for reducing their injury risk. However, current injury criteria were not created for rugby purposes and its choice highly influence computation output. Criteria may use linear and/or rotational components of measured head accelerations, and here, the one presenting the highest risk of being overtaken was based on rotational components. Unfortunately, data selection on the device is based on translational acceleration which may conduct to bias selection.

To conclude, this study highlight the interest of defining a proper injury criteria for rugby by presenting the high influence of criteria choice. Thus, a large scale study should be conducted to define criteria and threshold for helping staff to understand at-risk movements and eventually to better understand concussion occurrence.

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BIOMECHANICAL ANALYSIS OF VOLLEYBALL SPIKE ACCORDING TO TAKE-OFF STYLE OF RECREATIONAL PLAYERS

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INTRODUCTION: In the volleyball game, spike is one of the most dynamic motions and an important scoring technique. Since a high jump height can provide various attack routes, it is known as a very important factor that can improve a players offensive ability during spikes (1,2). South Korea, where recreational volleyball club league is very active, many recreational players are trying to perform spike movements like professional players. It is, however, difficult to obtain helpful information of spike because most of the preceding studies have been conducted on professional players. Therefore, the aim of this study was to find out the biomechanical differences between take-off style during the volleyball spike motion to provide useful information for improving the spike motion of club players.

METHODS: Twelve healthy male adults(age: 23.4±1.7 yrs, height: 178.7±5.7 cm, weight: 77.1±13.8 kg, career: 5.8±2.1 yrs) who had no experience of musculoskeletal injuries or surgery within the past six months were participated in this study. They were asked to perform spike movement of both hop-step style jump(HSJ: jumping after both feet touch the ground at the same time) and a closed-step style jump(CSJ: jumping after both feet touch the ground with a slight difference in time). A 3-dimensional motion analysis with eight infrared cameras(sampling rate: 100Hz), an eight-channel wireless electromyography(sampling rate: 1,000Hz), and two force plates(sampling rate: 1,000 Hz) was performed to examine the differences. The paired t-test was performed to find the significance and the statistical significance level was set at α=.05.

RESULTS: HSJ revealed significantly increased vertical COM velocity and left biceps femoris and medial gastrocnemius activation compared with those of CSJ in the approaching phase. CSJ also showed significantly increased horizontal COM velocity and right rectus femoris compared with those of HJS in all phases. In addition, CSJ revealed significant increased tibialis anterior muscle activation compared with HSJ in approach phase. Finally CSJ showed increased right biceps femoris, left biceps femoris and medial gastrocnemius activation in take off phase, respectively. For CSJ, significantly increased the maximum horizontal ground reaction force was found in right foot than that of HSJ.

CONCLUSION: he results of this study are expected to provide information on the difference in take-off style to volleyball club members and life sports leaders through the quantification of spike motion according to the two take-off style and to contribute to improvement of the spike skills of club members in the future.

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FORCE ACCURACY AND JOINT POSITION SENSE IN KICKING AND SUPPORTING LEG OF KNEE EXTENSORS IN FOOTBALL PLAYERS

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INTRODUCTION: The proprioception plays an important role in neuromuscular control and properly maintaining joint stability, especially in dynamic sports related with accurate dosing and reproduction of force such as football (1). The as-

sessment of the force sense (FS) and joint position sense (JPS) in active and passive mode, as well as their relationships connecting interlimb strength asymmetry (ISA) between the kicking (KL) and supporting leg (SL) in football players are less investigated (2). This study aimed to assess FS, JPS and ISA and the correlations between them in the KL and SL in football players.

METHODS: The FS, JPS and maximal isometric voluntary contraction (MIVC) of knee extensors were measured by isokinetic dynamometer (Biodex 4Pro) in 11 footballers (age 24±4 years) in an university football team. MIVC was measured in Nm at 90o position of the knee joint and further also used as a target of reproducing 50% self-estimated effort during FS testing. JPS was measured at 90o starting positon to target angles - 40o and 65o (active and passive), without feedback. The ISA was calculated as percentage difference between the torque of the stronger versus the weaker knee extensors. Descriptive statistics and Mann-Whitney test were used to assess the differences of mean±SD for all variables. Correlations were calculated with Pearson coefficient ($p<0.05$). The performance in the force and joint position matching tasks were determined by the absolute error (AE), as a measure of accuracy. It was calculated as absolute deviations from a target, and obtained through the arithmetic mean of the individual errors in the modulus (3).

RESULTS: The MIVC values (Nm) for extensors of KL and SL were :257±42 and 253±42, respectively. In 45% of the football players was found ISA above 10%. There was no linear correlations between: JPS with FS in KL or SL; AE of FS in KL; AE of active JPS in 40o and 65o in KL or SL; AE of passive in 40o and 65o in SL. High positive correlation ($r=0.86$; $p=0.0003$) was established between AE of FS of the extensors of SL and ISA, i.e. the players who achieved higher force accuracy with extensors of SL have lower strength asymmetry. A moderate negative correlation ($r=-0.53$; $p=0.005$) was found between AE of KL at 40o passive JPS and ISA, i.e. the players who attain better JPS accuracy of KL have higher bilateral strength asymmetry.

CONCLUSION: This study presents evidence that reveals differences in proprioceptive senses between extensors of KL and SL and their relationship with ISA, which are in accordance with their different role in the football game. This specificity is probably related to adaptation changes in the proprioceptive motor control, which are provoked by the unilateral demands in football.

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Acknowledgements

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KINETIC ADAPTATIONS MEASURED WITH INSTRUMENTED FOOTBALL SHOES DURING AN EXHAUSTIVE ON-FIELD RUN

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INTRODUCTION: Fatigue and excessive training load have been identified as major injury risk factors in football [1]. However, most of research in this field has been conducted in laboratory conditions, due to the lack of a portable device allowing kinetic assessment.

METHODS: Ten amateur football players performed an exhaustive run at a constant velocity corresponding to 90% of their maximal oxygen consumption on a turf football pitch. Each participant was wearing an instrumented football shoe (Phyling, France) recording vertical ground reaction forces (vGRF) [2]. Kinetic parameters (maximal force -Fzmax, vertical and leg stiffness -kvert and kleg, loading rate -LR, high frequency forces -HFF) and temporal parameters (duty factor -DF, time of maximal force -tFzmax, step frequency -FREQ) were extracted for each step. A cluster analysis (Random Forest Algorithm) was conducted based on differences between the non-fatigue condition and the fatigue condition, corresponding to the first and last 10% of the run, respectively. The cluster classification was validated by a leave-one-out cross-validation (LOOCV). Paired-sample t-tests (and Cohens d) were used to find differences in the fatigue related changes at group level (all participants) and cluster-level.

RESULTS: Mean time to exhaustion was 548 ± 147s, and 766 ± 206 steps were analysed (per participant). Cluster analysis identified two clusters (C1, n=7 and C2, n=3, LOOCV = 100%). Statistical analysis at the group level revealed a significant decrease for Fzmax ($p<0.05$), a significant increase for DF ($p<0.05$) and tFzmax ($p<0.05$) between the non-fatigue and the fatigue conditions. Cluster analysis revealed a significant increase among C1 subjects for HFF ($p<0.05$), DF ($p<0.05$) and tFzmax ($p<0.05$) and a significant decrease for Fzmax ($p<0.001$), kleg ($p<0.001$) and kvert ($p<0.001$). On the contrary, C2 participants showed significant increase for kleg ($p<0.05$) and kvert ($p<0.05$). Effect size was large (>0.8) for each analysis.

CONCLUSION: Kinetic adjustments induced by fatigue were detected in situ using an instrumented football shoe. To the best of our knowledge, this is the first study to analyse kinetic parameters directly in the field, thus contributing to ecological validity. Individual analysis also revealed different strategies among participants, which reinforces the need of injury prevention programs based on individual investigation. Further research is now needed to understand how these different strategies may affect the risk of injury in soccer.

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DIFFERENCES IN KINETIC FACTORS RELATED TO LATERAL CUTTING PERFORMANCE WITH AND WITHOUT COGNITION

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INTRODUCTION: Ball games require players to react and feint against opponents and the ball, and especially in basketball, the players frequently perform fast lateral moves. In addition, since the players must change their actions in response to the surrounding situation, they must move laterally with cognition. Although previous studies have investigated kinematic factors related to fast lateral cutting, no studies have investigated kinetic factors and included cutting tasks with cognition. Therefore, this study aimed to identify differences in kinetic factors related to fast lateral cutting with and without cognition.

METHODS: Fifteen male basketball players performed lateral cutting tasks with a turn in conditions with and without cognition (cognitive cutting: CC, non-cognitive cutting: NCC). Three-dimensional coordinates and ground reaction force were collected, and we calculated the lateral cutting index (LCindex) and net internal joint torques of the lower extremities during the turning phase in each condition. We calculated the LCindex by dividing the center of gravity velocity at take-off during the turning phase by the ground contact time. We considered the LCindex as an outcome reflecting the cutting performance, and a greater LCindex means better cutting performance.1 Paired t-tests were used to compare the LCindex between each condition. Pearson's correlation coefficient was used to examine the relationship between the LCindex and peak joint torque in each condition ($p < 0.05$).

RESULTS: There was no significant difference in the LCindex between conditions (CC vs. NCC: 4.97 ± 1.14 vs. 5.01 ± 0.75, mean ± SD). In the CC condition, there were significant correlations between LCindex and peak ankle plantarflexion (value +/-: -, r = -0.64), knee varus (+, r = -0.52), and internal rotation (+, r = 0.53) torques. In the NCC condition, there were significant correlations between the LCindex and peak hip extension (-, r = 0.53), internal rotation (+, r = -0.54), and external rotation (-, r = 0.53) torques.

CONCLUSION: Although this study revealed no difference in the LCindex between each condition, the kinetic variables related to the LCindex differed by the effect of cognition. It is possible that while hip variables are mainly important in the planned conditions, the cognitive condition requires faster reaction and force exertion, thus increasing the importance of ankle plantarflexion torque. As the results indicate that the force exertion characteristics required during the lateral cutting task could differ due to the cognition involved, the findings of this study could contribute to a better understanding of how to consider more practical training.

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PITCH VELOCITY AND MUSCLE ACTIVITY DURING SUPRA-MAXIMAL EFFORT PITCHING IN JUNIOR HIGH SCHOOL BASEBALL PLAYERS.

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INTRODUCTION: On the sports field, athletes exert their maximal effort to perform at their best. However, even when they think they have exerted their maximal effort, their performance may not be up to par. Therefore, the ability to exert ones maximal effort as aimed is important for athletes. Compared to top athletes, less skilled athletes, such as children, may not have a superior ability to exert their own maximal effort. In baseball pitching, ball velocity is one of the most important performance indicators, and a high ball velocity greatly enhances competitive advantage. In this study, ball velocity and muscle activity were recorded during supra-maximal effort pitching by junior high school baseball players in order to measure the ability of less-skilled baseball players to exert their maximal effort.

METHODS: Junior high school baseball players were asked to throw 8 pitches each at 110% and 120% of subjective effort after 8 pitches at 100% of subjective effort, and the electromyographic (EMG) activity was recorded. Participants threw balls toward a net set up 5 m away. EMG data were collected using a wireless surface EMG system (Trigno wireless EMG system: Delsys Inc., USA). EMG sensors were attached following muscles: biceps brachii (BB), triceps brachii (TB), ulnar carpal flexor (FCU), extensor carpi radialis (ECR) of the throwing arm, rectus femoris (RF), biceps femoris (BF), tibialis anterior (TA), and soleus muscle (SOL) of both legs. Two high-speed cameras (DSC2 RX10M4: SONY, Japan; 960 fps) were used to capture the ball trajectory. Ball velocity was defined as the magnitude of the velocity vector at ball release and was calculated from the center of the ball in the high-speed camera images digitized by automatic image recognition technology (DeepLabCut).

RESULTS: Ball velocity increased at 110% or 120% of subjective effort pitching compared to 100% of subjective effort pitching. Muscle activity of the muscles for which EMG was recorded in this study did not change with effort level.

CONCLUSION: To clarify the ability to exert maximal effort, ball velocity and muscle activity in supra-maximal effort pitching was investigated. As a result, ball velocity increased at supra-maximal effort pitching, but muscle activity did not change. The result of ball velocity suggests that junior high school baseball players are not successfully exerting their maximal effort. The EMG result suggests that the increase in ball velocity during supra-maximal effort pitching may not be due to simple muscle exertion, but rather to more efficient proximal-to-distal energy transfer. As the participants in this study were junior high school students, the current results may not apply to athletes at different levels, such as high school, college, and professional players. Proficiency may be related to the ability to exert maximal effort. Therefore, if highly skilled players are instructed to throw a supra-maximal effort pitch, their ball velocity may not change.

Conventional Print Poster

CP-MH05 Health and fitness in adolescents/children

EFFECTS OF INDIVIDUALIZED VERSUS STANDARDIZED DROP JUMP TRAINING ON PHYSICAL FITNESS IN YOUTH VOLLEYBALL PLAYERS

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INTRODUCTION: When performing DJs, the selection of appropriate drop-heights is important for two reasons. First, adequate drop heights enable individuals to maximize training-induced physical and physiological adaptations and thus performance enhancement (Taube et al., 2012). Second, adequate drop heights prevent mechanical stress through excessive loads on lower extremity muscle-tendon and bony structures (Peng et al., 2011, Wallace et al., 2010). With regards to the training specificity concept (Behm and Sale, 1993), training has to closely mimic the demands of competition (Behm & Sale, 1993), which is why training using high and low DJ heights have become popular means in (plyometric) jump training (Ramirez-Campillo et al., 2019). However, there is hardly any information available in the literature regarding the effects of drop-jump training using maximal height (individualized DJ training) in comparison to the standardized DJ training in youth athletes. Therefore, the objective of this study was to examine the effects of individualized drop jump training (IDT) using individualized drop height versus standardized training (SDT) on components of physical fitness in youth volleyball players.

METHODS: Thirty male youth volleyball players, aged 12 to 13 years, performed either an individualized or a standardized drop jump training. Both interventions lasted for 8 weeks with two weekly sessions. While the individualized exercise group (IDT) performed drop jump exercises using a drop height according to the individual's maximal rebound jump height, the standardized exercise group (SDT) performed drop jumps from a 30-cm drop box height. Pre- and post-training, drop jump performances from 20, 30, and 40-cm drop heights were assessed. Dynamic balance was tested using the Y-balance test, linear sprint speed using 5, 10 and 20-m sprint times, and change-of-direction speed using the T-test.

RESULTS: Significant group-by-time interactions were found for drop-jump, balance, and sprint tests ($p < 0.0001$; $P\eta 2$ range from 0.14 to 0.67) but not for CoD speed. Post-hoc tests showed significant improvements in favor of the IDT group for all drop jump heights ($P\eta 2 = .910$, $p = .0001$, $\Delta = 6.7\%$), 5-m ($P\eta 2 = .558$, $p = .003$), 10-m ($P\eta 2 = .681$, $p = .01$, $\Delta = .012$ %), 20-m ($P\eta 2 = .683$, $p = .01$, $\Delta = .24\%$) sprint times. Main effects for time identified similar pre-post improvements for dynamic balance and CoD speed in both IDT and SDT groups (all $p < 0.05$).

CONCLUSION: Findings revealed that IDT was more effective than SDT to improve drop jump performance and linear sprint speed. Due to the importance of vertical jumps and short accelerations for overall competitive performance in volleyball, our results suggest that young volleyball players should perform IDT as part of plyometric training if the goal is to improve acceleration and vertical jump performance.

PHYSICAL LITERACY AND PHYSICAL ACTIVITY IN SWEDISH PRESCHOOL CHILDREN – A CROSS-SECTIONAL STUDY

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INTRODUCTION: There are substantial evidence for the numerous positive health benefits of physical activity (PA) [1]. At the same time, PA-levels in European and Swedish children are insufficient [2]. Inadequate PA-levels, and associated non-communicable diseases, are regarded as one of the most significant public health challenges confronting us. Hence, it is important to understand how we can promote ways for children to reach adequate PA-levels. Physical Literacy (PL), a theory with potential benefits for PA-behaviors and health, has garnered increasing attention over the last few years. Encompassing physical, affective, and cognitive dimensions PL is often described as an individual's capacity, confidence, and motivation to partake- and engage in PA [3]. The early childhood years are suggested for PL promotion since this period is regarded as crucial for PA-behaviors, future health, and the opportunity to reach most children via school settings. However, the assessment and status of PL in young children, specifically in Sweden, is at best scarce. Consequently, research is required to assess PL and its connection to PA-levels in young Swedish children.

METHODS: The data for this study will be derived from hip-worn accelerometers (GT3X+, Actigraph) worn for 7 days to assess PA-levels, as well as a modified version of the Canadian Preschool Physical Literacy Assessment to assess PL. The study will include 412 preschool children, aged 3-6, from 20 preschools. The data will be analyzed and presented via descriptive statistics, and multi-level linear regression models will be used to determine associations between total- and intensity stratified PA-levels and PL.

RESULTS: Tentatively, the results of this study are expected to provide: 1) a picture of PL and PA in Swedish preschool children and the connection therein; 2) much-needed data for the fields of PL and early childhood research; 3) Indications on effectiveness of PL for promoting PA; and 4) guidance for future research in PL.

CONCLUSION: With individual, and public health advancements in mind, there is ample reason to enhance our understanding of the relationship between PL and PA-levels of Swedish preschool children, as well as, adding data to the PL-field. The present study has the potential to contribute to these objectives.

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ENERGY AND MACRONUTRIENT INTAKE OF JAPANESE ELEMENTARY SCHOOL STUDENTS PARTICIPATING IN SPORTS ACTIVITIES.

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INTRODUCTION: Adequate energy and nutrient intake during growth and development is necessary for meeting the daily minimum energy requirements, and for supplementing stored energy that is needed for physical growth. Furthermore, energy and nutrient intake must be sufficient to provide the additional energy that is consumed during exercise.

The International Olympic Committee (2014) introduced the concept of relative energy deficiency in sports (RED-S). RED-S can lead to problems with growth and development, metabolism, mental health, cardiovascular health, bone health, and can lead to poorer athletic performance.

The Japan Sport Association (2021) issued "Guidelines for sports activities in the developmental period," which highlights the importance of psychological and social aspects, adequate nutrition, and sports injury prevention. Nutritional considerations indicate sufficient nutrition, and a well-balanced diet are required for physical growth. Additionally, some reports suggest that adequate daily energy intake is important to combat RED-S in adolescent athletes.

The purpose of this study was to examine energy and macronutrient intake of elementary school students participating in sports activities and contribute to healthy sports life management during the early growth and development.

METHODS: Thirty-one elementary school boys (aged 9–12 years), belonging to sports clubs in Shiga-prefecture, Japan, participated in this study. Nutritional intake was investigated using the brief-type self-administered diet history questionnaire for 10-years old (BDHQ-10y, Okuda et al., 2009), and daily intakes of energy, carbohydrates, proteins, fats, vitamins, and minerals were calculated.

The amount of physical activity in a 1-week period was calculated using the International physical activity questionnaire short version (IPAQ-SV, Murase et al., 2001).

Additionally, the participants were divided into 2 groups: high (n = 9, H-PA) and low physical activity (n = 7, L-PA), according to physical activity levels and nutritional intake of each group was compared.

RESULTS: The mean height, weight, and body mass index were 139.9±8.4 cm, 32.0±5.2 kg, and 22.8±2.7 kg/m2, respectively. The daily intakes of energy, carbohydrates, proteins, and fats were 2118.4±766.0 kcal, 303.9±113.7 g, 74.6±31.1 g, and 63.8±25.4 g, respectively. Energy and protein intake was lower than the recommended intake in the Dietary Reference Intakes for Japanese (2020).

Moreover, the H-PA group showed lower energy ($p = 0.09$) and carbohydrate intake ($p = 0.05$) than in the L-PA group.

CONCLUSION: These findings indicate that low energy and inadequate macronutrient intake are prevalent in elementary school boys, particularly, in those with high levels of physical activity.

In conclusion, these results suggest that a dietary intake improvement plan is needed to increase energy and nutrient intake during the developmental period.

V̇O2MAX PREDICTION FROM SIMPLE VARIABLES IN ADOLESCENTS WITH OBESITY

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INTRODUCTION: In recent decades, the proportion of overweight adolescents in the population has been steadily increasing [1]. Overweight is associated with psychological, metabolic and functional complications [2]. Physical activity intervention could improve the health status of these patients and prevent deterioration. In this sense, V̇O2max is of particular interest to evaluate the physical fitness. While the usual tests are not adapted to obese population, the "Spartacus 15-15" test was developed as an intermittent progressive and maximal running field test more suitable for this population [3]. However, the measurement of V̇O2max is delicate on the field, requires appropriate device and specific expertise. This study aimed to predict V̇O2max from simple variables of "Spartacus" test.

METHODS: 44 obese boys and girls (13.4±0.8 yrs; BMI = 34±3.8 kg/m2) performed a Spartacus 15-15 test as previously described [3]. V̇O2max was quantified from a gas analyser (Cosmed® K4BII). Anthropometric measurements included height, body mass, body max index (BMI), fat and lean mass. Heart rate were recorded (Polar® RS400). The analysis concentrated on the values at rest (HRr), start (HRs), peak (HRp) and mean value (HRm). Peak running velocity was also recorded. V̇O2max was then predicted using three different models: A linear and non-linear models were performed using a forward regression method to select the model variables. The non-linear functions were chosen from the Akaike information criterion. The third model was an artificial neural network (ANN). The accuracy of the models was compared according to the mean absolute error (MAE) and the adjusted R2.

RESULTS: The average V̇O2max of the sample was 35.1±4.6 ml/min/kg (CrI 95% = [33.7, 36.5]). ANN was the most predictive model (MAE=1.8 ml/min/kg, R2=0.88) in which anthropometric played a major role. The non-linear model (MAE=2.2 ml/min/kg; R2=0.6) included 5 variables: fat, maximal velocity, HRs, HRr and age. The linear model retained only the variables fat, HRs and HRr variables but had the lowest accuracy (MAE=2.6 ml/min/kg; R2=0.43).

CONCLUSION: This study suggests that the Spartacus 15-15 test is suitable for predicting V̇O2max. Deep learning model outperforms the classical models but has the disadvantage of being more complex for practitioners to use. More usable models (linear and non-linear) showed acceptable error to monitor physical activity. It is noteworthy that the ANN and non-linear models had a better R2 than the one reported by a previous study, based on a cycle ergometer test [4]. Further analysis will aim to improve the accuracy of the model by considering the HR values at each step of the test and by predicting ventilatory thresholds.

PHYSICAL ACTIVITY INTENSITIES AND COGNITIVE ABILITIES IN ADOLESCENTS: THE ROLE OF CARDIORESPIRATORY FITNESS

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UNIVERSITAT JAUME I

INTRODUCTION: Previous evidence has suggested a positive association between physical activity (PA) and cognition in youth [1]. Likewise, it is well-known that higher levels of PA are associated with improvements in physical fitness in youth, which has also been shown to be positively associated with cognitive function in this population [2]. However, debate continues regarding the influence of the different intensities of PA on these variables. Thus, in this study we tested whether the association between accelerometer-derived PA intensities and cognition in adolescents was mediated by cardiorespiratory fitness.

METHODS: A total of 60 adolescents (17.75 ± 0.29 years; 38.3% girls) were included in the analysis. PA was evaluated by a wrist-worn GENEActiv triaxial accelerometer and expressed as minutes/day of light, moderate, and vigorous PA. Cardiorespiratory fitness was assessed by the 20-m shuttle run test. Cognition was assessed through the Spanish version of the Science Research Associates Test of Educational Abilities which measures verbal ability, numeric ability, and reasoning ability. Boot-strapped mediation procedures were performed and indirect effects with confidence intervals not including zero were interpreted as statistically significant. Analyses were adjusted by sex, pubertal stage, and socioeconomic status.

RESULTS: Our findings suggest that cardiorespiratory fitness acts as a mediator on the relationship between vigorous PA and numeric ability in adolescents (indirect effect = 0.0013 [0.0002; 0.0027]). Specifically, vigorous PA was positively associated with cardiorespiratory fitness (B=0.0172; p=0.0007), which in turn was also positively associated with numeric ability (B=0.0754; p=0.0083). Cardiorespiratory fitness did not mediate other associations between PA intensities and cognitive abilities.

CONCLUSION: Increasing vigorous PA levels may improve adolescents' numeric ability through its positive effects on cardiorespiratory fitness. Our results could aid to design effective physical exercise interventions aimed to enhance cognitive performance in adolescents. Specifically, stakeholders and education professionals should promote vigorous PA to improve both physical fitness and cognitive abilities in youth.

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DEVELOPMENT OF CARDIORESPIRATORY FITNESS IN CHILDREN IN THE TRANSITION FROM KINDERGARTEN TO BASIC SCHOOL ACCORDING TO PARTICIPATION IN ORGANIZED SPORTS

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INTRODUCTION: Increasing the time spent in vigorous physical activity (VPA) should be a major goal of PA programs to improve cardiorespiratory fitness (CRF) [1]. PA levels and CRF associate with lower body fatness among children [2]. This study examined the longitudinal development of cardiorespiratory fitness (CRF) in children in the transition from kindergarten to basic school according to participation in organized sports and estimated the associations of CRF and body composition indices during the transition from childhood to preadolescence.

METHODS: Children participated in the three-staged longitudinal study (Kindergarten, 6.6 years, n=212 (110 boys, 102 girls); 1st Grade, 7.6 years, n=136 (70 boys, 66 girls); 5th Grade, 11.5 years, n=142 (72 boys, 71 girls) for 5 years and were categorized into three groups according to participation in organized sports in study period (whole period, episodically, never). Cardiorespiratory fitness was assessed using 20 m shuttle run test, while body composition was measured by skinfold thicknesses and physical activity was registered with accelerometer. International gender- and age-specific CRF reference normatives were also used to characterize participants.

RESULTS: Children who participated consistently in organized sports had significantly higher CRF level and lower body fatness (31.3 ± 13.5 laps in 20 m shuttle run; 21.1 ± 6.3% body fat) in 11.5 years as compared to children who had never participated in sports clubs (20.7±12.0 laps in 20 m shuttle run; 26.1 ± 6.8% body fat). Body composition and CRF did not associate in consistently trained children. The proportion of 5th Grade children demonstrating age appropriate healthy CRF was almost threefold higher in group of consistent sports trainings among both in boys and girls than among non-members of sports clubs.

CONCLUSION: Consistent attendance in organized sports in childhood and early preadolescence ensures higher CRF and more healthier body composition as compared to children who had no experience of organized sports.

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RELATIONSHIP BETWEEN GLYCAEMIC CONTROL AND HEART RATE VARIABILITY IN CHILDREN WITH TYPE I DIABETES: A PILOT STUDY

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INTRODUCTION: Diabetes is a significant and chronic condition that occurs when the body cannot produce insulin or produces insufficient insulin, or when it cannot effectively use the insulin it does produce. Type 1 diabetes is the leading cause of childhood diabetes, but it can occur at any age. At the moment, it cannot be prevented. In the Community of Madrid (Spain), it has an incidence of 13.7 cases per-100.000 habitants.

Cardiovascular diseases are the leading cause of morbidity and mortality among diabetic patients (1). Heart Rate Variability (HRV) represents variations between consecutive heart beats (beat to beat or R-R intervals) and has long been used in stratification of the risk of sudden cardiac death and diabetic autonomic neuropathy. (2)

The aim of the study was to analyse heart rate variability in a cohort of children diagnosed with type I diabetes and the relationship with clinical variables such as insulin dose required for diabetes control, as well as time since diagnosis of diabetes or time to 24-hour normoglycaemia.

METHODS: An observational study was carried out with a sample of 14 children between the ages of 6 and 18, diagnosed with type 1 diabetes at the University Hospital of Getafe.

The assessment of the regulation of the autonomic nervous system was performed by measuring heart rate variability. For this purpose, the Firstbeat Bodyguard 2 heart rate monitor will be used for 24-hour recording (3). The HRV measurements performed were: RR intervals (or Normal to Normal-NN intervals), percentage of adjacent NN intervals differing by more than 50 milliseconds (pNN50), root mean square difference of successive RR intervals (RMSSD), low frequency (LF), high frequency (HF) and and Poincaré scatter plot (SD1 and SD2). Spearman´s Rho correlation were calculated among variables. P-value was set at 0.05.

RESULTS: The correlation between HRV variables and clinical data routinely collected in the management of diabetes was studied. A significant correlation was found between time to diagnosis of diabetes and PNN50 (rs=-0.536, p=0.048); RMSSD (rs=0.564, p=0.045), PNN50 (rs=0.597, p=0.031), and SD1 (rs=0.564, p=0.045), with time in normoglycaemic range; LF value (rs=-0.692, p=0.013), with total insulin dose per kg/day; RMSSD (rs=-0.657, p=0.02), LF value (rs=-0.804, p=0.002), HF value (rs=-0.643, p=0.024) and SD1 (rs=-0.657, p=0.02) with total insulin dose per day; and mean HR with PNN50(rs=-0.552, p=0.041) and LF (rs=-0.596, p=0.025).

CONCLUSION: The cohort of diabetic children have a decrease in HRV compared to normative values in healthy children. We found a positive correlation between lower variability as a function of longer time of diagnosis of diabetes and in those children with poorer glycaemic control. Targeted exercise programme could improve autonomic nervous system regulation.

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Conventional Print Poster

CP-MH06 Cancer I

EFFECTS OF A CLINICAL EXERCISE PROGRAM ON PHYSICAL CONDITION IN LUNG CANCER PATIENTS

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INTRODUCTION: Lung cancer is the third most frequent type of cancer in Spain after colorectal and breast cancer (1).Thanks to the scientific advancements in diagnostic procedures and treatments of cancer, survival rates in lung cancer patients have increased in recent years. However, there is still a significant percentage of patients who die because of lung cancer, recurrences and metastatic disease. While advanced treatments may increase survival rates, they also present with severe side effects. Some side effects can be treated with additional drugs, but some of them that are not simple to treat and may be chronic problems. For this reason, much attention has been paid to other strategies to reduce these comorbidities like physical exercise (2). This study aimed to report the feasibility of a multi-component exercise program for improving maximal cardiorespiratory fitness (CRF) in lung cancer patients.

METHODS: The study was an uncontrolled trial using a pre-post design with assessment at baseline and post-intervention (12 weeks, moderate to vigorous intensity). It was conducted at the Exercise Oncology Unit of the Spanish Cancer Association in Madrid. All eligible participants provided written informed consent and the study was conducted following the principles of the Declaration of Helsinki. Changes from baseline to post-intervention were analyzed using a paired t-test.

RESULTS: A total of 26 lung cancer patients completed the program and the post-intervention fitness assessment. Participants had a mean age of 60.6±9.2, 77.8% were women and 22.2% were men. In terms of medical data 88.9% had metastatic cancer,45% had surgery and 81.5% were on active treatment(36.4%chemotherapy,13.6%immunotherapy,18.2% targeted therapy,13.6% chemotherapy+ immunotherapy and 18.1% other treatments).

Exercise significantly improved VO2 max by 6.8 ml/kg/minutes($p<.001$),chest strength by 10.7kg ($p<.001$),leg strength by 32.3 kg ($p<.001$),lean body mass by 0.8kg ($p<0.001$),skeletal muscle mass by 0.5kg ($p=.007$),fat mass by -1.3kg ($p<0.001$) % fat mass by -1.7($p<.001$),waist hip ratio by –0.01 ($p=0.039$) and visceral fat area by -7.7($p<.001$).

CONCLUSION: A 12-week, supervised,multi-component exercise program involving moderate to vigorous intensity was found to be feasible and effective for lung cancer patients.

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CHANGES IN HEALTH-RELATED FITNESS AND FATTY LIVER INDEX AFTER A 12-WEEK REMOTE EXERCISE INTERVENTION FOR BREAST CANCER SURVIVORS: A RANDOMIZED CONTROLLED TRIAL

MIN, J.1, KONG, I.D.2

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INTRODUCTION: Exercise, along with other lifestyle modifications, is the most effective ways to manage breast cancer prognosis and recurrence. However, only around 40% of breast cancer survivors have a sufficient physical activity level. In particular, with less face-to-face contact after the COVID-19 pandemic, the decrease in exercise participation is emerging as a critical health problem. Accordingly, the application of remotely delivered exercise intervention is arising as a new alternative, although the efficacy of this method on breast cancer prognosis profiles was not fully understood. Therefore, the purpose of this study is to investigate the efficacy of a 12-week remote exercise program in breast cancer survivors on body composition, fitness, and metabolic profiles.

METHODS: A total of 50 breast cancer survivors (Stage 0-3) were randomly assigned to the exercise or usual care groups (1:1 ratio, mean age 53.9±6.5 years). Participants in the exercise group engaged 3 times per week in an instructional aerobic and resistance exercise program via Zoom (1 session: 30 minutes for 12 weeks). This was combined with unsu-

pervised home-based exercise on other days. The control group was asked to maintain their usual daily activity. The primary outcome was body composition, the secondary outcome was metabolic biomarkers, and the ancillary outcome was fitness parameters.

RESULTS: Among the 50 participants enrolled, 46 (92%) completed the trial with an exercise compliance. While there was no change in body composition factors in the control group for 12 weeks, in the exercise group, these factors improved after 12 weeks($p<0.05$). In addition, there were significant differences and changes between groups in weight($p<0.05$), body mass index($p<0.05$), and waist circumference($p<0.01$). After 12 weeks, there was a significant decrease in a fatty liver index($p<0.01$) in the exercise group, while there was no change in the control group. The exercise group experienced improved flexibility($p<0.01$), muscular strength($p<0.05$), and physical function($p<0.05$) compared to baseline.

CONCLUSION: Implementation of remote exercise intervention significantly improved breast cancer prognosis profile. We believe our study has important implications for understanding the efficacy and possibility of remote exercise as a new approach tool for intervention.

A PILOT RANDOMIZED CONTROLLED TRIAL EVALUATING A COMBINED AEROBIC AND RESISTANCE EXERCISE INTERVENTION IN PATIENTS WITH CANCER

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INTRODUCTION: The association between physical activity and the reduction in mortality and recurrence risk in patients with cancer is gradually consolidating. Exercise has been demonstrated to be an effective strategy in improving quality of life (QoL) and treatment-related side effects. Nevertheless, most patients are insufficiently active, and investigations show that patients compliance and adherence to an exercise intervention are challenging. Therefore, the aim of this study was to investigate the safety and feasibility, and preliminary efficacy of a 12-week combined aerobic and resistance exercise intervention in patients with cancer.

METHODS: A two-site, pilot, randomized controlled trial was carried out, including patients with different cancer types. The exercise intervention consisted of bi-weekly aerobic and resistance training personalized based on patients baseline conditions and preferences. Resistance training comprised body weight or elastic-bands exercises performed in 2-3 sets of 8-12 repetitions, whereas the duration of aerobic component, consisting in walking or cycling activity, training progressively increased over weeks. Both aerobic and resistance activity was performed at moderate intensity and checked using the 10-point Borg Rating of the Perceived Exertion Scale. Patients allocated to the control group received the usual care. The primary study endpoints were safety and feasibility. Safety was assessed using the Common Terminology Criteria for Adverse Events (AEs), whereas the feasibility evaluation included recruitment rate, adherence, and withdrawals. The secondary endpoints were: functional capacity, (Six minutes walking test), muscle strength, (handgrip and leg press test), and QoL, (European Organization for Research and Treatment of Cancer Quality of Life and Core Questionnaire (EORTC- QLQ-C30)). Descriptive statistics and repeated-measures analysis of variance were used to analyze data.

RESULTS: A total of 57 patients (38% recruitment rate; 68% breast, 14% colorectal) were randomly allocated to the intervention (n=37) and controls (n=20). During the 12-week, five dropouts were recorded, three in the intervention (leukemia onset n=1, psychiatric disorder n=1, gonarthrosis n=1), and two in the controls (lack of interest n=2), whereas the adherence to the exercise program was 93%. Three non-severe AEs occurred: n=2, worsening in the lymphedema (Grade 1), and n=1, elbow inflammation (Grade 1). Post-intervention evaluations showed improvements in the exercise group for functional capacity ($p<0.01$), and lower limb strength ($p<0.01$). For QoL, improvements in social function ($p<0.05$), fatigue ($p<0.05$), nausea and vomiting ($p<0.01$), dyspnea ($p<0.05$), insomnia ($p<0.05$), and loss of appetite ($p<0.01$) were observed.

CONCLUSION: Combined aerobic and resistance training is safe and feasible in patients with cancer, with improvements in physical fitness parameters and QoL.

FUNCTIONAL CAPACITY, MUSCLE STRENGTH, BODY MASS INDEX, AND QUALITY OF LIFE IN PATIENTS WITH CANCER: A REAL-WORLD EXPERIENCE

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UNIVERSITY OF VERONA

INTRODUCTION: Patients with cancer may experience a series of adverse effects related to the disease or treatments that collectively lead to a worsening quality of life (QoL). Exercise by alleviating some of the side effects and improving physical fitness is considered an important tool that can improve cancer patients' QoL. Additionally, QoL is an important predictor of patient survival. To our knowledge, little data are available about the association between physical fitness and patients' QoL. The present study aims to explore the associations between the components of physical fitness and QoL in a sample of patients with different types of cancer.

METHODS: A cross-sectional design was applied. Patients recruited at the Oncology Unit in the Verona Hospital underwent a series of assessments: (i) anthropometric measures, i.e., body mass index (ii) functional capacity, with the "Six minutes walking test" (6MWT), (iii) muscle strength, through the handgrip strength and the leg press strength tests, (iv) QoL, using the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire (EORTC QLQ C-30). Descriptive statistics, such as mean, standard deviations (or median and interquartile range), frequencies and percent-

ages, were applied to present data. Additionally, Pearson correlation was used to explore the association between physical fitness parameters and QoL domains.

RESULTS: Between 2019 and 2022, 164 patients with cancer were recruited. Overall, 71% were female, 45% had breast cancer, 14% pancreatic cancer, and 39% had metastatic disease. Regarding physical fitness, the mean values were: 512.12 meters (±95.81 meters) for 6MWT, 29.37 kilograms (±8.60) for right handgrip strength, 28.25 (±8.40) kilograms for left handgrip strength, 87.04 kilograms (±52.24) for leg press strength and 26.29 kg/m2 (±5.33) for body mass index. Correlation analysis showed that higher physical functioning was associated with a better 6MWT (r=0.458; p<0.001), right handgrip strength (r=0.217; p<0.001), and left handgrip strength (r=0.185; p=0.01). A higher 6MWT was correlated with a greater role functioning (r=0.258; p<0.001), global health status (r=0.279; p<0.001), and a reduction in dyspnea (r=-0.259; p<0.001), and insomnia (r=-0.259; p<0.001). Greater handgrip strength was associated with better cognitive functioning (right arm r=0.188, p=0.01; left arm r=0.18, p=0.02) and a lower pain level (right arm r=-0.187, p=0.01; left arm r=-0.241, p<0.01).

CONCLUSION: Preliminary results of our study suggest that better physical fitness is associated with a greater QoL and a lower level of symptomatology such as insomnia and dyspnea.

TREADMILL RUNNING SUPPRESSES TUMOR GROWTH THROUGH CD8+T CELL MOBILIZATION AND ACTIVATION

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INTRODUCTION: Aerobic exercise reduces the risk of cancer and disease recurrence. Yet the mechanisms behind this protection remain to be elucidated. The aim of this study was to investigate the anti-tumor effect and possible mechanism of regular treadmill running on MC38 colon cancer.

METHODS: Male C57BL/6 mice were placed placed in standard housing cages and maintained in a thermo-stated environment under a 12-hour light/dark cycle with free access to food and drinking water. At 8 weeks of age, mice were randomly divided into the exercise group (EXE, n=20) and the control group (CON, n=20). The EXE group mice were trained running using moderate intensity (60% of average maximum speed) for 60 min/day, 5 days/week for 4 weeks, and the control mice were housed with no intervention. After 4 weeks of aerobic running exercise intervention, the mice in both groups were inoculated with MC38 colon cancer cells, and the tumors were taken from each group when the average volume of the control mice reached 1000 mm3. Part of the tumor tissues were used for flow cytometry to detect the infiltration of immune cells (CD4+ T cells, CD8+ T cells, NK cells, macrophages, neutrophils). DAB staining of tumor tissues was used to further verify the infiltration of immune cells. Differential gene expression of tumor tissues was detected by RNA-sequencing; RT-PCR was used to verify sequencing results of differential genes in tumor tissues. Western Blot was used to detect the expression of key proteins of related signaling pathways and to clarify the possible mechanism pathways of aerobic exercise against tumor.

RESULTS: In mice inoculated with MC38 colon cancer cells, the tumor volume in the EXE group was significantly smaller than that in the CON group from day 8 after inoculation ($P < 0.01$). Flow cytometry results showed that the ratio of CD8+ T cells /tumor cells in tumor tissues of mice in the EXE group was significantly higher than that in the CON group ($P < 0.05$), while other immune cells did not show significant differences. Immunohistochemical results of tumor tissues showed positive CD8+ T cells consistent with the flow cytometry results ($P < 0.05$). RNA-SEQ results showed that the expression of inflammatory cytokines (Tgtp2, Zbp1, Gzmc, Gzmd) associated with interferon regulation and CD8+ T cell effector function were significantly higher in the tumors of the EXE group than in the CON group ($P < 0.01$). RT-PCR verified the results of RNA-SEQ ($P < 0.01$). Western Blot results showed that the phosphorylation levels of STAT and JAK proteins in tumor cells in the EXE group were significantly higher than those in the CON group ($P < 0.05$).

CONCLUSION: 4 weeks of moderate intensity treadmill running could exert an inhibitory effect on tumor growth of hyperimmunogenic MC38 colon cancer by increasing STAT and JAK protein phosphorylation levels and their mediated signaling pathways to induce CD8+ T cell mobilization and release of interferon-related inflammatory cytokines.

ASSOCIATIONS OF PHYSICAL FITNESS WITH NON-ALCOHOLIC FATTY LIVER RISK PARAMETERS IN BREAST CANCER SURVIVORS AND HEALTHY CONTROLS

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INTRODUCTION: Non-alcoholic fatty liver disease (NAFLD) is one of the most typical liver diseases globally. In middle-aged women, hormonal imbalance after menopause may result in an increased risk of NAFLD. In addition, breast cancer treatment is associated with an increased risk of NAFLD. However, there is a lack of clear evidence on the differences in NAFLD risk factors between breast cancer survivors (BCS) and healthy women is still lacking. Growing evidence has shown that a high level of cardiorespiratory fitness (CRF) may be associated with low risks of NAFLD or breast cancer. Also, muscular strength may be an important physical fitness marker given that sarcopenia is associated with both increased risks of NAFLD and breast cancer. However, the interrelationship of CRF and grip strength with NAFLD in BCS is unclear. Thus, the purpose of this study was to compare the NAFLD risk parameters between BCS and healthy controls (non-BCS), and to examine the association between NAFLD risk parameters and physical fitness levels.

METHODS: Using a case-control design, women with treated stage <4 breast cancer (n=40) and non-BCS women (n=40) were matched 1:1 by age and weight. We measured body composition using multi-frequency impedance technique (In-

Body 720, Biospace, Seoul, Korea), NAFLD risk parameters from blood samples (i.e., fasting glucose, insulin, ALT, AST, WISP-1, WISP-3, etc.), CRF using a step test, and grip strength using a handgrip dynamometer (TKK 5401, Japan). We also calculated Fatty Liver Index (FLI) which is a noninvasive method for predicting NAFLD. Descriptive statistics were used to compare characteristics. All study outcomes were compared using independent sample t-tests, or Mann-Whitney U-test, depending on the distribution of the data. Statistical significance was set at $p < 0.05$, and data were analyzed using SPSS version 20 (IBM Corp., Armonk, NY, USA).

RESULTS: Compared to non-BCS, BCS had significantly higher body fat percentages ($p<0.001$), fasting glucose ($p=0.02$), insulin ($p=0.04$), HOMA-IR ($p=0.02$), Aspartate transaminase (AST, $p<0.01$), and WNT1-inducible-signaling pathway protein (WISP-1, $p=0.01$). In contrast, WISP-3 ($p=0.02$), CRF ($p=0.02$), and relative hand grip strength ($p=0.01$) in BCS were significantly lower than in non-BCS. There was a significant relationship between fitness level and NAFLD risk parameters in both BCS and non-BCS. In particular, women with high CRF (BCS 20%, non-BCS 0%) had a significantly lower rate of FLI≥ 30 than women with low CRF (BCS 57.9%, non-BCS 44.4%).

CONCLUSION: BCS has a higher risk than non-BCS of developing NAFLD risk factors. To reduce the risk of NAFLD, it may be crucial to manage high levels of fitness.

EFFECTS OF A CLINICAL EXERCISE PROGRAM ON HEALTH-RELATED FITNESS AND QUALITY OF LIFE IN SPANISH CANCER PATIENTS RECEIVING ADJUVANT THERAPY

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INTRODUCTION: Chemotherapy and radiotherapy are 2 widely used therapeutic approaches for the treatment of cancer. Despite their survival benefits, chemotherapy and radiotherapy cause several side effects which interfere with the patients' functional capacity and quality of life (1). Among the most common side effects of these treatments are nausea, fatigue, diarrhea, neutropenia, muscle weakness, cardiotoxicity, and main side effects that are directly related to a worse prognosis of the disease and an increase in mortality from a variety of causes: reduced cardiovascular capacity and changes in body composition including loss of muscle mass and gain of fat mass. Related to cardiorespiratory fitness (CRF), it has been observed that cancer treatments reduce it up to 30%which is associated with a worse prognosis of the disease and an increase of mortality (2). Moreover, changes in CRF are associated with changes in quality of life (QOL) and fatigue. Since there are no established pharmacological treatments for these side effects, much attention has been paid to other strategies and therapies to reduce these comorbidities. More specifically, exercise has been shown to improve these outcomes in cancer patients receiving adjuvant treatments such as chemotherapy and radiation therapy thereby improving fatigue and QOL. The aim of the study was to report the feasibility and effectiveness of a newly developed clinical exercise program for improving maximal cardiorespiratory fitness in Spanish cancer patients receiving adjuvant chemotherapy or radiation.

METHODS: The study was conducted at the exercise Oncology Unit of the Spanish Cancer Association in Madrid and it was a single group implementation feasibility study using a pre-posttest design. Participants performed a 12-week, twice-weekly, supervised, multi-component exercise program during adjuvant therapy

RESULTS: We had 100 cancer patients referred to the clinical exercise program of which 85 (85%) initiated the exercise program and 76 (89%) completed the post-intervention fitness assessment. Exercise significantly improved VO2max by 4.8mL/kg/minutes ($P<.001$). Exercise also significantly improved chest strength ($P<.001$), leg strength ($P<.001$), lean body mass ($P<.001$), skeletal muscle mass ($P<.001$), fat mass ($P<.001$), % body fat ($P<.001$), quality of life ($P=.0017$), and fatigue ($P=.007$)

CONCLUSION: A 12- week, supervised, multi-component exercise program was effective for improving health-related fitness in Spanish cancer patients receiving adjuvant therapy. Our results show the benefits of incorporating clinical exercise programming into the supportive care of cancer patients receiving treatments.

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ASSOCIATIONS BETWEEN DOSE-DEPENDENT RESPONSES OF CARDIORESPIRATORY FITNESS AND BREAST CANCER MORTALITY: A SYSTEMIC REVIEW AND META-ANALYSIS

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INTRODUCTION: Conflicting findings about the associations between cardiorespiratory fitness and breast cancer are present in the literature. As such, this meta-analysis sought to investigate the associations between cardiorespiratory fitness and breast cancer mortality.

METHODS: Eleven studies were chosen for the current meta-analysis by searching the MEDLINE and EMBASE databases for English-language publications indexed between January 1990 and January 2023. Studies were deemed relevant for inclusion if they reported a relative ratio (RR) or hazard ratio (HR) of the associations between cardiorespiratory fitness and

breast cancer mortality, cancer mortality, and all-cause mortality. For inclusion, studies were required to indicate the methods of measuring cardiorespiratory fitness and report relative ratios (RRs) with 95% confidence intervals (CIs) or hazard ratios (HRs) with CIs of breast cancer mortality, cancer mortality, or all-cause mortality. Pilot, protocol, or review studies and studies that did not report RRs were excluded. A comprehensive meta-analysis version 1.25 software program (Biostatic, Inc., Englewood, NJ, USA) was used for this meta-analysis.

RESULTS: The cardiorespiratory fitness of breast cancer survivors was divided into three levels of low, moderate, and high to determine the associations between level of cardiorespiratory fitness and survival statistics, including breast cancer mortality, cancer mortality, and all-cause mortality.

CONCLUSION: High and moderate levels of cardiorespiratory fitness were inversely associated with breast cancer mortality, cancer mortality, and all-cause mortality compared to low cardiorespiratory fitness. Additionally, increased 1-MET of cardiorespiratory fitness was associated with cancer mortality and all-cause mortality, but an association between cardiorespiratory fitness and breast cancer mortality was not found because of a lack of appropriate studies to compute the summary of RRs. In summary, breast cancer mortality, cancer mortality, and all-cause mortality depend on the level of cardiorespiratory fitness, and cardiorespiratory fitness plays a pivotal role in cancer survival, including surviving breast cancer survival, other cancers, and other associated diseases.

Increased cardiorespiratory exercise can help to enhance breast cancer survival, cancer survival, and all-cause survival. The preferred level of cardiorespiratory fitness was more than 7 METs, but more studies to support this are needed. Enhancing 1-MET cardiorespiratory fitness decreased cancer mortality and all-cause mortality. No association between increased 1-MET cardiorespiratory fitness and breast cancer mortality was found due to a lack of relevant studies. Further research to find the association between cardiorespiratory fitness and breast cancer survival may be needed.

EFFECTS OF PERIOPERATIVE EXERCISE THERAPY ON CARDIORESPIRATORY FITNESS, POST-OPERATIVE COMPLICATIONS AND 5-YEAR SURVIVAL RATE IN PATIENTS WITH COLORECTAL CANCER: A SYSTEMATIC REVIEW AND META-ANALYSIS

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INTRODUCTION: Exercise has demonstrated to be beneficial for cancer patients in improving physical fitness [1]. Furthermore, improving cardio-respiratory fitness before and after surgery has potential to improve important post-operative outcomes [1,2]. Therefore, this systematic review and meta-analysis evaluated the effects of perioperative exercise therapy (aerobic, resistance, mind-body, flexibility, or mixed exercise (combined aerobic and resistance)) on cardio-respiratory fitness, post-operative complications and 5-year survival rate for patients diagnosed with colorectal cancer undergoing surgery.

METHODS: All methodological processes for this meta-analysis (i.e., data extraction, collection and analysis) and reporting were conducted in accordance with the Preferred Reporting Items for Systematic review and Meta-Analyses (PRISMA) guidelines. Eligible published randomised controlled trials were identified from an electronic database search (inception - 31st May 2020). Databases included PubMed, CINAHL, SPORTDiscus, Cochrane Library (CENTRAL), and Web of Science.

RESULTS: The systematic electronic search resulted in a total of 1,849 individual records. Researchers found 18 eligible trials (401 patients) that were subsequently included in the analysis. Pooled standardised mean differences (SMD) with 95% confidence intervals (CI) were compared and heterogeneity assessed using Cochran's Q and I2 statistics. Exercise either before or after surgery showed a small improvement in cardio-respiratory fitness (SMD = 0.18, 95% CI = 0.03, 0.32; $p < 0.05$). Exercise was also shown to improve anaerobic threshold (AT) in colorectal, colon and rectal cancer patients when compared to usual care (SMD = 0.53, 95% CI = 0.11; $p < 0.05$). Additionally, post-operative complications (Clavien-Dindo classification) and adverse events were found to have no significant differences.

CONCLUSION: These results demonstrate that perioperative exercise (whether alone or in combination) has the potential to safely improve cardio-respiratory fitness in colon, rectal and colorectal cancer patients. Therefore, primary care and allied health practitioners should consider the benefit of perioperative exercise therapy as a complementary component to standard colorectal cancer treatment.

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EFFECT OF EXERCISE-CONDITIONED SERA FROM CHILDREN WITH CANCER ON THE PROLIFERATION OF EWING SARCOMA AND RHABDOMYOSARCOMA CELLS

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INTRODUCTION: Exercise not only improves the fitness and well-being of adult cancer patients, but it also has direct effects on cancer itself including effects on cancer cell proliferation. Childhood cancers differ from adult cancers, and it is

poorly understood whether exercise affects cancer hallmarks in pediatric cancer patients. The aim of this study was therefore to 1) investigate whether incubation of two sarcoma cell lines with exercise-conditioned sera alters cell proliferation compared to resting sera and 2) whether there are metabolite biomarkers whose concentration predicts the proliferative/mitotic effect of a serum.

METHODS: We screened 212 patients with pediatric malignancies of which 11 children performed a high intensity interval training (HIIT) with 10 x 15 s intervals (1). Blood was drawn before and after the exercise and processed to serum. Subsequently, we incubated Ewing sarcoma (A673) and rhabdomyosarcoma (RD) cells with 10% exercise-conditioned or control media in triplicates and measured cell proliferation by WST-1 assay. Proliferation data were further correlated to serum metabolites quantified by mass spectrometry (AbsoluteIDQ p180 kit).

RESULTS: To find out whether exercise alters A673 and RD proliferation, we incubated these cells with the resting and exercise-conditioned sera and measured proliferation by WST-1 assay. When compared to sera taken at rest, exercise-conditioned sera reduced proliferation of A673 cells by 7 ± 30% (p=0.2), and of RD cells by 3 ± 7% (p=0.22), respectively. However, the inter-individual difference between proliferation responses to patient sera was greater: up to 400% for the A673 cell line and 84% for the RD cell line.

Next, to identify possible metabolite biomarkers for proliferation, we correlated exercise-induced metabolite concentration changes with exercise-induced proliferation changes.

This revealed two metabolite concentration ratios: Ornithine (Orn) to Arginine (Arg) (RD cells: r=0.788, p=0.006; A673 cells: r=0.782, p=0.006) and Asymmetric Dimethylarginine (ADMA) to Arg (RD cells: r=0.910, p=0.0002; A673 cells: r= 0.622, p=0.045).

CONCLUSION: The main finding of this study is that exercise-conditioned sera decreased the proliferation of Ewing sarcoma and rhabdomyosarcoma cells by less than 10%. However, we found large inter-individual variations in the proliferation effect of sera from different patients. Moreover, the serum changes of the ADMA/Arg and Orn/Arg ratios in response to exercise correlate with the change of proliferation in sarcoma cells, identifying ADMA/Arg and Orn/Arg ratios as candidate biomarkers for the proliferation effect of sera.

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Conventional Print Poster

CP-BM06 Balance and Coordination

CORTICOSPINAL EXCITABILITY CHANGES AND MODULATION INDUCED BY SHORT-TERM BALANCE PERTURBATION TRAINING

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INTRODUCTION: Balance control is a fundamental motor skill that requires rapid adaptation to dynamically changing environments (i.e. balance perturbation tasks). Several studies have examined how sensorimotor training (1), strength training (2), and even cognitive training (3) can improve balance control and induce neural modulation during training. However, neural modulation is known to be highly related to the motor task. Currently, little is known about how repeated balance perturbation training affects balance performance and its neural control. Therefore, this study investigated corticospinal adaption and its modulation in short-term balance perturbation training.

METHODS: 12 subjects completed two test sessions (TS1 and TS2) and one identical perturbation training session in between. The balance perturbation system operated at 25cm/s, accelerating at 2.5m/s2 over 30cm displacement in anterior or posterior directions, randomly. During the training session, subjects under 200 perturbations. In each test session, single-pulse TMS at 110% active motor threshold and electrical stimulation at 5% (±2%) of maximum M-wave elicited motor evoked potentials (MEP) and H-reflexes in the right leg soleus muscle, respectively, at two delays (40ms: short latency response (SLR) and 140ms: voluntary activation) after the onset of perturbation. Average velocity of center of pressure (COP) (mm/s) and maximum displacement (mm) was analyzed 1s before perturbation (Pre- phase), during perturbation (Act-phase) and 1s after perturbation (Rec-phase), respectively, normalized by individual height and body weight (m*kg).

RESULTS: COP velocity decreased at all the three phases in TS2 when compared to TS1 by Paired t-test (Pre-phase, TS1:0.148, TS2:0.121 ((mm/s)/(m*kg)), p = 0.024; Act-phase, TS1:1.726 , TS2:1.384 ((mm/s)/(m*kg)), p = 0.006; Rec-phase, TS1: 1.037, TS2: 0.719 ((mm/s)/(m*kg)), p<0.001). MEP/H-reflex ratio demonstrated significant decreases at voluntary activation phase (140ms) after perturbation training (TS1: 0.44 ± 0.33, TS2: 0.29 ± 0.14, p = 0.026). No differences occurred at SLR phase (40ms).

CONCLUSION: The main hypothesis of this study was that balance performance would improve together with a reduction in cortical excitability after short-term balance perturbation training. This hypothesis was supported by the finding of a progressively reduced velocity of COP in TS2. However, MEPs which represents corticospinal excitability did not change. On the other hand, the MEP/H-reflex ratio showed a reduction during the voluntary activation phase in TS2. This implies that neural control may have been transferred from motor cortex to more sub-cortical structures. This is in-line with a

previous study, in which acquired motor knowledge was stored in the sub-cortical area (i.e., basal ganglia) and can be recalled via cortical to sub-cortical network connections (4).

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EFFECTS OF INDIVIDUALIZED THERAPY ON OBJECTIVE AND SUBJECTIVE INSTABILITY AFTER ANKLE INVERSION TRAUMA

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INTRODUCTION: In chronic and acute ankle instability, postural control has been quantified using the amount and structure of variability of the centre of pressure (CoP) [1,2,3]. This study aims to analyse the objective and subjective recovery of postural control of acute and chronic patients during their rehabilitation process and compare them to healthy controls.

METHODS: Sixteen patients (26 ± 6 years) suffering from ankle instability after ankle inversion trauma were evaluated over 3 months. The patients received individual physiotherapy focusing on e.g., muscle strengthening, coordination, and or joint mobility. One-limb stance eyes-open and eyes-closed performance was recorded for 60 seconds using Qualisys 3D motion analysis system. Performance was quantified by assessing CoP cumulative distance, standard deviation, and sample entropy as percentages of the healthy control means. The FAAM and CAIT were used to monitor daily life performance subjectively. Objective and subjective performance assessments were made in weeks 0, 3, 6 and 12. Mixed models allowing for subject differences were used to test for effects.

RESULTS: There was no significant difference between chronic (6) and acute (10) patients. At week 0, standard deviation and cumulative distance were 10-16% and 10-30% higher, respectively, in patients compared to controls. Sample entropy was 3-12% higher with eyes-open and 2-8% lower with eyes-closed in patients compared to controls. This difference reduced significantly for all parameters by 0.7-1.4% per week. Also, the patients reported a significant improvement in daily activities (FAAM-ADL), sports (FAAM-S), and instability score (CAIT) over time.

CONCLUSION: In both one-limb stance conditions, the patients showed larger excursions than the healthy controls. Furthermore, with eyes open, the patients showed noisier postural control while in the eyes-closed situation, the patients showed more rigid control. The differences between the patient and healthy groups converge over time, which was accompanied by a subjective reduction of instability impairments.

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COMPARISON OF RESULTS OF SCALING ANALYSIS OF FORCE PLATFORM AND EMG RECORDS OF STANDING WITH KNEE INJURY

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INTRODUCTION: We compared long-range temporal characteristics of simultaneous force platform and EMG records of quiet standing with knee injury to one leg only, with same sets of data from non-injured standing. The EMG data in our dataset were taken from m. quadriceps femoris of both (injured and non-injured) legs. We analysed all our recordings from two force platforms, to assess scaling in quiet standing for each leg separately.

METHODS: We used wavelet transform spectral analysis (WTS) to quantify force platform and EMG data, to characterize quite standing with WTS peaks as relevant parameters, and to show how those parameters change with knee injury to one leg. WTS is a method comparable to Fourier spectrum analysis (PwS) that has better signal localization in both time and scale (frequency). It is a two-dimensional time series decomposition in both time and frequency, with functions constructed by expanding by time scale and translating along real time of a specifically chosen original wavelet function.

RESULTS: We found long-range autocorrelated behaviour in all our force platform records, with a visible crossover in long-range dynamics, a random behaviour on small time scales and a distinct non-linearity on higher time scales. Under the knee injury to one leg, only the scaling above the crossover, on time scales from 100ms to 1s, changed in our dataset. We observed two main types of response to injury: a compensation, seen as an increase of all the characteristic modes above the crossover point that causes a shift of the position of crossover to smaller scales, and an 'underachievement', which presents as a decrease of amplitudes of the characteristic WTS peaks above the crossover region that brings about a shift of the position of crossover point to higher time scales. We found that, especially for the 'underachievement' behaviour, changes in WTS spectra associated with the knee injury are mainly visible in changes of the amplitude of WTS peaks

at 250ms and 650ms. Our EMG WTS results provided further insights into the m. quadriceps femoris engagement and engagement time scales (frequencies) that are associated with this change.

CONCLUSION: Our results show that scaling techniques such as WTS can distinguish knee injury even in quiet standing. In that regard, those can be used as simpler and less invasive methods to detect or understand injury.

INTER-JOINT COORDINATION DURING UNILATERAL SEATED SHOT PUT TEST

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UNIVERSITÉ LYON 1

INTRODUCTION: The Unilateral Seated Shot-Put Test (USSPT) as described by Chmielewski et al. (1) consists of a maximal forward push of a 3-kg medicine-ball from a seated position. Distance reached is positively correlated to maximal upper-limb pushing power and is about 8% superior for the dominant side in comparison to the non-dominant one (2). Nevertheless, such a side difference is not explained by bilateral maximal power difference, suggesting that other factors like inter-joint coordination may be involved. The purpose of this study was therefore to assess the influence of upper-extremity side on inter-joint coordination during USSPT.

METHODS: Fifteen healthy male athletes (Age: 24.4±2.8 years; Height: 179.1±7.6 cm; Mass: 72.0±7.9 kg) were involved in this study. After being fitted with 56 reflective markers located on the trunk, clavicle, scapula, humerus, forearm and hand, they performed one familiarization trial followed by three USSPT trials per side. Raw marker trajectories were recorded with a 10-cameras optoelectronic system. Humerothoracic, elbow and wrist angles were computed for each side using a multibody kinematic optimization, and derived by the time to obtained angular velocities. Percentages of movement corresponding to peak angular velocity of humerothoracic flexion, elbow extension and wrist flexion were kept for analysis. USSPT distances were allometrically normalized.

RESULTS: USSPT distances were significantly higher for the dominant side in comparison with the non-dominant one (86.9±9.3 cm.kg0.35 vs 83.1±5.9 cm.kg0.35, $p<0.05$). For the dominant side, humerothoracic peak velocity was achieved before ($p<0.05$) elbow peak velocity, which was achieved before ($p<0.01$) wrist peak velocity (71.3±19.0% vs 86.0±3.9% vs 90.4±3.1%, respectively). For the non-dominant side, humerothoracic peak velocity was achieved before ($p<0.05$) elbow and wrist peak velocities, while the two latter occurred simultaneously ($p=0.13$) (69.3±18.1% vs 85.9±4.4% vs 87.8±7.4%, respectively).

CONCLUSION: Similarly to ballistics movements (3), upper-extremity inter-joint coordination during USSPT is characterized by a proximo-distal sequence. Nevertheless, the alteration in this sequential coordination for the non-dominant side may explain the lower USSPT distance reached in comparison to the dominant side. Our findings provide a first evidence of inter-joint coordination involvement in the USSPT performance.

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JOINT MOVEMENT PHASE DIFFERENCES DURING SITTING DOWN AND STANDING UP MOVEMENTS BETWEEN PEOPLE WITH AND WITHOUT LOW BACK PAIN

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INTRODUCTION: Past kinematic studies compared the joint movement of people with and without Chronic Low Back Pain (CLBP) during sitting down and standing up tasks. Different studies tend to use slightly different tasks and different data analysis methods, causing difficulty in results synthesis in a meta-analysis. Five Repetition Sit-To-Stand (5RSTS) test are validated and objective physical functioning tests where people with and without CLBP have significant performance differences, and were used as the measured tasks in this study to investigate significant difference in trunk and lower limb joint movement kinematics.

METHODS: 34 Men and women aged 19 to 55 with CLBP and minimum Oswestry Disability Index (ODI) score of 16 were recruited and compared to 20 asymptomatic participants. Both CLBP and asymptomatic participants had reflective markers attached to their trunk and lower limbs and were instructed to do the 5RSTS test with joint position data captured using 11 Vicon motion capture cameras . Maximal joint Range of Motion (ROM), Mean Absolute Relative Phase-angle (MARP) and Deviation Phase were calculated for each participant. One-way Multivariate Analysis of Covariance (MANCOVA) with CLBP status as the independent variable and gender, age and height as the covariates to investigate the difference between groups.

RESULTS: CLBP participants have significantly larger left knee to left hip and right knee to right hip MARP and DP on the standing up movement, with $F(24,26) = 1.944$, $p = 0.05$, Wilks' $\Lambda = 0.358$, and partial $\eta 2 = 0.642$ in 5RSTS task. CLBP status did not have significant effects on the maximal joint ROM in the analysis.

CONCLUSION: CLBP participants' lower limb joint coordination was significantly out-of-phase, with a larger standard deviation compared to asymptomatic participants, with no significant difference in maximal joint ROM during sitting down and standing up from a chair. This result indicates that despite significantly lower speed performance in CLBP participants, they do not have significant joint movement restrictions to fulfill the 5RSTS tast. Future intervention studies may consider focusing on trunk and lower limb joint movement coordination on people with CLBP instead of increasing their maximal range of motion.

ADAPTIVE FORCE – THE CONCEPT, MEASUREMENT AND POTENTIAL IMPORTANCE OF A NEUROMUSCULAR FUNCTION

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INTRODUCTION: Orthopaedic injuries are related to muscle lengthening actions under load.[1] During motion the neuromuscular system often has to adapt to external forces by adjusting the muscle tension and length permanently to the varying external circumstances. For this neuromuscular function, the term Adaptive Force (AF) was introduced.[2,3] For AF assessment the subject has to adapt adequately to an increasing external force while holding isometrically. If the maximal holding force (AFisomax) is exceeded the muscle starts to lengthen. The external load should be decelerated further as good as possible (peak value = AFmax). Holding isometric and eccentric muscle actions require high efforts of motor control,[2-5] especially during adaptation to changing external demands. It was shown that afferent influences, as imagery,[6,7] odors,[3] and post-infectious states (Long COVID) [8,9] can affect the holding capacity. However, this neuromuscular function was not considered in motor science so far. The aim is to objectify the AF, present its neurophysiological particularities and to discuss its possible value.

METHODS: To measure AF, force and kinematics have to be monitored simultaneously while a subject adapts to a varying external load, firstly isometrically. Two devices were developed to objectify the AF: (1) pneumatic system (pneumatically controlled lever pushes against the subject); (2) handheld device (force increase is applied manually by an examiner via handheld device). The decisive parameter to be identified is the force at the moment in which the subject merges from holding isometric to eccentric action (AFisomax).

RESULTS: Both systems show force-angle courses in a reproducible way. Muscles of healthy subject start to lengthen at submaximal forces (~80% MVIC) when tested with the pneumatic device. During manual testing 100% of AFmax or MVIC can be reached and mutual oscillations (~10 Hz) appear. In case of disturbing stimuli AFisomax is significantly reduced (~50% of AFmax) but the force increases further during lengthening. AFmax and MVIC do not differ significantly. Moreover, AFmax does not react to disturbing stimuli as AFisomax does.

CONCLUSION: Early yielding muscles could imply instability of the related joint. It is suggested that a low AFisomax (related to AFmax or MVIC) reflects a reduced muscular stabilization. The holding capacity might indicate functional disturbances which could be relevant for different health conditions. Muscular instability couldcould be tied with risk of musculoskeletal complaints, and injury mechanisms.

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ANKLE AND KNEE STABILITY AS PREDICTORS FOR DYNAMIC BALANCE

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INTRODUCTION: The Y-balance test (YBT) is a commonly used clinical tool to predict lower extremity injury risk in athletic populations. Specifically, anterior and posteromedial reach asymmetries of ≥4 cm have been found to elevate injury risk [1,2]. It is unclear which factors impact YBT dynamic balance. In this study we examined whether muscle mass difference between lower limbs, joint movement during unilateral squat, or static balance during stork balance test were associated with YBT dynamic balance performance.

METHODS: 14 collegiate Division 1 female volleyball players (20.4 ± 1.8 yrs, 174.9 ± 7.6 cm, 69.7 ± 9.3 kg) completed body composition scan via dual x-ray absorptiometry, dynamic balance testing via YBT, and movement analysis via 3-D markerless DARI Motion. YBT reach distances were performed in three directions: anterior, posteromedial, and posterolateral; and difference between left and right legs was calculated. For the unilateral squat, participants were asked to stand on one leg with arms outstretched in front, then squat as low as possible. Sway during a 30-sec open-eyes stork test on either leg was calculated. All assessments were conducted during one visit shortly after the team's competition season. Data were analyzed using Pearson correlation and stepwise linear regression.

RESULTS: Average reach differences were 6.4 ± 7.1 cm for anterior, 4.4 ± 2.9 cm for posteromedial, and 3.8 ± 3.4 cm for posterolateral. Lean mass was similar in the legs (left: 7740 ± 1301 g or 62.6 ± 3.0%, right: 8070 ± 1407 g or 63.2 ± 3.2%). No significant correlations were found between YBT reach differences and leg lean mass differences ($p > 0.05$). Posterolateral reach difference was correlated with dynamic knee valgus (left knee $r = 0.56$ and $p = 0.046$, right knee $r = 0.56$ and $p = 0.048$) and ankle flexion ($r = 0.55$, $p = 0.051$) during the unilateral squat. No other correlations with joint angles were found. Right and left ankle medial/lateral sway during stork balance test significantly predicted anterior reach difference ($r2 = 0.75$, $p = 0.001$).

CONCLUSION: Lower limb muscle mass was not associated with dynamic balance. Ankle and knee stability seem to play a role in maintaining dynamic balance. Strength and conditioning programs should focus on ankle and knee functional dynamics.

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SMART EYEGLASSES TO CHARACTERIZE PHYSICAL PERFORMANCE OF OLDER ADULTS: A CLUSTERING-BASED APPROACH ON FUNCTIONAL AND BIOMECHANICAL PARAMETERS

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INTRODUCTION: The decline in physical capacities with aging is often associated with falls and/or frailty. Falls and/or frailty are detrimental for older adults, impairing their quality of life and leading to a progressive loss of autonomy. Assessing falls and/or frailty with multifactorial measures is highly recommended due to the complexity and non-linearity that characterizes older adults' clinical status [Lee et al., PM&R, 2013]. For this purpose, recent approaches using unsupervised analyses helped to categorize the risk of falling from different clinical tests [Wong et al., IEEE, 2021]. In addition, the development of wearable technologies integrated in everyday objects allows the monitoring of daily life movements. The purpose of this study was to characterize a population of older adults through the measurement of functional and biomechanical parameters collected with an accelerometer embedded in smart eyeglasses.

METHODS: Eighty-four older adults equipped with connected smart eyeglasses performed different functional tests (i.e., 30-s Sit-to-Stand, 6-min walk and Timed-Up and Go [TUG] in comfort and fast condition). Seven functional and biomechanical parameters (i.e., number of Sit-to-Stand, maximal vertical acceleration values during Sit-to-Stand movements, total walking distance, step duration and length, duration of TUG in both conditions) were collected from the smart eyeglasses' acceleration data. First, supervised analyses (ANOVAs) compared the parameters measured between groups according to their "fall" and "frailty" status. Second, an unsupervised analysis (i.e., clustering algorithm based on K-means) was realized to characterize the participants from the functional and biomechanical parameters.

RESULTS: Only one of the seven parameters (i.e., step length) tended to differ according to "fall" status ($p=0.06$). While no parameters differed between frail and pre-frail participants, five of them were different ($p<0.05$) between frail and robust participants (i.e., number and maximal vertical acceleration of Sit-to-Stand, distance covered, step length, TUG time in fast condition). The unsupervised analysis characterized the population into three distinct physical performance groups (i.e., low, intermediate, and high). The seven parameters measured were useful to differentiate the low and high-performance groups. Four of the measured parameters (i.e., distance covered, step length, TUG time in both conditions) discriminated the three performance groups ($p<0.05$). In addition, the low-performance group had a higher proportion of frail participants ($p<0.01$).

CONCLUSION: The seven functional and biomechanical parameters were different between the physical performance groups determined with the unsupervised analysis. An accelerometer embedded in smart eyeglasses, an object of everyday life for most of older adults, could be useful to assess daily life movements and to identify a possible decline and/or improvement of physical capacities.

THE TRUNK'S CONTRIBUTION TO POSTURAL CONTROL FOR CHILDREN WITH CEREBRAL PALSY.

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INTRODUCTION: In typically developing (TD) children, postural sway control matures from infancy through adolescence[1]. The individual contribution of each joint to postural oscillations in orthostatic posture has not been questioned in pediatric population. In particular, while the inverted double pendulum model is widely accepted, it is now suggested that the involvement of the upper body, and especially the trunk, should also be considered[2]. Trunk control, which is a determining factor in the acquisition of posturokinetic abilities[3], is also known to be deficient in children with cerebral palsy (CP)[4], which could impact their oscillation control strategies. Therefore, the aim of this study was to determine the relative contribution of the trunk to the lower limb joints in the control of postural oscillations in TD and CP children.

METHODS: Seventeen TD children and 13 PC children aged 7 performed one quiet stance task. They had to stand as still as possible during 20 seconds, on two force plates (AMTI, Watertown, MA, USA). Whole-body kinematics were measured using 3D motion capture with 9 cameras (Vicon, Oxford Metrics, Oxford; UK) with the Conventional-Gait-Model markerset. Kinetics and kinematics were sampled at 1000Hz and 100Hz respectively. The ankle, knee, hip and trunk range of motion (Amp), angular velocity (Vel) and standard deviation (SD) in the sagittal plane were computed. We also calculated the Amp, Vel and SD from the anterior-posterior center of forces (CoF) data. We performed multiple linear regression analyses

of joint kinematic variables as predictors of the CoF matching variables, for our two populations. The threshold for statistical significance was set to $p<0.05$.

RESULTS: The Amp-model was significant ($R^2=0.67$), with the ankle having the greater B-coefficient absolute value (B=2.05), followed by the trunk (B=0.58), the knee (B=-0.37) and the hip (B=-0.12) for the TD children group. The SD-model and the Vel-Model were not significant.

With the CP children, the Amp-model and SD-model were significant ($R^2=0.78$ and $R^2=0.71$ respectively), with absolute values of B-coefficients higher for the ankle (B=-3.53 and B=-3.03) than for the knee (B=1.86 and B=1.43), the trunk (B=1.09 and B=0.88) and the hip (B=-0.47 and B=-0.23). The Vel-Model was not significant ($R^2=0.38$, $p=0.38$).

CONCLUSION: In both groups, the trunk was more important than the hip in controlling balance, underlining that the double inverted pendulum model blurs the real impact of the trunk[2]. Trunk control disorders have been shown to be a significant predictor of lower limb behavior during walking in CP children, more than neuromuscular dysfunction[5]. Because of this, it is possible that the larger contribution of the ankles and knees in PC children are compensatory strategies for poor trunk control, which is known to influence postural sway during sitting and standing[4].

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RELIABILITY AND VALIDITY OF AN INERTIAL SENSOR-BASED KNEE ANGLE MEASURING DEVICE FOR GAIT SONIFICATION

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INTRODUCTION: For real-time feedback devices in gait therapy, accurate measurement of the corresponding gait parameter is important. Additionally, the technique should be cost-effective and simple in application to make it accessible to patients. Inertial sensor-based systems are comparably low in cost, while still having good measurement agreement for relevant gait parameters (Petraglia et al., 2019; Picerno et al., 2017). The aim of this study was to test the measurement capability of a self-developed IMU-based gait sonification system (sofigait, BeSB, Berlin, Germany) that measures and sonifys the sagittal knee angle curve in real-time.

METHODS: The study was carried out with a sample of N=28 participants (22.8 ± 2.9 years) on a treadmill (cosmos hp). It consisted of determining the criterion validity of the knee angle measurement by comparison of the measurement with an optical system (Vicon, Oxford, UK). Prior to this, testing for temporal stability and for reproducibility of the knee angle measurement was conducted with two persons (34 ± 2 years, 172 cm). Each person did 5 trial walks for 5 continuous minutes.

RESULTS: For the first part, deviations were calculated for four events of the curve (2 maxima, 2 minima). Within each 5-minute walk, deviations ranged from 0.36° to 8.21° for all events with a mean of 2.23° ± 1.5°. Between the different walks (reproducibility), measurements deviated in a range of 0.9° to 12.09° (mean 5.41°). For the measurement comparison, the root mean squared error (RMSE) was 7.6° ± 2.6° (left) and 6.9° ± 3.1° (right). Statistical parametric mapping (SPM) revealed significant differences between the two measurement systems for the range 45 - 90% of the gait cycle ($p < .001$) (left) and 45 - 80% ($p = .007$) (right).

CONCLUSION: No systematic drift over time was detected and the variation between the repeated measurements was greatest for the peak angle values. In terms of criterion validity, differences between the optical motion-capturing system and the prototype inertial-sensor-based system were found to be in the expected range. The RMSEs are comparable to Favre et al. (2009). The SPM further revealed non-agreement between both systems in the area of maximum knee flexion.

It is concluded that the knee angle curve is reliably reproduced by the inertial sensor system for the purpose of generating sonification feedback.

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Conventional Print Poster

CP-SH02 Physical activity promotion

A QUALITATIVE CASE STUDY ON EXPERTISE OF SPRINT GUIDE RUNNER : CONSIDERATION BASED ON CASE OF FOUR ATHLETES WITH SEVERE VISUAL IMPAIRMENT FOR OVER 20 YEARS.

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Introduction

The guide discussed in this study is a specific method for the competitions with visually impaired athletes in Paralympics, in which the guides directly assist athletes to run by holding a guide rope with the athlete, so as to ensure their smooth participation of the competitions. Athletes who require a guide runner are with severe visual impairments. It is indispensable for them to have direct support such as guide runners to run in competitions. However, securing guide runners is still recognized as a challenging issue, especially for short-distance (sprint) events. It is considered that clarifying the factors necessary to be sprint guide runners and presenting role models would be effective to secure sprint guide runners. The purpose of this study was to qualitatively examine the factors related to the development of expertise in a sprint guide runner.

Methods

The subject was one adult male who had experiences as a sprint guide runner for various severe visual impaired athletes for about 20 years. He was asked to cooperate and give consent based on the common purpose viewpoint in qualitative research. In this study, the analysis was conducted using a method based on semi-standardized interviews and the structure laying techniques (Flick, 2011 ; Japanese edition) to reconstruct the subjects subjective theory.

Results

As a result, the subject had no prior knowledge of sprint guide runner and had never had any contact with visually impaired people. The subject started the guide activities by working and learning from a visually impaired person who became his first partner. The subject is now taking actions to maintain appropriate distance in daily life and trying to establish a "normal" relationship considering "gender," "age," and "whether the disability is congenital" to build a good relationship. It has been revealed that the process of creating synchronized movements using the guide rope as "sensor" is important in sprint guiding methods. The study also indicated that guiding a sprint runner requires quick movements and also split-second timing to judge while running which are still difficult to control. In addition, when his partner was a junior athlete who was considerably slower and had a height difference, it was necessary for the subject to lower the position of the guide rope and adjust to "slower pace" of the partner.

Discussion

Compared to long-distance running, sprint guide runners must start using starting blocks. In some cases, they may also need to serve as a "caller" in the long jump event. Becoming proficient sprint guide runner may take time, but it will increase the potential for training up sprint guide runners for athletes with sever visual impairments through the learning programmes taken into consideration the cases and factors shown by this study.

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COMPARISON OF PARTICIPATING MECHANISM OF LEISURE MARATHON AMONG CHINA, THE UNITED STATES AND JAPAN

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Purpose – The goal of this study is to test whether the leisure constraints negotiation model is effective in cross-cultural sports participation scenarios, to understand whether the negotiation strategy helps people overcome leisure sports participation constraints, and further explain the participation behavior mechanism of marathon runners.

Design/methodology/approach – Based on using quantitative research methods and comparative research methods, this study developed the "China-US-Japan Marathon Questionnaire on Participation Behavior Mechanism" in collaboration with experts from three countries. A total of 356 valid questionnaires were collected from the U.S., 308 from China and 305 from Japan through online surveys (M-Turk, Questionnaire Star, off-line,etc.), snowballing referrals, contacting clubs and participating in marathons. Structural equation modeling was used to verify the direct effects of constraints, motivation, negotiation, and participation loyalty on engagement behavior, and the indirect effects of negotiation and loyalty. Then multigroup invariance using AMOS was operated to compare in details with the differences in the formation path of marathon participation mechanism among China, the United States and Japan .

Findings – Results showed that (a) the general revision model paths were all significant except for negotiation to participation behavior, also (b) motivation had significant impact on negotiation and participation loyalty, (c) constraints and motivational factors indirectly and positively influenced participation loyalty and behavior through negotiation, and (d) both negotiation and motivational factors indirectly and positively influenced participation behavior through participation loyal-

ty. (e) In respective country, constraints had a significant impact on negotiation and participation loyalty in Japanese and U.S., also (f) the motivation for participation behavior and negotiation for participation loyalty were significant in China and the US. Negotiation was significant for participation behavior only in the US, and participation loyalty was significant for participation behavior only in Japan.

Practical implications – This study expects to understand whether negotiation strategies could help people overcome the constraints of marathon participation, and what behavior mechanism existed in the participation process of recreational marathon runners so as to provide for national authorities with suggestions about formulating or guiding people to promote active leisure participation. This has important practical implications for countries to formulate and implement leisure-based health promotion programs.

Originality/value – The above findings contribute to the literature in the following points. In the first place, the relationships between motivation, constraints, negotiation, participation loyalty and participation behavior were tested, also spotlight on the chain mediating role played by negotiation factors and participation loyalty. In another, this study confirms that the overall model is basically applicable in the China-USA-Japan cross-cultural scenario. Additionally, this study confirms that the most effective way to increase runner participation behavior is to activate the motivational factors of the marathon runners in China, the US and Japan.

Keyword: Leisure; Marathon; Constraints; Negotiation; Participation; Cross-culture

EXERCISE PROVIDERS IN THE UK ARE NOT USING THE PHYSICAL ACTIVITY GUIDELINES TO INFORM THEIR STRENGTH PRESCRIPTION WITH OLDER ADULTS

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Strength recommendations have been embedded within the United Kingdoms (UK) Chief Medical Officers' physical activity guidelines since 2011. There is limited evidence that these recommendations are used by exercise instructors in the community to underpin strength prescription in the older adult population. This study aimed to explore exercise instructors' utilisation of the guidelines when prescribing strength training to their older adult clientele. Fifteen exercise instructors working with older adults in the UK participated in one online interview. A general inductive approach was conducted to allow for major themes to be identified from the raw data. We found that most exercise instructors, but not all, were familiar with the guidelines. Only one of 15 instructors had reportedly implemented the guidelines into their practice; other instructors reported that the guidelines were irrelevant. The interviewees each had their preferred sources of information that they relied on to underpin their exercise prescription, and each had their own interpretation of 'evidence-based strength training.' This individualised interpretation resulted in exceptionally varied prescription in the community and does not necessarily align with the progressive, evidence-based prescription known to build muscular strength. We suggest that i) an improvement to the guidelines, ii) an additional handbook on how to implement the guidelines, iii) an update to theoretical and practical teaching materials and courses, and/or iv) a re-(education) of exercise instructors already in the field may be necessary to bring about a consistent, evidence-based strength prescription that would be required for the best possible outcomes for our ageing population.

A STUDY ON THE RELATIONSHIP AMONG PHYSICAL FITNESS AND ACADEMIC PERFORMANCE, SPORTS CLUB PARTICIPATION, TIME SPENT ONLINE, AND SLEEP

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Introduction: The internet, is a modern tool used in computers and mobile phone, providing vast chances to its users changing their lifestyle such as education, entertainment and social communication, (Öz, et al.,2015). Given the quick and easy access of the internet, leading excessive use causing a negative outcome which is known as internet addiction. However, excessive and dysfunctional uses of the Internet causes certain problems. One of these negative outcomes is described as internet addiction and could lead to poor sleep quality (Chou et al., 2005). Poor sleep quality and related sleep disorder has caused great influence on student's university life reveal that sleep-related disorders and have a great impact on students' daily life (Schlarb et al., 2017). Studies have found that physical exercise showed beneficial for individuals mental and physical health. (Gust & Bryan, 2021). Decreasing the danger of long-lasting diseases such as, lipids and hyperglycemia (Pourtaghi et al., 2021). Furthermore, it enables wellbeing social engagement, healthy lifestyle, improves depression related problems and obesity (Chu-Ko et al., 2021).

Method: Physical fitness tests for cardiorespiratory endurance, instantaneous strength, muscular endurance, and flexibility, as well as internet use and sleep quality were analyzed. A total of 31,356 students (11,274 males and 20,082 females) were enrolled in our physical education program from 2017 to 2020 academic years and analyzed the changes in physical fitness of students from university in Taiwan.

Result: The results showed that physical fitness was positively associated with academic performance ($r = .033$, $p < .05$) and sports club participation ($r = .087$, $p < .05$); physical fitness was negatively associated with time spent on the Internet ($r = -.021$, $p < .05$) and physical fitness was not associated with sleep. The results are consistent with most previous studies (Castelli et al, 2007, Wu, 2010, Tseng, Jong-Wei et al, 2012, Han, Ma-Li et al, 2014) which confirmed that students physical fitness is positively associated with academic performance.

Discussion: In order to implement the national policy to promote students physical fitness and to revitalize the campus to improve students vitality and health. The study proposed and analyzed the changes in physical fitness of students from university in Taiwan during 2017 to 2020 to evaluate the rate of physical fitness test and pass rate during the period before and after the COVID-19 epidemic, and to further understand the relationship between physical fitness and various students learning and school activities habits such as; time spent on the internet, and sleep. Furthermore, we further observed the differences in academic performance, time spent on the Internet, and sleep among students of different fitness levels. This studied fund that,= physical exercise showed a positive relationship among students academic performance, internet use and sleep.

WALKING CHARACTERISTICS OF TOP FASHION MODELS DURING PARIS AND MILANO COLLECTIONS IDENTIFIED BY QUANTITATIVE ANALYSIS OF PUBLICLY AVAILABLE MOVIES -VOGUES OVER PAST THREE DECADES-

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[Introduction]

Aesthetic walking has been raised as one of the goals of walking training for various ages. Understanding the characteristics of aesthetic walking is, therefore, essential for the various services that aim to promote such walking (e.g., physical trainers). Walking styles of fashion models who walk the runway of world's top collections could be considered as one of the good examples of an aesthetic walking. Traditionally, it was not easy to assess their walking styles. Recent advancement of computer vision technology and movie sharing services, however, enable us to analyze such walking characteristics. This study quantitatively analyzed the publicly available movies of Paris and Milano collections of world's top brands over past three decades, to understand (1) the walking characteristics of top fashion models, and (2) the vogues of walking characteristics on the runway over time.

[Methods]

The videos of 72 female fashion models who walked the runways of the Paris and Milan spring/summer collections of Dolce & Gabbana, Louis Vuitton, Valentino, Versace, and Yves Saint Laurent from 1989 to 2023, shot from the front, have been quantitatively analyzed by the following process. First, skeletal coordinates of the models have extracted by using the human pose detection library (Vision Pose). Second, Principal Component Analysis was applied to the time-normalized data to reduce the dimensions of datasets. Third, Hierarchical Cluster Analysis was applied to the principal component scores of extracted principal component vectors to classify the characteristics of models' walking. Finally, the stick figure animations that representing the walking characteristics of each cluster have reconstructed by using the component matrixes.

[Results and Discussion]

The walking characteristics of top fashion models were classified into six clusters. From the reconstructed stick figure animations of each cluster and the basic information of the movies (brands and year of the show), we found that the cross-legged walking style, which is commonly imagined as the models walking styles, is rarely seen since the early 2010s. After the late 2010s, walking style without crossing their legs has become common. Further, asymmetric left-right motion was observed in many models. Because of the ways this study took, we cannot fully determine whether these results are caused by the models themselves changing the way they walk, the effect of the dress, shoes, or the location of the show, or the effects of other aspects such as the advancement of filming technology. However, it is very interesting to notice that such differences of walking styles have found from the films released as a record of the worlds top brand shows. This study clearly showed the walking characteristics of top fashion models on the runway and the vogues over time as a good example of an aesthetic walking.

A LONGITUDINAL STUDY ON EXERCISE HABITS AND MENTAL HEALTH AMONG SWEDISH POLICE STUDENTS

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Introduction

In Sweden, police education should promote students' physical activity and mental health. According to national goals, police students should be provided with sufficient conditions to develop and maintain advantageous exercise habits and tools to handle various mentally and physically demanding tasks. The national goals also state that students' physical fitness must be better at graduation than what the requirements are for admission (see Krugly et al., 2022). Although the improvement of students' physical fitness and mental health are national goals, there is a general lack of knowledge regarding: 1) police students physical and mental health, especially from a Swedish perspective; and 2) how well police education promotes students' level of physical activity during education. Against this background, the aim is to explore police students' mental health and level of physical activity during police education in Sweden.

Methods

The data derives from the largest project in Sweden on police students' physical and mental health, and consists of longitudinal data on police students answers of a self-rated questionnaire about exercise habits and mental health (N = 785). The data used in this study was gathered between 2019–2021, and consisted of four data collection points, from two police educations in Sweden. The analysis was conducted in two steps. First, exploratory- and confirmatory factor anal-

yses were conducted to create scales for mental health orientation. Second, these scales, together with the variable exercise habits, were used as outcome variables in t-tests, X2 test and ANOVA. Effect size measurements were calculated and interpreted based on established guidelines.

Results

The results show high psychometric support for two scales named positive health orientation and negative health orientation. Based on the scales and the variable of exercise habits, three primarily results emerge: 1) the levels of physical training for men decrease during education; 2) there are gender differences showing that women have a more negative health orientation; and, 3) the positive mental health orientation decreases during education for both men and women.

Discussion

Swedish police education should prepare students for physically and mentally demanding work. However, as this study concludes, this tends to not be the case, especially given that both the level of physical activity and the positive mental health orientation decrease during education. This raises questions on whether the Swedish police education is doing "enough" to provide the students with adequate conditions for improving their mental and physical health.

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STAND UP UNIVERSITY, BREAK SEDENTARY BEHAVIOURS: UNIFIT STUDY

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Many studies show that sedentary behaviour is strongly associated with higher risk of cardiovascular and metabolic diseases in adults. The World Health Organisation (WHO) recommends limiting the amount of time spent in sedentary behaviour suggesting that every move counts for health. Active breaks (ABs), defined as short (2-10 minutes) bursts of PA incorporated in the working hours, were shown to be an effective strategy to improve physical and mental health. The aim of this study is to collect different perspectives from a group of employees of the University of Bologna (Italy) on incorporating ABs in the workplace and to demonstrate the feasibility of such interventions.

We conducted three focus groups (FGs). Participants were recruited on a voluntary basis: PhD student, research fellows, medical residents and administrative staff of University of Bologna (N=18). The age of participants was between 27-64 years. After the focus groups, a questionnaire was administered to participants and it was subsequently analysed to determine the barriers and facilitators of implementing ABs in the workplace.

88,8% of the participants responded that they had a sedentary lifestyle. 94,4% showed interest in incorporating ABs in the workplace. The most common barriers identified were lack of time and a suitable space, along with social acceptability and need for appropriate clothing. However, time flexibility, different types of exercises and group activity are major facilitators in organising ABs in the workplace. Participants also felt that structuring ABs with an effective outcome was very important for facilitating the participation of workers.

This study highlights that ABs could be an acceptable intervention for breaking-up sedentary behaviours among university employees. FG is a valid technique to evaluate the barriers and facilitators of an ABs intervention in the workplace.

HOW PHYSICAL ACTIVITY INTENTION IS INFLUENCED BY MOTIVATION, RESILIENCE, MOOD AND PERSONAL AND SOCIAL RESPONSIBILITY

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Introduction

Physical activity intention is an essential part of health-related behaviour. However, physical activity intention and its outcome are influenced by a number of factors. These factors comprise intrinsic motivation (Hein et al., 2004), basic psychological needs in exercise (Vlachopoulos & Michailidou, 2006), resilience (Manzano-Sanchez et al., 2021), mood (Pedrosa et al., 2014), and personal and social responsibility (Li et al., 2008). The aim of our study was to investigate the relationships between physical activity intention, motivation, basic psychological needs in exercise, resilience, mood and personal and social responsibiliy in university students through the lenses of the Self-Determination Theory (Deci and Ryan, 1985) and the Dual-Process Framework (Cheval and Boisgoutier, 2021).

Method

Following ethical clearance, 105 university students from Budapest (mean age = 22.6 years (s=4.24); 46% female, 54% male) participated voluntarily in our study. Participants completed the Academic Motivation Scale (AMS; Vallerand el al., 1992), Basic Psychological Needs in Exercise Scale (BPNES; Vlachopoulos & Michailidou, 2006), Resilience Scale (RS-14; Domasio et al., 2011), Trait Meta-Mood Scale (TMMS-24; Fernandez-Berrocal et al., 2004), Personal and Social Responsibility Questionnaire (PSRQ; Li et al., 2008), and Intention to be Physically Active after School Graduation Questionnaire (IPA; Hein, 2004). Data were analysed by employing IBM SPSS v.25, and performing inferential statistics, Pearson correlations, and Mann.Whitney U Test in order to test group differences.

Results and Conclusions

Results showed significant relationships (p<0.01) between physical activity intention and external regulation (r = 0.31), competence (r = 0.44), relatedness (r = 0.38), resilience (r = 0.34) and personal responsibility (r = 0.41). According to Mann.Whitney U Test, females scored significantly (p=0.008) higher in social responsibility, younger participants reported higher (p=0.019) perceived competence as opposed to older participants, and older participants demonstrated higher (p=0.013) emotional clarity than younger ones. Younger university students that have greater competence of their basic psychological needs may feel more motivated to continue their physical activity participation after their graduation. Female students demonstrating higher social responsibility may want to improve in their academic studies as well as sport activities. Older respondents having higher emotional clarity are aware of their emotions during different activities, such as physical activity behaviours.

In conclusion, our investigation confirmed that studies of factors that influence physical activity intention is helpful for researchers to promote health-related behavious among university students.

Key words: physical activity intention, motivation, basic psychological needs, resilience, mood, personal and social responbility

Conventional Print Poster

CP-MH07 Obesity/Weight loss I

BODY (DIS)SATISFACTION: COULD THE EVALUATION BE INFLUENCED BY SEX?

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INTRODUCTION: Body image is a multidimensional and complex construct, which includes cognitive, perceptual, emotional, and behavioural aspects. It varies along sex and the aging process with relations to weight control. Body image may be defined in simple terms as the way a person perceives or thinks about his body and how it looks to others. The negative interaction of the mentioned factors could generate body (dis)satisfaction (1). Previous research has shown that body dissatisfaction could result in risky weight-loss behaviours and concerns about both weight and muscularity, in females (F) and males (M), respectively (2). Therefore, the aim of the present study was to investigate male and female body dissatisfaction in relation to body size.

METHODS: One hundred-five volunteers took part in this study. Fifty M (age:25.3±9.2yrs; body mass:72.5±8.7kg; height:176±7cm; BMI:23.3±2.2kg/m2) and fifty-five F (age:27.6±10.6yrs; body mass:61.9±13kg; height:166±6cm; BMI:22.5±3.9 kg/m2). To assess the individual's body dissatisfaction in relation to body size, the Body Image Dimensional Assessment (BIDA) instrument was used (3). BIDA assesses the subjective and emotional dimensions of body image by means of a neutral silhouette-based scale. The questionnaire consists of four questions (Q1 to Q4) ranging from 1.8 to 5.2, with increment of 0.1, related to individual's perceived and ideal body shape to calculate the Body Dissatisfaction (BD=(Q1-Q2)×100/3.4), the most appropriate body shape for their peer for Comparative Body Dissatisfaction (CBD=(Q1-Q4)x100/3.4) and the most appreciated body shape by the opposite sex, to calculate the Sexual Body Dissatisfaction (SxBD=(Q1-Q3)×100/3.4). Body Dissatisfaction Index (BDI=(BD+SxBD+CBD)/3) was sequentially calculated. Means, standard deviations and ranges were calculated separately for M and F for each variable. To evaluate sex differences, two-sample t tests were performed for all variables.

RESULTS: Sex differences emerged for BD (F: 12.4±14.9% range:-17.6-58.8; M:-1.4±12.4% range:-29.4-29.4, p=0.000), SxBD (F: 9.0±17.6% range:-28.2-58.8; M:-1.1±14% range:-29.4-20.5, p=0.0016), BDI (F:15.2±7.4% range:2.9-29.4; M:12.2±5.7% range:0-24.5, p=0.02). No differences emerged for CBD.

CONCLUSION: BIDA proved to be effective in detecting body image differences in relation to sex. Although sex differences emerged, both M and F are exposed to body dissatisfaction, with F at a higher risk regarding BD and SxBD. Literature (3) suggested BDI values higher than 30% as a threshold to define subjects at risk of body image disorders. While based on our results the sample of the present study could be defined not at risk, findings suggest to draw attention to the tendency to became at risk.

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SHORT-TERM EFFECTS OF EXERCISE ON BODY IMAGE

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INTRODUCTION: Body image (BI) is a multidimensional construct focused on body's appearance and function, representing how subjects see, feel, think and behave regarding their bodies (1). Weight dissatisfaction and negative body image

are predictors of health-related problems such as depression, weight control and eating disorders. Since the regular practice of physical activity (PA) has physical and psychological health benefits, it could also play a key role in improving BI. Therefore, this study aimed to evaluate the short-term effects of exercise on BI in physically active adults.

METHODS: Twenty-one physically active adults (age:30±12.9yrs; mass:66.4±12.4kg; height:167.6±6.8cm; body mass index (BMI):23.55±3.7kg/m2) participated in the study. Before (pre) and after (post) their individual not structured workout, the Body Image Dimensional Assessment (BIDA) questionnaire (2) was administered. BIDA assesses the subjective and emotional dimensions of BI by means of a neutral silhouette-based scale, ranging from 1.8 to 5.2. Participants had to indicate their perceived and ideal body shape, the most appropriate body shape for their peers and the most appreciated body shape by the opposite sex. The Body Dissatisfaction Index (BDI) was estimated through the mean of the absolute values of Body Dissatisfaction, Sexual Body Dissatisfaction and Comparative Body Dissatisfaction. The BDI ranges from 0 to 100AU, with people scoring > 30 considered at risk of BI disorders. At the end of their individual workout, to evaluate the overall exercise intensity, rating of perceived exertion (RPE) was collected using the Borg category-ratio-10 scale. A paired t-test was used to examine the effects of a single workout on BDI. Statistical significance was set at $p<0.05$.

RESULTS: The mean RPE at the end of the workout was 6.8±1.9AU indicating a vigorous intensity session. No significant differences ($p=0.61$) in BDI were found between pre (16.8±3.3AU) and post (17.5±6.9AU) workout.

CONCLUSION: Although most BDI participants' scores changed after the workout, no significant differences emerged between pre and post values. It might be assumed that BI is not immediately affected by a single workout session. Probably, to improve physical wellness and psychological benefits to observe changes in BDI, a longer period of training is required. In addition, the participants' post exercise responses could have been influenced by the knowledge of their previous answers due to the short time between the pre and post administration. Moreover, since participants had a normal range of BMI and were physically active, future researches could investigate the effect of a single workout session on BI in individuals with different BMI categories or sedentary individuals.

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THE EFFECT OF HIIT ON BODY COMPOSITION, CARDIOVASCULAR FITNESS, PSYCHOLOGICAL WELL-BEING, AND EXECUTIVE FUNCTION OF FEMALE YOUNG ADULTS WITH OVERWEIGHT/OBESITY

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INTRODUCTION: Higher prevalence of physical inactivity among female young adults resulted in constantly rising rate of overweight and obesity, which in turn caused a variety of physical, cognitive, and mental issues [1]. The main barrier to regular exercise is generally "lack of time". The training program of HIIT, which characterized with time-effectiveness in health promotion, was of a great deal of interest in recent years [2]. Given that the previous findings are inconsistent and dose-response relationship of health/fitness adaptations to HIIT was still vague [3], the purpose of the current study was to evaluate a short-term HIIT program on selected health-related parameters for female young adults with overweight/obesity in a university context.

METHODS: 48 participants were randomly divided into two groups. The exercise group (HIIT) received a HIIT intervention of aerobics for four weeks, while the control group (CON) received no training. Body composition including waist circumference (WC), body fat percentage (BF%), Cardiorespiratory fitness (VO2max), the score of Self-Rating Depression Scale (SDS), and Stroop word-color test (SCWT) results were assessed before and after the intervention along with within- and between-group comparisons.

RESULTS: All the indices were significantly improved in HIIT group ($P < 0.01$) after 4 weeks of intervention. No significant changes were found in CON. There were significant differences between HIIT and CON in cardiovascular fitness ($P < 0.01$), SDS ($P < 0.01$) and SCWT ($P < 0.05$) before and after 4 weeks. In addition, weekly measurements of HIIT effects showed significant changes ($P < 0.01$) from the second week in the variables of body composition, VO2max, SDS and SCWT when compared with the baseline and maintained the tendency till the end of program.

CONCLUSION: The short-term HIIT aerobics of campus program conducted in non-lab setting induced significant improvements in body composition, cardiovascular fitness, psychological well-being and executive function in young female adults with overweight. In the future, the minimum training volume and its combination with training intensity in HIIT that could produce the improvement of health outcomes are of interest for further exploration.

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COMBINED PHYSICAL ACTIVITY AND MINDFULNESS MEDITATION INTERVENTION FOR WEIGHT LOSS AND EATING DISORDERS IN OBESE INDIVIDUALS

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INTRODUCTION: Today, obesity is considered one of the most important health issues in the world due to its health, social, and economic costs (1). Physical activity (PA) is a key element of obesity management (2). However, a strand of literature exploring the effect of mindfulness-based interventions (MBIs) including mindfulness meditation (MM) on weight loss and obesity-related eating disorders has developed recently (3,4). The aim is to collect and then evaluate the results of the aforementioned studies to indicate potential future research paths.

METHODS: A literature review was conducted on the effects of MBIs on weight loss and eating disorders in people with obesity. Pubmed and Google Scholar databases were searched for original studies as well as review articles. Keywords related to mindfulness were entered in conjunction with terms related to weight loss and eating disorders (e.g., "(mindfulness-based interventions OR mindfulness meditation OR mindfulness) AND (weight loss OR eating disorders OR eating behaviors)").

RESULTS: The database search yielded 241 records. Subsequently, based on the inclusion criteria, 214 records were excluded, and the final sample included 27 RCTs and reviews. MBIs lead to a lasting behavioral change and better emotional regulation, help develop body awareness, and improve the persons relationship with both food and their body. MBIs help people achieve weight loss goals by decreasing stress, improving self-regulatory capacities, and by helping individuals become more resilient, well prepared, and motivated to overcome challenges.

CONCLUSION: The review results are promising and offer potentially valuable insights to clinicians. Moreover, by identifying gaps in the literature, it opens new research paths. For instance, the underlying mechanisms of MM are indicated as offering potentially valuable synergic effects with the standardized, PA-centered treatments. However, despite these promises, the effects of a combined treatment are still to be investigated.

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A CROSS-OVER EXAMINATION OF EXERCISE INTENSITY AND ITS IMPACT ON THE ACUTE RELEASE OF IRISIN IN INDIVIDUALS OF DIFFERENT OBESITY STATUS

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INTRODUCTION: During acute exercise, skeletal muscle releases myokines, which play a key role in exercise-related health benefits. Irisin, an adipo-myokine mainly secreted by skeletal muscle, has been shown to increase during acute exercise. However, limited data exist regarding the impact of different exercise intensities on irisin release and its association with insulin sensitivity in individuals of different obesity status.

The purpose of this study was to investigate: 1) the impact of exercise intensities on the acute release of irisin in non-obese (NOB) and overweight-obese individuals (OB), and 2) if irisin release during an acute bout of exercise was associated with greater insulin sensitivity among NOB and OB individuals.

METHODS: A randomized controlled crossover design study was conducted on 26 NOB (body mass index (BMI: <25kg/m2)) and 28 OB (BMI: >27kg/m2) adults (19-50 years). Participants performed, in a random order, a 1) resting condition (in a reclined position for 35 mins), 2) a moderate continuous intensity (MCI) exercise session (50% of heart rate reserve for 35 mins), and 3) a high-intensity interval training (HIIT) exercise session (35 mins with intervals increasing from 50% to 85-90% of heart rate reserve for 2 mins, every 5 mins. Blood samples were taken at 0, 14, 28, and 35 mins to quantify irisin via ELISA and western blotting. Each participant underwent a 2-hour oral glucose tolerance test from which insulin sensitivity (Si) was estimated using the Matsuda index. For analysis purposes, NOB and OB participants were categorized as low-Si (<25 percentile Si) and high-Si (>25 percentile Si).

RESULTS: There was no significant difference in irisin release between NOB and OB individuals during the control condition ($p>0.05$). However, NOB individuals displayed significantly higher irisin release compared to OB individuals during acute MCI exercise ($p<0.05$), while no such differences were observed for acute HIIT exercise ($p>0.05$). NOB individuals had greater insulin sensitivity compared to OB individuals (NOB: 38.7 ± 26.3 vs. OB: 19.8 ± 23.6; $p< 0.001$). Insulin sensitivity was negatively correlated with BMI ($r=-0.55$; $p< 0.001$) and positively correlated with change in irisin during MCI exercise ($r= 0.29$; $p<0.05$). NOB individuals with low-Si had a 1.58-fold ($p<0.05$) increase in irisin during HIIT exercise, while NOB with high-Si had a 3.58-fold ($p=0.06$) increase. OB individuals with low-Si and high-Si had a 1.85 and 1.11-fold increase in irisin (all $p<0.05$) during HIIT.

CONCLUSION: The results of this study confirm that irisin is released differently with varying intensities of exercise. In addition, these data suggest that the release of irisin varies according to obesity status, with healthy individuals releasing more irisin compared to individuals with obesity.

BIBLIOMETRIC ANALYSIS OF RESEARCH TRENDS IN RELATIONSHIP BETWEEN PHYSICAL EXERCISE AND OBESITY

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INTRODUCTION: The relationship between physical activity and obesity has attracted an increasing number of researchers in recent years. Obesity is a complex, multifactorial disorder of the energy homeostasis system. Growing evidence suggests that skeletal muscle produces myokines in response to physical exercise, which allow for crosstalk between the muscle and other organs (such as adipose tissue, brain, liver etc.) in order to maintain homeostasis. It is known physical inactivity is one of the primary contributors to the obesity. However, the relationship among obesity, physical activity and myokines were still not fully understood. Our study aimed to identify the current research hotspot, status and trend in this field by using bibliometric and visualization analysis.

METHODS: Articles published in the PubMed database in the period 2010-2022 were filtered using keywords 'physical activity', 'exercise', 'myokines' and 'obesity'. Bibliometric analysis was done using VOSviewer tool (version 1.6.19). Two standard weight parameters were applied - "links attribute" and "total link strength attribute" (TLS) to find out the most common keywords and its links, trending themes, organizations and authors who research these topics the most.

RESULTS: In total 410,106 scientific articles were published between 2010 and 2022, including both clinical trials (19.9 %) and reviews with keyword 'physical activity' and 325,649 scientific articles with keyword exercise during the same period, 22.3% of them are clinical trial type (TLS 77), and associated with keyword 'myokines'. Publications number of authors who studies the connection between myokines and exercise in the top 100 range from 4 to 20. B.K. Pedersen (Denmark) was the most productive author in this field (number of publications = 20) and was cited 51 times (TLS 82). The most citated articles was written by A. Lucia (Spain). He published 11 articles and was cited in 74 other articles (TLS 113). The most related keywords to exercise and myokines theme were keywords 'irisin', 'skeletal muscle' and 'obesity'. Keyword 'obesity' had 68 occurrences (TLS 361) and irisin appears to be the most researched myokine, having 206 occurrences (TLS 974).

CONCLUSION: The relationship between physical activity /exercise and obesity was well-discussed topic in recent years and number of publications grows exponentially. Our study showed that the study in this field mainly focused on physical exercise, role of skeletal muscle and myokines. Irisin is one of these myokines, and its link with different types of physical exercise was investigated. Irisin a newly identified exercise responsive myokine has emerged as a promising therapeutic strategy (using exercise) in the prevention and management of obesity.

COVID-19 LOCKDOWN EFFECT ON WEIGHT AND FAT MASS IN FRENCH ELITE ATHLETES

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INSEP

INTRODUCTION: Medical-technical staff around athletes had to adapt to minimize the negative effects of 2020 Covid-19 lockdown on performance [1], as well as changes in body composition associated with isolation [2]. Our objective was to evaluate the effects of the COVID-19 lockdown on mass and body fat in French elite athletes.

METHODS: 122 French elite athletes (23.3 ± 5.2 years old; 43% of female athletes) training at the National Institute of Sports (INSEP) during the 2019/2020 season and from 17 different sports were included. Weight and fat mass data from the medical consultation, the post-confinement anthropometric assessment and a questionnaire were compared with their pre-confinement values. The influence of gender, training load, nutrition management and injuries was also explored.

RESULTS: The statistical analysis shows a significant increase in weight (71.23 ± 13.75 vs. 72.03 ± 14.50; P =.002) and in fat mass (15.01 ± 6.28 vs. 15.86 ± 6.42; P < .001) during lockdown. Regarding the gender, only men significantly increased their weight (77.61 ± 12.92 vs. 78.80 ± 13.89; P =.002) but women and men increased their body fat by +0.9 ± 2.7% and +0.8 ± 2% respectively. Athletes whose training load decreased between before and during lockdown gained significant weight (70.17 ± 12.98 vs. 71.12 ± 13.85; P =.002) and fat mass (14.52 ± 5.86 vs. 15.56 ± 6.21; P <.001). Athletes who were not injured during lockdown gained significant weight (70.72 ± 14.40 vs. 71.45 ± 14.83; P =.01) and fat mass (14.82 ± 6.61 vs. 15.76 ± 6.64; P <.001). Finally, weight was significantly increased in athletes reporting difficulties in weight and nutrition management (70.41 ± 15.84 vs. 71.81 ± 16.59; P =.004) compared to athletes not reporting difficulties (P = NS).

CONCLUSION: Changes in the sport practice and lifestyle of elite athletes had a negative impact on the management of their body composition. If this type of isolation occurs again, vigilance must be exercised to at least maintain the training load and accompany athletes who have difficulties in managing their weight and their diet. It also appears that athletes injured prior to lockdown were already deconditioned compared to non-injured athletes. Thus, particular attention should be paid to the management of weight and fat mass from the beginning of the athletes' injury.

Conventional Print Poster

CP-MH08 Sports Medicine: Children

THE EFFECT OF TRAINING TIME AND MATURITY STATUS ON BONE GROWTH IN CHILDREN TENNIS PLAYERS

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INTRODUCTION: Tennis has been a model in studying the effects of physical activity on bones [1]. Compared to the non-racket arm (NRA), the induced racket arm (RA) bone hypertrophies are more pronounced during growth and correlate with training [2, 3]. As this data stem merely from cross-sectional testing, this study used Tanner stage (TS) and maturity offset (MO) to explore bone change over a 9-month period in children tennis players.

METHODS: Four groups of players aged 7.5-13 years were tested: I (Tanner I-I, MO -3.5 ± 0.8 yrs, N = 17); II (Tanner I-II, MO -2.6 ± 0.8 yrs, N = 14); III (Tanner II-III, MO -1.4 ± 1.0 yrs, N = 7); IV (Tanner III-IV, MO -0.3 ± 1.4 yrs, N = 8). Bone mineral content (BMC) and bone area (BA) of both arms were measured using DXA. Descriptive statistics and multiple regressions assessed the effects of maturity status (MS) and training time (TT) on bone change.

RESULTS: During the 9-month period significant RA bone hypertrophies were developed in all groups. BMC hypertrophy changed for group I from 7.7 ± 5.0 grams (16.2 ± 11.9%) to 9.0 ± 6.4 grams (16.4 ± 11.4%), for group II from 9.0 ± 5.7 grams (15.9 ± 9.8%) to 12.6 ± 5.6 grams (19.6 ± 9.2%), for group III from 12.7 ± 3.9 grams (20.4 ± 6.9%) to 16.1 ± 4.2 grams (22.5 ± 8.4%), and for group IV from 18.5 ± 7.7 grams (19.6 ± 7.6%) to 19.3 ± 8.0 grams (18.1 ± 7.2%). BA hypertrophy changed for group I from 7.8 ± 5.7 cm² (10.2 ± 8.1%) to 9.4 ± 6.2 cm² (11.3 ± 7.3%), for group II from 10.0 ± 4.0 cm² (11.3 ± 4.6%) to 12.3 ± 6.3 cm² (12.8 ± 6.8%), for group III from 12.1 ± 5.1 cm² (12.7 ± 6.1%) to 12.9 ± 5.8 cm² (12.5 ± 7.5%), and for group IV from 14.5 ± 5.7 cm² (11.5 ± 4.8%) to 12.5 ± 6.4 cm² (8.8 ± 4.7%). Regressions ($p < 0.001$, $R^2 > 36\%$) revealed that MO change is the best determinant of bone gains in both arms (BMC: $p < 0.001$, LMG: 71% & 78%; BA: $p < 0.001$, LMG: 77% & 83%), while TT change is much impactful for the RA (BMC: $p < 0.005$, LMG: 23%; BA: $p < 0.05$, LMG: 18%) and mostly for BMC ($p < 0.01$, LMG: 56%) than BA ($p = 0.084$, LMG = 13%) hypertrophy.

CONCLUSION: The transition from Tanner stage I to II and from Tanner stage II to III is the optimal period for the bones to benefit more from exercise. The respective rate of osseous improvement from Tanner stage III to IV appears much slower. While change in maturity status affects about equally both arms' skeletal growth, training becomes highly determinant mostly for bone content and less for bone size. The results have health and growth implications, with prior ideas for more symmetric training during childhood [3] appearing reasonable.

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DETERMINATION AGE-RELATED DEFICIENCY OF FUNCTIONAL MOVEMENT PROFICIENCY AND LOWER BODY STRENGTH IN ADOLESCENT SOCCER PLAYERS

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INTRODUCTION: Quality of movement improves physical performance and reduces injury risk. It is known that biological maturation status (BMS) has a significant impact on the development of physical performance. However, strength development and functional movement (FM) competence show differences depending on BMS in adolescent soccer players. The goal of this study was to investigate the differences between different age categories (U13-U16) on FM proficiency and lower body strength (LBS) based on BMS of adolescent soccer players.

METHODS: A sample of 79 male soccer players, aged 12,24 ± 0,26 to 15,21 ± 0,42 years, were recruited from a professional soccer club and examined into four age groups (U13, U14, U15 and U16). The Functional Movement Screen (FMS), counter movement jump (CMJ), squat jump (SQJ), counter movement jump free-arm (CMJ-FA) and isokinetic quadriceps/hamstring (Q/H) knee test by 60°s, 180°s, 300°s speeds were administered to assess FM proficiency and LBS based on peak height velocity (PHV) level of the individuals. Mirwald (2002), maturation offset was used to calculation of BMS, respectively.

RESULTS: In this study, ANOVA showed a significant between-group effect in peak height velocity (PHV), FMS, isokinetic strength of Q/H (except H at 300°s), jump height (JH) of CMJ-FA, CMJ and SQJ and jump impulse relative of SQJ ($p < 0.05$). Along with this, there was found significant differences between older groups (U15, U16) and younger groups (U13, U14) in all the JH results of vertical jumps by ANOVA test ($p < 0.05$). When an ANCOVA was applied to account for the influence of biological maturation (PHV) on between-group differences, FMS and JH of all the jumps no longer displayed any signifi-

cant differences between age groups. In addition, ANCOVA presented significant differences between older groups (U15, U16) and younger groups (U13, U14) in all the speeds of isokinetic strength ($p < 0.05$). Given that, PHV was found a significant covariate for all isokinetic strength tests, JH of CMJ-FA, CMJ and SQJ.

CONCLUSION: The outcome of this study, FM competence and LBS methods were found to be affected differently depending on maturation. It was observed that vertical jump performance, which is a complex movement depending on maturation, did not change in direct correlation with FM, but isokinetic strength increased in the older groups depending on maturation. Moreover, biological age (PHV) was found one of the key indicators to observe whether any differences between age groups in FM proficiency and LBS. Future research should focus on developing targeted intervention studies within divided age groups according to PHV level of the players to improve FM quality and physical strength in the young population.

SYSTEMATIC REVIEW OF PARENT-BASED MOBILE HEALTH INTERVENTION TO PROMOTE PHYSICAL ACTIVITY, DIETARY BEHAVIORS AND REDUCE SLEEP PROBLEMS IN PRESCHOOLERS

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INTRODUCTION: Preschoolers' lifestyles have become physically inactive and sedentary, their eating habits unhealthy, and their sleep routines increasingly disturbed. These changes have led to an ever-increasing prevalence of obesity. Parents have a profound impact on the healthy lifestyle of preschoolers and are the key agents of behavioral modification. Improved access and lower costs make mobile health (mHealth) interventions appealing. However, it is currently unclear whether parent-based mHealth intervention may be harnessed to improve the aforementioned lifestyle behaviors. This study aims to systematically review the current literature concerning the effectiveness of parent-based mHealth intervention to improve preschoolers' physical activity (PA), dietary behaviors (DB) and sleep problems.

METHODS: This systematic review conforms to the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) statement. Six databases (EMBASE, PubMed, MEDLINE, Web of Science, SPORTDiscus and PsycINFO) were retrieved for the period from January 2000 to August 2022. Studies were eligible if (1) they were quantitative study designs; (2) they targeted parents of children aged 3-6 years and used an mHealth modality; and (3) at least one variable included in either the primary or secondary outcome should be concentrated on PA, DB, and sleep. The risk of bias was assessed based upon Version 2 of the Cochrane risk-of-tool for randomized trials (RoB2).

RESULTS: Seven studies were screened. Two studies focused on DB and sleep respectively, the remaining five studies included more diet modules than PA and sleep ones. PA was examined in four studies, which all reported a significant changes within the intervention group at the post-intervention, but only two studies found a significant group-by-time difference. Five of six studies that reported on DB outcomes indicated significant improvements compared with the control. Two studies evaluated sleep outcomes, one demonstrated significant improvements in sleep between intervention and control groups, while the other did not. The quality of the interventions was generally not high; therefore, these results should be interpreted with caution.

CONCLUSION: Studies reviewed either emphasized one variable (e.g., sleep or diet) or failed to balance the dosage of PA, diet, and sleep modules and consider the intervention sequence during the intervention period. It is recommended that high-quality, robust designed research studies to balance the intervention content and sequence are needed to determine the effectiveness of mHealth interventions to support behavior change in Chinese preschoolers and target parents as an agent of behavioral change.

THE EFFECTS OF A MOVEMENT SKILLS TRAINING PROGRAMME ON GROSS MOTOR SKILLS, EXECUTIVE FUNCTION, AND SOCIAL COMPETENCE: PRELIMINARY FINDINGS FROM A GROUP-RANDOMISED CONTROLLED TRIAL

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INTRODUCTION: Children who have more proficient movement skills tend to have better cognitive skills and social competence. However, most evidence has been drawn from associational studies, which limits the understanding of the underlying mechanisms. We explored the relationship of movement proficiency with the cognitive and social domains of child development by implementing a targeted movement skills training program and measuring motor, cognitive and social outcomes.

METHODS: The study design is a group-randomized controlled trial. Participants consisted of children aged 3-5 years (N = 140) from a local kindergarten who were randomly allocated by class to either a training or active control condition. A 10-week training program focused on the gross motor skills curriculum of the kindergarten; the active control consisted of typical movement activities following the local curriculum guide. The outcomes consisted of locomotor and object control skills proficiency (1), executive function (2) and social competence (3). Tests were administered at baseline, post-training, and following a 4-month period of pandemic-related school suspension. Mixed-models repeated measures analysis of variance was performed on each variable while controlling for known correlates.

RESULTS: There was a significant main effect of test ($F(4,132)=34.08$, $p<0.001$) and an interaction between test and group ($F(4,132)=6.45$, $p<0.001$) on locomotor and object control skills. The training group displayed greater improvements post-training than the control group. Following school suspension, both groups displayed improvements in object control but not in locomotor skills. There were significant main effect of test ($F(2,130)=89.46$, $p<0.001$) and interactions of test with fine

motor skills (F(2,130)=5.05, p=0.008) and group (2,130)=7.84, p=0.001) on executive function. The training group displayed greater improvements post-training than the control group. Following school suspension, the groups' improvements were comparable. There was a significant main effect of test (F(2,134)=40.87, p<0.001) on social competence; interactions of test with sex and group were not significant. Both groups displayed improvements post-training and declines following school suspension.

CONCLUSION: The findings showed that a movement training program can facilitate improvements in gross motor skills and executive function but not social competence. These findings contribute to the growing evidence of the relationship between motor and cognitive development in young children. Children displayed a lack of improvement in locomotor skills and a decline in social competence following a period of school suspension, highlighting the negative impact of pandemic-related disruptions on child development.

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THE IMPACT OF CARDIORESPIRATORY FITNESS TRAJECTORIES THROUGH ADOLESCENCE IN THE ASSOCIATION OF BDNF WITH COGNITIVE AND ACADEMIC PERFORMANCE

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UNIVERSITAT JAUME I

INTRODUCTION: Brain-derived neurotrophic factor (BDNF) is a protein implicated in neuronal development, differentiation, and survival [1], which has led to suggest that it could benefit cognitive and learning processes. However, previous studies showed conflicting results regarding the association of circulating BDNF and cognitive performance, since both significant and non-significant results have been reported [2]. Interestingly, cardiorespiratory fitness (CRF) is suggested to positively influence cognition and brain function [3]. Yet, the role of the CRF levels in the association of BDNF with cognitive and academic performance has not been previously investigated in adolescents. Thus, the aims of this study were: I) to analyze if changes in circulating BDNF predict changes in cognitive and academic performance and II) to analyze the impact of CRF trajectories in this association.

METHODS: A total of 163 adolescents (79 girls) aged 13.9±0.3 years at baseline and 15.8±0.3 at 2-year follow-up were included in the analyses. Plasma BDNF concentration was measured using a commercially available ELISA kit after an over-night fasting. Cognitive performance was assessed through the overall score of the Science Research Associates Test of Educational Abilities. Academic performance was calculated through the average of the final scores achieved in all participants. CRF was assessed by the 20-m shuttle run test. Participants were classified as fit or unfit based on the sex and age specific 60th CRF percentile [4]. CRF trajectories were established as follows: persistently high (fit at baseline and at follow-up), increasing (unfit at baseline but fit at follow-up), decreasing (fit at baseline but unfit at follow-up), persistently low (unfit at baseline and at follow-up). We performed linear regression analyses between changes in BDNF and changes in cognitive or academic performance; level of significance p<0.05.

RESULTS: The change in circulating BDNF was positively associated with the change in academic performance (β=0.178; p=0.02), but not with the change in cognitive performance (p>0.05). When considering the trajectories of CRF, only participants with persistently high CRF showed a significant association between the change in circulating BDNF and the change in academic performance (β=0.233; p=0.01).

CONCLUSION: Our results contribute to understand the physiological mechanisms influencing academic performance. Maintaining a fit CRF level during adolescence seems important to achieve the benefits that BDNF may exert on academic performance. Interventions aiming to boost educational performance in adolescents should promote CRF improvement through physical exercise practice.

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THE IMPORTANCE OF SKILL COMPETENCE AS A KEY PREDICTOR OF THE ENERGY EXPENDITURE ASSOCIATED WITH PERFORMING FUNDAMENTAL MOVEMENT SKILLS

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INTRODUCTION: The association between physical inactivity and many non-communicable diseases is now well established. Physical activity is a complex and multi-dimensional behaviour, with proficiency in fundamental movement skills (FMS) recognised as a key correlate of increased physical activity levels, as well as being positively associated with further health outcomes. In children and adolescents, the associated energy expenditure (EE) of performing discrete tasks has been shown to be influenced by biological and developmental characteristics. The present study aimed to identify the

influence of FMS proficiency, along with age, sex, and biological maturation, on the associated EE of FMS in children and adolescents.

METHODS: 27 youth (14 girls: 12.0 ± 2.2 years; 13 boys: 12.2 ± 2.4 years) participated in the study. Using the Test of Gross Motor Development - version 3 (TGMD-3), five FMS (overhand throw, kick, two-handed strike, hop and slide) were assessed independently in a randomised order for six bouts of 30 seconds, separated by 15 seconds recovery. Associated EE was measured using indirect calorimetry and predicted maturity offset was recorded as estimated years from peak height velocity. Separate linear mixed models were performed, with the associated oxygen uptake (VO2) in absolute (l·min−1) and allometrically scaled (VO2ALLOM) terms as the outcome variables.

RESULTS: Boys were found to have a higher VO2 (l·min−1; β = .66; p=≤0.01) and VO2ALLOM (β = 13.1; p=0.03) across all skills performed. A significant sex*maturity interaction was found in boys (β = .23; p=≤0.01) for VO2. For VO2ALLOM, a significant interaction was observed between skill competence and skill type in the kick (β = 4.68; p=0.01), hop (β = 7.86; p=≤0.01) and slide (β = 10.24; p=0.01). Similarly, for VO2 (l·min−1), a significant interaction was observed between skill competence in the kick (β = .10; p=0.02) and hop (β = .17; p=≤0.01).

CONCLUSION: The approach taken to measuring the absolute and allometrically scaled EE associated with FMS has further extended understanding of the related energy costs of these movements. The present findings showed skill competence to be a significant factor for the EE associated with FMS, and further highlights the potential health-enhancing benefits associated with achieving proficiency in FMS. The findings not only highlight the inter-individual variance that exists when performing these skills but also contributes to extending knowledge on the respective EE associated with those activities most commonly participated in during childhood and adolescence. From an intervention perspective, these findings reinforce the contribution of FMS towards both direct (i.e. associated EE) and indirect (i.e. physical activity, weight status, health-related fitness) health-enhancing benefits.

AGE-RELATED CHANGES AND TRACKING OF CARDIORESPIRATORY FITNESS FROM CHILDHOOD TO LATE ADOLESCENCE

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INTRODUCTION: Cardiorespiratory fitness (CRF) is an important indicator of health in childhood and adolescence and is believed to have both short- and long-term effects on various health-related factors [1,2]. Longitudinal studies on age-related changes in CRF during this period are scarce. The aim of this study was to assess age-related changes and tracking of absolute (L/min) and relative (mL/kg/min) VO2max from childhood to late adolescence.

METHODS: Participants were Icelandic children born in 1999 measured at the age of 7 (n=190), 9 (n=163), 15 (n=239) and 17 (n=201). CRF was assessed with maximal cycle ergometer test and expressed as absolute (L/min) and relative (mL/kg/min) VO2max. International standards were used to classify participants with healthy CRF (relative VO2max ≥42 mL/kg/min for boys and ≥35 mL/kg/min for girls) [3]. Linear mixed-effects models were used to study age-related changes in CRF and tracking was assessed with Pearson correlation coefficients and odds ratios.

RESULTS: Boys had higher absolute and relative VO2max than girls at all time points (p<0.001). Absolute VO2max increased by 0.11 (95% CI: 0.11 to 0.12) L/min per year for girls and 0.21 (95% CI: 0.20 to 0.22) L/min per year for boys, while relative VO2max decreased by -0.8 (95% CI: -0.9 to -0.7) mL/kg/min and -0.2 (95% CI: -0.4 to -0.1) mL/kg/min per year for girls and boys, respectively. Proportion of participants with healthy CRF changed from 88.7% and 79.8% at age 7 to 50.0% and 51.8% at age 17 for girls and boys, respectively. Pearson correlation coefficients for CRF at different ages ranged from 0.36 (age 7 to 17, p<0.001) to 0.91 (age 15 to 17, p<0.001). Those who had healthy CRF at the age of 7, 9 and 15 were 2.1 (95% CI: 0.6 to 8.7), 2.4 (95% CI: 0.8 to 8.6), and 23.6 (95% CI: 8.5 to 84.8) times more likely to still have healthy CRF at the age of 17, respectively.

CONCLUSION: Absolute CRF increases while relative CRF decreases for both girls and boys from age 7 to 17. Girls have lower CRF than boys and present higher decline of relative CRF than boys from childhood to late adolescence. Tracking of CRF is high in late adolescence, indicating that interventions that aim to increase CRF should be implemented before adolescence.

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CHANGES IN PHYSICAL ACTIVITY, BODY COMPOSITION AND CARDIORESPIRATORY FITNESS FROM 15 TO 17 YEARS OLD

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INTRODUCTION: Decreased levels of physical activity (PA) challenge health outcomes among European adolescents as levels of moderate to vigorous PA declines [1]. Participation in regular PA has been linked to higher cardiorespiratory fitness (CF) and more favorable body composition [2]. The aim of the study was to assess changes in PA, sports participation, body composition and CF in adolescents from age 15 to17.

METHODS: PA was measured over one week with wrist actigraphy in 154 adolescents (98 girls), with data from two time points, 2015 and follow up in 2017. From questionnaire, sports participation and general PA were assessed. CF was measured with a maximal cycle ergometer test and calculated as VO2max ml/kg/min. Body composition was assessed with dual-energy X-ray absorptiometry (DXA) scan.

RESULTS: PA was significantly lower all days (16.7%), on school days (20.9%) and non-school days (8.6%) between age 15 to17 years ($p<0.001$). Sports participation decreased from 69.1% to 50.3% between ages 15 and 17 and general PA, at least 4 hours/week, decreased from 74.3% to 64.7%. Between ages 15 to 17 body mass index (BMI) and lean mass index (LMI) increased significantly ($p<0.001$), trunk fat percentage increased significantly between the two years ($p=0.006$) and total body fat percentage increased significantly for girls ($p=0.006$) but not for boys. CF lowered significantly from 40.1±8.9 to 38.1±8.9 between the two years ($p<0.001$). PA was positively associated with CF at ages 15 and 17 $r=0.205$ ($p=0.015$) and $r=0.170$ ($p=0.044$). At both 15 and 17 years, lower BMI ($r=-0.543$, $r=-0.435$), body fat percentage ($r=-0.863$, $r=-0.861$), trunk fat percentage ($r=-0.839$, $r=-0.839$), was associated with higher values of CF and LMI was positively associated with CF ($r=0.274$, $r=0.343$), all $p<0.001$.

CONCLUSION: Conclusion: Higher PA levels and sports participation are associated with more favorable body composition and higher CF. Recreational and formal sports participation may therefore serve as an important tool in increasing PA and overall fitness.

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Conventional Print Poster

CP-SH03 Physical education teachers

EYE-TRACKING AND PROFESSIONAL VISION OF TEACHERS

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While the importance of visual attention has been shown in coaches and athletes, PE teachers were hardly studied. This is surprising, because Physical education teachers constantly perceive teaching situations while deriving possible teaching actions or movement corrections in highly stressful and noisy surroundings. The aim of this systematic review is to identify quantitative perceptual research using eye-tracking on professional vision (PV; van Es & Sherin, 2002) in classroom contexts and to discuss existing studies in the context of possible applications to physical education.

Eight databases were systematically searched according to PRISMA using the term ("professional vision" OR "eye tracking") AND (education OR teach* OR classroom OR school). The initial results (n=2,141) were reduced to quantitative expertise-dependent eye-tracking studies of lessons or naturalistic instructional videos in student teachers and teachers through the application of systematic inclusion and exclusion criteria.

In addition to eight quantitative approaches, six studies with mixed-method designs were identified. In addition to existing incongruences regarding applied expertise criteria, the systematic review compares different analysis procedures of the gaze measures within the studies. The studies, mostly performed within STEM subjects and languages, show result-pattern with longer fixation sequences and more consistent gaze patterns among experts. This can also be deduced from coefficients reported in the studies, which show a more evenly distributed gaze behaviour for experts. PV is only discussed in a content-unspecific way for classroom management or the recognition of inattentive, off-task students, but not in a subject-specific way for the individual challenges and needs of physical education lessons.

The application of a mixed-method design using eye-tracking and post-hoc interviews could address this desideratum in order to use findings on gaze behaviour also for the training of "noticing" and "reasoning", especially for physical education teachers in training. Expertise studies with increased perceptual complexity of dynamic processes in physical education, together with qualitative approaches already performed in physical education, such as video-club work for learning teaching practices, could contribute to bridging to existing concepts of adaptive teaching competence. By doing so, the professionalisation processes of physical education teachers could be evaluated and further developed by using eye-tracking hand in hand with qualitative reflective practices.

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TASK ANALYSIS SKILLS OF GERMAN PHYSICAL EDUCATION TEACHERS – WHAT INFLUENCES THE QUALITY OF TASK-RELATED JUDGEMENTS?

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Introduction

Teachers should adapt the tasks in physical education (PE) to the prerequisites of the students in the sense of individual support. Therefore, they need to be able to assess the demands of each task (Rieu et al., 2020). The ability to choose tasks according to the individual needs of the students is an important aspect of PE-teachers' professional competence but has rarely been investigated. This study aims to answer the questions if teachers can assess motor and cognitive task demands in PE and what factors may influence the quality of their assessments.

Methods

Tasks were systematically developed and then assessed by experts (each n=6 of university professors, sports didactics PhDs, and PE subject leaders) in terms of their motor and cognitive demands. Based on this, eight pairs of tasks differing in the level of motor and cognitive demands were formed. Finally, in a pairwise comparison, PE-teachers (N=62) rated the respective higher cognitive and motor demand level of the tasks.

Results

The results show that PE-teachers are better at assessing cognitive (76,6% correct assessments) than motor demands (67,6% correct assessments). Furthermore, there is no correlation between the ability to assess cognitive and motor demands. These findings may indicate that the assessment is based on different abilities. The study also demonstrates that work experience has no influence on the quality of the assessments. The results and potential implications for teacher education will be discussed in consideration of the professional competence of PE-teachers.

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THE USE OF GYMNASTIC RINGS IN PHYSICAL EDUCATION CLASSES: AN EMPIRICAL VIEW ON GERMAN HIGH SCHOOL TEACHERS

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INTRODUCTION: Gymnastic rings have ordinarily been installed in most school sport gymnasiums to serve as basic equipment. Concomitantly, gymnastic rings have been reported to decline in popularity not least due to a lack of teachers' expertise and material requirements (Badic et al., 2012). Thus, the present study aimed to examine today's scope of gymnastic rings' used by Physical Education (PE) teachers (i.e., German high schools). It was hypothesised that gymnastic rings are only used infrequently and that the frequency of usage is related with the teachers' self-assessment of expertise and the given infrastructural conditions.

METHODS: 250 PE teachers (age: 41.4±8.9 years; female: n=123, male: n=127) from North Rhine-Westphalia participated in a questionnaire-based cross-sectional study. With respect to gymnastic rings' usage, a preceding literature review disclosed frequency, expertise and infrastructure as variables to be defined by items and rating scale tasks. Following a three-stage pre-test phase obtaining content- and structure-related feedback of five trainee PE teachers, the revised questionnaire was applied within a 29-day data collection phase using SoSci Survey. After excluding eleven drop outs, data of all valid questionnaires was processed for descriptive analyses. In addition, X^2-tests were calculated using Cramer's V as effect size to estimate frequency distributions. Statistics were computed using IBM SPSS (28.0). The level of significance was set at $p<.05$.

RESULTS: Descriptive analyses revealed 90.4% of those surveyed to use gymnastic rings in their PE classes. Of these, 81.0% stated an infrequent to very infrequent usage. Of these again, 68.6% rated their expertise as competent and 63.7% appraised the usage as secure. The X^2-test showed a significant relation between the variables frequency and expertise ($p<.05$, $V=0.22$). Furthermore, 66.4% of those who stated an infrequent to very infrequent usage of gymnastic rings report good infrastructural conditions. The X^2-test showed no significant relation between the variable's frequency and infrastructure ($p>.05$).

DISCUSSION: The present study's main findings showed that the vast majority of teachers reported fundamental experience in using gymnastic rings; their infrequent usage, however, is in line with our initial hypothesis. Moreover, the hypothesised relations of the frequency of gymnastic rings' usage can only be confirmed for the self-assessed expertise, but not for the infrastructural conditions. Taking further termed inhibitory problems into account (i.e., organisational efforts, the students' physical conditions), future research is suggested to evaluate teaching strategies for intensifying students' movement time by the use of gymnastic rings.

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EVALUATION OF THE STRESS LAB – A VIDEO-BASED TOOL FOR PROSPECTIVE PHYSICAL EDUCATION TEACHERS

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Introduction

Prospective physical education (PE) teachers often experience stress (1). In order to prepare PE students to deal with potentially stressful teaching situations, the stress lab was developed for PE teacher education programs. The aim of the present study was to find out whether PE students felt better prepared for stressful teaching situations after participating in the stress lab.

Methods

The study was conducted with 100 PE students who were allocated to one of two groups: One group took part in the whole stress lab consisting of two parts, an e-learning unit to impart knowledge about stress and coping, and a practical unit to practice dealing with potentially stressful situations based on real-live videos (ELPU group, n = 47). The other group took part exclusively in the practical unit (PU group, n = 53). Students were asked before (t0) and after (t1) participation how prepared they feel for stressful teaching situations using an adaptation of a German questionnaire assessing stressful PE situations (ABIS, (2); e.g. pupils' discipline problems). Data were analyzed using 2x2 ANOVAs (time x group).

Results

Results showed a significant increase for both groups of feeling prepared for pupils' discipline problems ($F(1, 69) = 5.84$, $p = .018$), inadequate facilities and equipment (facilities) ($F(1, 69) = 6.75$, $p = .011$), physical strain ($F(1, 69) = 5.87$, $p = .018$), noise ($F(1, 69) = 19.87$, $p < .001$) and pupils' heterogeneity ($F(1, 69) = 12.49$, $p < .001$). No effect of group was found. A significant interaction was found for facilities ($F(1, 69) = 10.24$, $p = .002$), problems with colleagues ($F(1, 69) = 6.82$, $p = .011$) and noise ($F(1, 69) = 6.22$, $p = .015$). In these items, the ELPU group showed higher values compared to the PU group.

Discussion

Results showed that PE students felt better prepared for a variety of stressful teaching situations after participating in the stress lab. This suggests that practicing coping strategies make PE students feel being able to handle stressful teaching situations. Moreover, the interaction effects showed that the benefit was particularly for the ELPU group. The reason could be that the ELPU group received information on stressful teaching situations and coping strategies by additionally participating in the e-learning unit. It can be concluded that PE students benefit from both parts and therefore both should be integrated into the education of PE teachers.

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EXPERIENCES OF TEACHER-FACILITATORS OF PROFESSIONAL LEARNING IN SCHOOL PHYSICAL EDUCATION

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Background: Physical education (PE) is generally taught by classroom teachers in primary schools. Improving the quality of PE depends upon professional development of teachers. Effective professional development is assumed to be based on the teachers' needs, embedded in their workplace, and taken place in collaboration with their colleagues. Therefore, the role of a teacher-facilitator who leads and supports teachers' professional development within the school is critical. However, there is little research on how classroom teachers are empowered to facilitate professional development for teaching PE. This study examined the experiences of primary school teachers who engaged in a district-based project for promoting PE and physical activity among pupils.

Methods: Participants were four primary school teachers in separate schools who engaged in the project as teacher-facilitators and three researchers as external facilitators. Data were collected through interviews with the teacher-facilitators and from the reflective journals maintained by the external facilitators over one year of observing meetings and visiting the schools. Qualitative data were analysed with a thematic analysis method.

Findings: The results were summarised in terms of challenges faced by the participants, their experiences as teacher-facilitators, and their perceptions of their involvement in the project. The teacher-facilitators realised that the difficulties in implementing the project plan at their schools included classroom teachers' burden of teaching all subjects, insufficient time, and their inadequate knowledge of teaching PE. Based on these issues, they developed basic instructional resources for teaching strategies and developing pupil's fundamental movement skills. However, instead of imposing them on other teachers, they provided the resources in appropriate opportunities that could be used immediately or demonstrated their use in practice through their own classes. They also contributed to be intermediaries when external facilitators provided lesson assistance in their schools. Through their involvement in the project, they realised and valued that they had improved their professional abilities by sharing their ideas and practices with external facilitators and teachers

from other schools. The development of instructional resources further enhanced their desire to share the outcomes with their colleagues.

Conclusions: Facilitator-teachers encountered some challenges in promoting PE in their schools. However, they were able to support their colleagues with careful consideration of the teachers' reality and function as intermediaries to collaborate with external facilitators within their schools. It is also important to empower teacher-facilitators- themselves to see the value in their own professional growth and enhance their willingness to share their achievements.

TEACHERS' EXPERTISE WITH DIAGNOSTICS IN PHYSICAL EDUCATION AND THEIR ATTITUDE TOWARDS THE USE OF MOTOR TESTS

FOKKEN, I., STAUB, I., VOGT, T.

GERMAN SPORT UNIVERSITY COLOGNE

INTRODUCTION

Diagnostic competences are considered to be a core aspect of teachers' expertise [1]. In physical education (PE), teachers need to gather information about the students' motor skills in relation to the sports content being taught. Findings suggest that PE teachers often fail in adequately assessing their students' motor skills [2,3]. However, little is known about the extent to which teachers are prepared for their diagnostic tasks in their teachers' education (i.e., academic studies followed by traineeship). As part of our survey on the diagnostic approach of teachers in swimming lessons, we further investigated (1) teachers' experiences with diagnostics in PE during their teaching training and (2) their attitudes towards the use of formal motor tests.

METHODS

A two-step approach was used for data collection. Subsequent to qualitative interviews (n=10) with teachers from German primary and secondary schools (n=10), a quantitative online survey (n=551) was conducted reaching out to all PE teachers in North Rhine-Westphalia. The interviews were transcribed, double-coded and categorically analysed [4]. The statements for the online survey were derived from the teachers answers in the qualitative study. The teachers participating in the quantitative online survey were asked to comment on these statements using a five-point scale (i.e., 1 = strong disagreement to 5 = strong agreement).

RESULTS

(1) Many of the teachers gained little to no experience with diagnostics in PE during their teachers' education. 54.9% did not learn any diagnostics in PE during their academic studies. 62.1% of the teachers state no specific diagnostics for students' motor skills were taught in the traineeship either. (2) The teachers' attitudes towards the use of formal motor tests varied. 60.6% of the teachers believe motor tests to be helpful in determining the learning prerequisites in PE, whereas 40.1% consider the use of motor tests to be difficult from an organisational point of view. Overall, very few teachers (11.8%) regularly use formal diagnostics (e.g., motor tests) to determine the students' learning prerequisites.

CONCLUSION

Only few teachers can rely on knowledge from their academic studies or traineeship for their diagnostic work. This is despite the fact that diagnostic competence is considered to be of great importance [1]. Formal testing procedures, which are less prone to error than informal or semiformal approaches, are rejected by many teachers, mainly for organisational reasons. The preconditions of PE teachers for accurately assessing their students' learning prerequisites must therefore be considered unfavourable.

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THE EFFECT OF STEAM PROGRAM ON JUMPING SKILL OF TEACHER TRAINING COURSE STUDENTS

ISHIZAWA, J.1, SASAKI, R.2

1SHIRAYURI UNIVERSITY, 2KEIO UNIVERSITY

INTRODUCTION: Human exercises are carried out based on physical mechanisms. Therefore, teachers need to understand the anatomical structure and tips of movement when they teach children movement skills. However, most students tend to be unable to imagine the relationship between the mechanisms of exercise which they learned in science and their own body movements. Thus, we thought STEAM (Science, Technology, Engineering, Arts, Mathematics) education, which includes making a model and doing experiments, will be useful to understand these movements. In our previous research we developed the STEAM learning program on Jumping in physical education for teacher training course students (Ishizawa et.al, 2022). This study aimed to analyze the effect of this program.

METHODS: Participants were the teacher training course students (N=9, third-year, female) who took "Jumping" program in the physical education teaching method class. The contents of the STEAM program were as follows: self- and peer-evaluation by observing jumping motions using video recording (Science, Technology), making a lower limb model using a paper cup and rubber bands to understand mechanism of jumping movements (Engineering, Arts), doing experiments

for long jump using a paper cup rocket to find the appropriate angle and strength for long jump (Science/Mathematics). After learning the movement mechanisms, they planned and practiced the activities including jump for children(4-8 years old) based on what they learned(STEAM). The students took the questionnaire about the Jumping movement itself and their confidence in teaching it, before and after the program, and wrote the final report as well. We compared the answers of the questionnaires and analyzed the reports.

RESULTS: According to the answers to the questionnaires, the students' knowledge of jumping skills and their confidence in teaching children were significantly higher than before. They noted in their final reports as follows, 1) It was easy for them to understand the jumping mechanisms, due to evaluating their movements observationally and making leg models. 2) They noticed the importance of children having various kinds of jumping movement experiences.

Discussion & CONCLUSION: There seems to be a good effect on the confidence of teaching jumping to children once they have learned the principles of movement and implemented the knowledge in the kids program. All of the students were not aware of STEAM education beforehand, however, this program helped them scientifically understand jumping. In addition, they noticed the need for cross-curricular learning and STEAM education. To conclude, it is suggested that the STEAM program on jumping skills is effective for teacher training course students.

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PERCEIVED STRESS AND SOURCES OF STRESS IN PRIMARY SCHOOL PHYSICAL EDUCATION TEACHERS IN GERMANY

ZAMMIT, N., HARTMANN, U., KLEINERT, J., PELS, F.

PSYCHOLOGY

Introduction

Secondary school PE teachers, PE pre-service teachers and PE students in the German schooling system experience moderate levels of stress. The most frequent sources of stress encountered are inadequate facilities, the curriculum and the low social status of PE teachers [1]. However, to date, no data on perceived stress and the occupation-related sources of stress, as well as their relation is present for primary school PE teachers in Germany. The aim of this study was therefore to examine (1) perceived stress intensity, (2) the sources of stress, and (3) the association between perceived stress intensity and sources of stress in primary school PE teachers.

Method

Participants were 70 primary school PE teachers in Germany (59 females, 11 males, age: 44.25 ± 11.61 yrs). Perceived stress intensity in the past 4 weeks was measured using the Perceived Stress Questionnaire (response scale: 1 = rarely to 4 = frequently) [2]. PE-related sources of stress were measured using the German language questionnaire assessing occupational sources of stress in PE teachers (1 = never to 6 = regularly) [3]. Descriptive statistics were calculated for perceived stress intensity and sources of stress, and a linear regression analysis was used to investigate the statistical prediction of perceived stress intensity by the sources of stress.

Results

Primary school PE teachers reported moderate perceived stress intensity (2.29 ± .54). The most frequent sources of stress were noise (3.59 ± 1.25), heterogeneity of pupils (3.09 ± 1.5) and discipline problems of pupils (3.04 ± .85). The results of the whole regression model indicated a large goodness of fit ($R2 = .388$, $F(4.83) = 7.77$, $p < .001$). However, no source of stress significantly predicted perceived stress intensity.

Discussion

The perceived stress intensity found in primary school PE teachers was moderate, and comparable to, albeit slightly higher than those found in secondary school PE teachers [1]. The same applies to the frequency of sources of stress. The finding that none of the sources of stress measured were significantly associated with the perceived stress intensity may be due to the low number of participants included, and to the fact that the frequency of sources but not their appraisal was assessed. It may therefore be useful to further investigate the association between perceived stress intensity and sources of stress with a larger sample and a measure of appraisal.

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BEYOND SPORT: THE EFFECTIVENESS OF TEACHING LIFE SKILLS TRANSFER THROUGH PHYSICAL EDUCATION CURRICULUM

PAN, Y.H., HUANG, C.H., ZHANG, Y.Y., LIN, C.P., HSU , W.T.

NATIONAL TAIWAN SPORT UNIVERSITY

Introduction: Adolescents with good life skills are able to adapt to social changes and face the challenges in life. According to previous research, students could develop life skills through school sport and physical education. However, there is

a lack of empirical studies in physical education regarding the life skills transfer to different life domains. It is worth to explore what kind of pedagogical model could improve life skills transfer through physical education lessons. The purpose of this study was to examine learning effects that teacher integrated teaching life skills transfer into different physical education curriculum. Method: This study adapted the research method of quasi-experimental design. All participants attended 32 weeks with 64 physical education lessons in a Taiwan middle school. A physical education teacher taught the experimental group and the control group, and the experimental group integrated teaching life skills transfer into sport education model (TLST-SE), and the control group integrated teaching life skills transfer into traditional teaching model (TLST-TT)". The particpants contained that the experimental group had two classes with a total of 59 students (Mage=14.74 ± 0.50 years) and the control group had two classes with a total of 49 students (Mage =14.41 ± 0.50 years). The " Youth Life Skills Transfer Scale for Physical Education (YLSTS-PE)" was used to measure students' learning effect. YLSTS-PE has 7 components, including teamwork, goal management, time management, emotional skills, interpersonal interaction, problem solving and reflection. Data analysis was carried out through dependent sample t-test and analysis of Covariance (ANCOVA). Results:1. The posttest scores of the TLST-SE (experimental group) and TLST-TT (control group) were both significantly higher than those of the pretest in all components of life skills transfer. 2. The posttest scores of the experimental group were higher than those of the control group in all components of life skills transfer, it meant that TLST-SE model had significantly higher learning effects than TLST-TT in life skills transfer. Conclusion: This study confirmed that integrated teaching life skills transfer into physical education curriculum, whether TLST-SE with team-based learning approach or TLST-TT with individual-based learning approach, both of them could reinforce students' life skills transfer in life domain. Moreover, team-based learning has higher learning effect of life skills transfer than those of traditional individual-based learning.

18:15 - 19:30

Plenary sessions

PS-PL01 Fifty shades of fatigue: which colour is the elephant in the room?

EXTREME EXERCISES AND CHRONIC DISEASES: THEY SHARE MORE THAN YOU THINK!

MILLET, G.

JEAN MONNET UNIVESITY

Running 170 km with 10,000 m of elevation is an extreme experience. And so is going through an intensive care unit (ICU) stay after Covid-19 or a cancer. In both cases, neuromuscular function is severely altered although the causes are totally different: central and peripheral fatigue and muscle damage in ultramarathon vs ICU acquired weakness/cachexia in pathological conditions. In both cases, sleep is affected although not similarly: acute total sleep deprivation vs chronic partial sleep deprivation. In both cases, individuals go through an unusual affective experience, although it is chosen by ultramarathon runners and not by patients. Nevertheless, none of these factors can explain by themselves the subjective fatigue experienced by both the athletes and the patients, nor the performance they can accomplish. By performance, we mean the speed in runners and the amount of daily exercise that a patient can do. In this lecture, we will show how neuromuscular fatigue/function can play a role in the perceived effort/fatigue that both ultramarathon runners and cancer/ICU/multiple sclerosis patients may experience throughout feedback and feedforward mechanisms.

In this context, the role of central fatigue deficit as well as the need to measure neuromuscular fatigue appropriately (Brownstein et al. 2022), i.e. using dynamic exercises involving large muscle mass and with no recovery thanks to an innovative ergometer (Doyle-Baker et al. 2018) will be discussed. Yet in both extreme athletes and patients, the neuromuscular function cannot fully explain the perceived effort or the chronic fatigue so that using a more holistic approach that consider sleep alterations, mental fatigue, emotions, pain, etc., is mandatory. Although initially developed to explain ultramarathon performance, we will discuss the relevance of applying the "flush model" (Millet 2011) to fatigued patients, i.e. we will show that perceived fatigue/effort is the most common outcome that determine strategy (pacing in runners vs energy conservation in patients) and eventually performance in both populations. The model also contains a security reserve that may be helpful during extreme exercise to not put athletes into danger but may be counterproductive and thus must be minimized in patients. In summary, applying the flush model to what happens in daily life of a fatigued patient may help to understand the multifactorial nature (i.e. physiological, biological, psychosocial, behavioural parameters) of her/his chronic fatigue. It may also help to avoid the patients to enter in the vicious circle of fatigue throughout a tailored exercise intervention, i.e. a training program that should address the involved components of fatigue, specific to each patient.

MANY NAMES, ONE MEANING: A BIBLICAL CONCEPT OF FATIGUE?

PATTYN, N.

ROYAL MILITARY ACADEMY/VRIJE UNIVERSITEIT BRUSSEL

The holistic approach described in Lecture 1, consider sleep alterations, mental fatigue, emotions, pain, etc., is also what drove the conceptualization of a new transactional model of fatigue (Pattyn et al., 2018), applicable to patients, athletes and extreme performers alike. This model identified three components that are essential to understand the occurrence of fatigue: the perception of effort; the propensity to exercise effort, which is the product of a decision-making process; and the motivation. As most of the human decision-making is beyond the reach of our consciousness, all three identified critical components are the result of a constant interaction between conscious and subconscious processes, the measure of which is, by definition, outside of the scope of human conscious experience.

This second lecture will illustrate this holistic approach with data from chronic patients, fundamental research in cognitive psychology, and performance in extreme environments. These different data-sets show the remaining "gaps" in the current fatigue narrative: how both the resource depletion and overload models fall short in explaining all the clinical and experimental findings; how neither functional brain imagery, nor metabolic measures, nor subjective ratings are able to coherently explain performance decrements along the performance continuum, from chronic patients to elite performers; and how one size does not fit all in terms of fatigue reference frameworks.

One of the reasons why fatigue researchers seem to keep hitting a brick wall in our attempts to uncover all the aspects of this protean phenomenon might be the methodological vagueness of the concept: fatigue can still mean a cause, a mechanism, or an outcome, depending on the research question, field of work or specialty of the researcher. Hence the necessity to promote multidisciplinary approaches, where a method of "converging indicators" might allow, if not to pinpoint the exact mechanisms, at least to rule out the less relevant ones.

Furthermore, we will illustrate how the currently available models in the literature may differ in a conceptual way regarding the mechanistic elucidation of the cause of fatigue, yet how there seems to be a growing rift between the current theoretical debates and the applied research field practice demands. Almost two decades after Abbiss and Laursen (2005), and now that mental fatigue seems to have convinced most researchers of its pre-eminence over peripheral or metabolic limitations, we will repeat the exercise of a critical comparison between the milestone models in the field, expanded with the more recent ones (e.g.Millet, 2011; Marcora, 2016; Pattyn et al., 2018).

Furthermore, we will summarize how the scientific evolutions in clinical research (e.g. Mairesse & Neu, 2016) or fundamental cognitive mechanisms (e.g. Van Cutsem et al., 2022) need to be considered, if we wish for exercise science to remain at the forefront of the fatigue research.

Thursday, July 6, 2023

08:00 - 09:15

Invited symposia

IS-SH03 Safeguarding athletes in sport: The past, present and future

WHAT HAVE WE LEARNED SO FAR ABOUT SAFEGUARDING IN SPORT?

KERR, G.

UNIVERSITY OF TORONTO

Research into safeguarding in sport over the past 10 years has diverged enormously, partly based on the increase in media attention of athletes speaking out about the abuse received and the lack of infrastructure to help best safeguard athletes. Notable examples include Barry Bennell who sexually abused children within English football, the systematic verbal, emotional and sexual abuse within National Women's Soccer League, and the racial discrimination at Yorkshire County Cricket Club. While such examples appear extreme, cases of athletes being physically, psychologically, and sexually abused are exposed frequently. Nearly a third of athletes across all sports have indicated that they have been victim of abuse at some point in their career, which can cause drop out in sport, disordered eating, acute and chronic depression and anxiety, self-harm, and suicide.

Given the above, the aim of this session is to provide a brief historical review of the safeguarding in sport literature and highlight notable examples and the prevalence of abuse in sport. The session will provide definitions of the types of abuse athletes can experience, such as physical, psychological, sexual and neglect, with notable examples at an individual, interpersonal, and organisational level provided. Special emphasis will be given to at risk population groups, such as disabilities, children, and adolescents, and what facilitates abusive behaviours in these groups. Finally, the challenges of conducting research will be highlighted, emphasising the barriers that athletes may experience in speaking out about abuse in fear of reputational damage or via ignorance, silence, and collusion.

WHAT ARE WE DOING ABOUT SAFEGUARDING ATHLETES?

HURST, P., CHATZIEFSTATHIOU, D.

CANTERBURY CHRIST CHURCH UNIVERSITY

Research and attention related to safeguarding in sport is rapidly increasing, and there is now international and national recognition of the significant harassment and abuse athletes can experience in sport. There is also a greater understanding of when athletes are more at risk of receiving abuse, and the safeguarding measures that can be implemented to prevent, deter, and detect it. Centralised sport integrity bodies, organisation, and services, at both a international and national level are in place, which are specifically aimed at safeguarding athletes. These organisations are often devoted to targeting multiple forms of safeguarding issues, including competition manipulation, doping, discrimination, inequity, anti-social behaviour, and governance with the prevention and response to abuse in sport. Such organisations are global and span various sports and countries, including Sport Integrity Australia, the Athletics Integrity Unit, Japan Sport Council's Sport Integrity Unit, the International Hockey Federations' Integrity Unit, and the Equestrian Community Integrity Unit.

The aim of this session is to provide an overview of the organisations in place to target abuse and what they are doing to safeguard athletes. Emphasis will be given in highlighting the behaviours and cultures within sport organisations that are known to facilitate and encourage abuse, and what methods can be put into practice to prevent this from occurring. The session will provide examples of the policies sport organisations have adopted to prevent abuse in sport, how athletes themselves can foster a safe sport environment and the significant role sport science researchers and practitioners can do to help further engender a safeguarding culture that protects athletes' participation in sport.

WHAT STILL NEEDS TO BE ACHIEVED TO BEST SAFEGUARD ATHLETES IN SPORT?

RULOFS, B.

GERMAN SPORT UNIVERSITY COLOGNE

Although the protection of athletes and the absence of abuse are the overarching goals of safeguarding policies and organisations, there is a significant lack of research examining the effectiveness of safeguarding programmes. Similarly, research monitoring the implementation of child protection policies in sport organisations is scarce, while introducing athletes' protection to sport organisations usually evokes resistance. It is therefore central that strategies for developing athletes' protection in sports organisations can overcome resistance to change. To highlight this, we conducted a study on sport clubs in Germany, and applied the theoretical framework of organisational capacity to examine whether a sport organisation's organisational capacity influenced their activation towards child protection. While it is a wide-spread and often-used argument by sport managers that sports federations do not have sufficient financial resources to implement

child protection activities, this study confirms that financial factors are of secondary relevance, and that human resource capacity and structural capacity are more important.

To progress knowledge and understanding of the influence safeguarding programmes have on the prevalence of abuse in sport, and taking into consideration the issues mentioned above, the aim of this session is to address the following two questions. First, how can sports organisations be developed and implemented to reduce resistance to the adoption of athletes' protection measures and ensure a positive mindset for the protection of children and young people? Second, which specific structural and human resource capacities are relevant for the development of athletes' protection activities in sports organisations and how can they be generated?

Invited symposia

IS-AP04 Technology and Performance in Sports

IDENTIFYING THE ADVANTAGES AND LIMITATIONS OF SPORTS PERFORMANCE WHEN USING AUGMENTED REALITY

MADELEINE, P., EISENHARDT, D., KRISTIANSEN, M.V.

AALBORG UNIVERSITY

In all sports, sportsmen strive for the highest level of performance. The development of modern electronics and computer enable today to feed the sportsmen with metrics that inform about their current level of performance. Combining real environment with added sensory information using audio, tactile or visual feedback places the sportsmen in an augmented or extended reality. Such approaches are becoming used in both laboratory and real-life settings. In laboratory, goalkeepers can rehearse penalty sessions in virtual environment. Augmented reality has also entered real life as commercial products like running watches and swimming googles provide visual information about running or swimming style, effort level and progress. For such applications, data from e.g., accelerometer and inclinometer are fused to feed algorithms that benefit from large datasets by means of machine learning approaches.

This offers a vast number of possibilities that can affect the performance level positively. However, feeding the sportsmen with additional sensory information can also have negative effect especially if the added information increases the cognitive load or changes the focus of the sportsmen. In this talk Pascal will review recent development related to augmented reality describing both pros and cons of the approaches in sports.

The target audience covers experts in performance assessments as well as sport engineers developing applications providing feedback on performance level to athletes and sportsmen.

UNDERSTANDING THE PLAYER/RACKET INTERACTIONS BASED ON EMBEDDED ACCELEROMETERS DURING RACKET SPORTS PERFORMANCE

CHADEFAUX, D.

UNIVERSITÉ SORBONNE PARIS NORD

The equipment is crucial for sport performance. It determines the quality of the athletes' gesture, but also plays a key role in the mitigation of injury risks. Among other parameters, the equipment's vibrations and radiated sound are empirically used by athletes to assess the comfort and the quality of the performance. In racket sports, shock-induced vibrations are likely to be driven by various performance parameters as the racket properties, the grip-force, the segment's alignment, or the playing techniques (ball speed and spin).

However, no robust method has so far been developed, that can efficiently guide the athletes in choosing their equipment. The main limitation to develop such a method is our little knowledge concerning the effects of the equipments mechanical properties on the biomechanical aspects of sport performance. In this talk, Delphine will present some recent work aiming at understanding the links between rackets, i.e., tennis and padel properties and athletes' perception of the equipment quality.

The target audience is people interested in evaluating the quality of sports equipment based on vibration analysis to optimize it with regard to athletes perception, performance and injury risk.

THE WEARION PROJECT: USING REAL-TIME FEEDBACK FROM INSOLE TECHNOLOGY TO IMPROVE THE BIOMECHANICS OF RUNNING AND REDUCE INJURY RATES.

MEIJER, K.

MAASTRICHT UNIVERSITY

Real-time biofeedback from wearables may help to guide and optimize running training and contribute to enhance performance and potentially avoid injuries. Recent advances in insole sensing and app development have created the opportunity to provide feedback on key biomechanical outcomes related to

running technique. Key challenges to capitalize on these developments are optimization of system design for accurate biomechanical assessments, validation of outcome variables against ground truth data and rigorous evaluation of different feedback approaches.

The aims of the WEARION project were i) to redesign the insole sensors to optimize assessment of loading parameters, ii) to validate the sensor design via mechanical and human testing at the CAREN system, ii) develop new AI algorithms to provide real-time feedback on running technique and loading parameters and iv) to evaluate the optimized system in a 6-month lasting RCT in which the effect of two different feedback modes on injury rate in running was tested .

While there are numerous applications of real-time feedback provided by wearables to enhance performance, there are also several limitations and challenges that need to be overcome to ensure these methods are effective. This talk will discuss the lessons learned from the WEARION project and highlight

limitations and challenges in this emerging field of application.

The target audience includes individuals interested in using technology and in particular wearables to optimize running performance.

Oral presentations

OP-PN05 Physiology: Energy Metabolism

LOW ENERGY AVAILABILITY IN FEMALE ENDURANCE TRAINED ATHLETES IMPAIRS EXERCISE PERFORMANCE AND INCREASES OXIDATIVE STRESS IN IMMUNE CELLS

JEPPESEN, J.1, CALDWELL, H.2, LOSSIUS, L.1, ATTI, J.1, BANGSBO, J.1, HELLSTEN, Y.1

1DEPARTMENT OF NUTRITION, EXERCISE AND SPORTS, UNI OF COPENHAGEN, DENMARK, 2CENTRE FOR HEART, LUNG AND VASCULAR HEALTH, SCHOOL OF HEALTH AND EXERCISE SCIENCES, UNIVERSITY OF BRITISH COLUMBIA, CANADA

INTRODUCTION: Low energy availability (LEA), defined as an inadequate amount of dietary energy available to sustain physiological functions, is an established phenomenon that is prevalent among female endurance athletes. Some reports suggest negative effects of LEA however, there is a paucity of well-controlled studies investigating the physiological consequences of a period of LEA. This study aimed to determine the impact of 14 days of LEA, with a particular focus on exercise performance and immune function in female endurance athletes.

METHODS: Twelve female endurance athletes participated in a randomized blinded crossover study. The athletes were assigned to begin with either 14-days of an energy balanced (EB) diet (50 kcal/kg FFM/day) or LEA (22 kcal/kg/FFM/day) followed by 3 days of EB recovery (REC). The athletes maintained their training volume throughout the study. Exercise performance was assessed by a 20-min time trial (20TT) and time to exhaustion (TTE) at 110% of power output at VO2max. Before and after each diet period, blood samples were obtained at rest and immediately following the exercise performance tests, and used for isolation of peripheral blood mononuclear cells (PBMC). The PBMC were analyzed for mitochondrial respiration and emission of reactive oxygen species (ROS) by high-resolution respirometry (OROBOROS, Oxygraph-2k). Further characterization of PBMC and analysis of immune-related plasma proteomics are ongoing. A linear mixed model for repeated measurements was used to estimate within- and between-period effects of EB and LEA.

RESULTS: Energy intake was 47% lower ($P < 0.001$) during LEA compared to the EB period. The LEA period lowered whole-body weight by 2.7±0.6 kg ($P<0.01$). Performance (20TT and TTE) decreased by 7.7% (17±4W) ($P<0.01$) and 18% (23±8s) ($P < 0.05$) after the LEA period, respectively. In LEA, 20TT performance remained reduced by 6.7% (16±4W) ($P<0.01$) after REC. PBMC ROS emission in complex II ($P<0.01$) and I+II ($P<0.01$) was 99% and 89%, higher ($P<0.05$), respectively after LEA. The rate of mitochondrial respiration in PBMC was unaltered by LEA. Acute exercise performed after LEA caused a 33% smaller increase in white blood cell count ($P<0.05$). Systemic cortisol was increased ($P<0.01$) by 22% (147±71 nmol/L) after LEA. No differences were found after EB.

CONCLUSION: A brief period of LEA in female endurance athletes acutely impaired exercise performance and lasted for at least 3 days into recovery with EB. LEA also increased immune cell ROS emissions at rest, blunted the rise in immune cells after acute exercise, and increased resting plasma cortisol levels, indicating a stress response which may affect recovery and adaptations to exercise and potentially increase susceptibility to infections. Collectively, our data may indicate that LEA is detrimental to the health of female athletes.

Funding: The study was supported the Danish Ministry of Culture and Team Danmark.

LOW ISOMETRIC KNEE-EXTENSION FORCE AND SLOW FREE-LIVING SIT-TO-STAND TRANSITIONS PREDICT PHYSICAL FUNCTIONAL DECLINE AMONG OLDER ADULTS: 4-YEAR FOLLOW-UP STUDY.

LÖPPÖNEN, A.1,2, KARAVIRTA, L.1, FINNI, T.1, PALMBERG, L.1, PORTEGIJS, E.3, RANTANEN, T.1, DELECLUSE, C.2, VAN ROIE, E.2, RANTALAINEN, T.1

1 UNIVERSITY OF JYVÄSKYLÄ, FINLAND, 2 KU LEUVEN, BELGIUM, 3 UNIVERSITY OF GRONINGEN, NETHERLANDS

INTRODUCTION: Lower-extremity strength is an important factor in maintaining a high level of physical functioning among older adults (1, 2), but it is unclear how free-living strength-demanding activities predict a future decline in lower-extremity functioning. The aim of this study was to examine whether isometric knee-extension force and the number and intensity of free-living sit-to-stand (STS) transitions can predict a decline in lower-extremity functioning over a 4-year follow-up among community-dwelling older adults.

METHODS: Older adults (n=340, 60% women), aged either 75, 80 or 85 years at baseline, participated in a baseline and 4-year follow-up measurement. At baseline, maximal isometric knee-extension force was measured in a dynamometer and a thigh-worn tri-axial accelerometer was used to estimate the number and intensity (mean and maximal thigh angular velocity) of STS transitions in a free-living environment (continuous monitoring for 3-7 days). A decline in lower-extremity functioning was defined as at least a two-point drop in the Short Physical Performance Battery (SPPB) from baseline to follow-up. Logistic regression analysis was the main statistical method.

RESULTS: A total of 85 (25 %) of the participants (75 % women) experienced a decline in physical function over a 4-year follow-up. After adjusting for age, sex, baseline SPPB points and the number of diseases, higher knee extension force (OR = 0.64; 95% CI = 0.50-0.81, per 1 N/kg increase) and higher free-living maximal angular STS intensity (OR = 0.84; 95% CI = 0.73-0.97, per 10 deg/s increase) protect against a future decline in lower-extremity functioning. When comparing the odds ratios of the standardized values, isometric knee-extension force was a better protector against functional decline (OR = 0.53; 95% CI = 0.37-0.75) than free-living maximal angular velocity (OR = 0.70; 95% CI = 0.51-0.94). No significant interaction between force and STS performance was observed. The number of STS transitions and mean angular velocity were not significantly associated with functional decline.

CONCLUSION: Free-living STS performance can predict a future decline in lower-extremity functioning. Even though laboratory tests of muscle force appear a better predictor of future decline, the assessment of STS performance in a free-living environment would allow frequent remote assessments. This in turn allows detecting changes in performance in an early stage, so that preventive strategies can be initiated in time.

SHORT BOUTS OF WALKING UP STAIRS REQUIRE MORE METABOLIC POWER THAN LONGER ONES: PHYSIOLOGICAL AND MECHANICAL DETERMINANTS.

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UNIVERSITY OF MILAN

INTRODUCTION: Breaking up sedentary time with brief walks improves health, but the energy demands of such activity are poorly understood. Previous studies showed that short walking bouts require proportionally more oxygen than longer ones (1) and have a lower efficiency, the ratio of mechanical to metabolic power (2). This discrepancy could be due to variable demands during walking, or fixed ones to start or end the bout. To clarify these mechanisms, studies with standardised mechanical powers and bout durations are needed. This study assessed the power and efficiency of short bouts of stair walking; such activity was chosen as it mainly requires positive mechanical power (Pmech) to move the body centre of mass, with minimal contribution from elastic storage, and negative or internal power.

METHODS: Based on sample size estimation, ten participants (5 F; 27±5 y; 69±15 kg) walked up on a Technogym Climb Excite escalator at Pmech of 1.3, 1.6 and 2.3 W/kg for 10, 30, 60, 90, and 240 second bouts in randomised order. Net oxygen uptake was measured by a Cosmed K5 metabograph and time-integrated during bout and recovery to give total oxygen consumption (VO2bout; mL/kg). Metabolic power (Pmet) and efficiency were calculated with two methods: i) VO2bout was divided by bout duration and multiplied by the energy equivalent of oxygen (EqO2; J/mL) at steady state (2), and efficiency was given by Pmech/Pmet. ii) Four more 240-second VO2 on-kinetics were collected at Pmech 2.3 W/kg, interpolated, averaged, and fitted with an exponential model: cardiodynamic oxygen transfer was calculated as in (3) and subtracted to VO2bout. The resulting oxygen volume was multiplied by a time varying EqO2 accounting for changes in energy substrates during bout (4), and the mechanical work to start walking was included in efficiency calculation (2).

RESULTS: At all Pmech, increasing bout duration decreased Pmet (mixed linear model, fixed effect [95%CI]: -1.9*10-2 [-2.6*10-2; -1.3*10-2]) and increased efficiency (2.4*10-4 [1.7*10-4; 3.0*10-4]). The differences in metabolic power were explained by the cardiodynamic oxygen transfer, the mechanical work to start walking, and changes in EqO2, leading to a duration-independent efficiency (9.8*10-5 [-5.8*10-6; 2.0*10-4]) of about 20%.

CONCLUSION: Short bouts of walking up stairs require more metabolic power than longer ones. This increase is partially apparent, due to the fixed amount of oxygen consumed during the cardiodynamic phase, while the rest is explained by the work to start walking and differences in EqO2 during the on- and off-VO2 transient. These results provide a framework for studying locomotion bioenergetics when a steady state is not achieved and shed light on the physiology of a common practice to promote physical activity.

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STRESS FRACTURES, MENSTRUAL IRREGULARITIES AND LOW ENERGY AVAILABILITY IN ITALIAN ÉLITE TRACK AND FIELD ATHLETES

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INTRODUCTION: Élite athletes, due to the intense mental and physical demand, may experience injuries and hormonal dysfunction, including overuse injuries and menstrual disorders. Both these factors are influenced by Low Energy Availa-

bility (LEA), so this study aims to determine the relationship between menstrual irregularities, stress fractures and LEA in Italian élite track and field athletes.

METHODS: The study included 149 high level (national, European, world and Olympic) female track and field athletes specialized in sprints, jumps, hurdles, combined events, middle and long distance. They were asked to answer a questionnaire about stress fractures (SF), a questionnaire to identify presence of LEA (LEAF-Q) [1] and consequentially to be at higher risk of developing the Triad and 66 of them also filled a food diary.

RESULTS: The 50.3% of the total sample had at least one SF and the 45% of the total sample has or had menstrual irregularities. Specific disciplines have a significant impact on SF number (p=0.012), with middle- and long-distance runners resulting more exposed to SF (62.5% of them had at least one SF), even if sprinters and hurdlers had also high percentages of SF (respectively 50% and 43.2%). Athletes who had at least one SF had higher probability than not injured athletes of having menstrual irregularities ($\chi 2$=8.42 p=.015). It was found a significant negative correlation between age of menarche and lowest BMI (r=-.315 p=.008), a positive correlation between LEAF-Q scoring and age at menarche (r=.314 p=.001) and between number of SF and age of menarche (r=.37; p=<.001) and LEAF-Q scoring (r=.33; p=<.001). Analyzing the food diary of the athletes, by reference to ISSN exercise and sport recommendation guidelines[2], we observed that 27.7% was under the recommended amount of protein, the 12.1% was under the recommended amount of fats, the 84.8% was under the recommendation of carbohydrates and last the 84.8% of the athletes was considered under the estimated range of caloric needs (40-70kcal/kg/day).

CONCLUSION: The results of the present study underline that menstrual irregularities and bone stress injuries are common problems in élite athletes; early intervention and injury prevention can be achieved by implementing management strategies. Nutritional factors play also a significant role in the risk of developing SF and the Triad, moreover, it was unexpected that carbohydrates had the biggest impact on the falling to reach the recommended energy intake. These data underline that even among élite athletes is necessary more awareness of the importance of nutrition intervention to support trainings, performances and to avoid injuries.

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WITHIN-DAY ENERGY BALANCE AND SYMPTOMS OF RELATIVE ENERGY DEFICIENCY IN SPORT (RED-S) IN RECREATIONAL FEMALE ATHLETES

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INTRODUCTION: Relative Energy Deficiency in Sport (RED-S) is a syndrome whereby low energy availability (LEA) causes downregulation of physiological processes, resulting in health and performance consequences. Energy availability is normally calculated over 24-hrs, however this may conceal energy deficient periods in the day. Such periods of energy deficiency have been associated with menstrual and endocrine dysfunction in female athletes (1) however high training loads may influence this interaction. This was the first study to explore within-day energy balance (WDEB) in relation to various RED-S consequences in recreationally active women (4-6 hours per week moderate-vigorous physical activity). Furthermore, our understanding of RED-S within this population stems primarily from self-report questionnaires, thus our study extended this by combining questionnaire, lab, and field-based measures to assess LEA prevalence and RED-S symptoms in premenopausal, recreational female athletes.

METHODS: Seven-day food and training diaries alongside accelerometry and heart rate were used to estimate 24-hr energy availability and hourly WDEB. The largest within-day energy surplus and deficit, the number of hours spent in a surplus and deficit, and the maximum number of consecutive hours in each, were calculated daily and averaged across the 7-days. Body composition, quantitative ultrasound of bone, hematocrit, hemoglobin, total cholesterol, maximum voluntary contraction at the knee during flexion and extension, VO2peak and lactate profile were all assessed. Questionnaires assessed menstrual function, psychological, immunological, and gastrointestinal health, disordered eating, and injury history.

RESULTS: Of the 16 participants (age=27±6 yrs., height=1.67.0±0.05 m, mass=63.5±8.2 kg) only 12.5% had low energy availability (<30 kcal/kgFFM/day), yet 75% had subclinical energy availability (30-45 kcal/kgFFM/day) typically associated with weight loss. Partial correlations accounting for energy availability showed menstrual health was negatively correlated with mean largest energy surplus (p=0.045). Body fat percentage was positively correlated with mean number of hours (p=0.003) and mean maximum consecutive hours (p=0.020), spent in an energy deficit. Relative muscle strength variables were positively correlated to within-day energy surplus variables (p=0.008-0.026). VO2peak and lactate threshold were negatively correlated with within-day energy deficit variables (p=0.001–0.022). Radius T- and Z-scores were positively correlated with absolute largest energy surplus (p=0.004 and p=0.010, respectively).

CONCLUSION: In conclusion, 24-hr LEA is not highly prevalent in recreationally active women, but WDEB may have health and performance implications that are overlooked when assessing LEA alone.

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Oral presentations

OP-BM04 Neuromuscular Physioloogy

RUNNING IN THE HEAT DOES NOT AFFECT OPERATING FASCICLE LENGTHS COMPARED TO TEMPERATE ENVIRONMENT

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INTRODUCTION: Muscle mechanics is paramount in our understanding of motor performance. Growing literature demonstrated the decoupling of gastrocnemius medialis (GM) muscle fascicle and tendinous tissues during running, highlighting the crucial role of soft tissue dynamics during locomotion (1). GM operating fascicle lengths also demonstrated a leftward shift over their force-length relationship in response to an increase in running velocity from 10 to 16 km.h-1 (2). However, little is known regarding the sensitivity of fascicle dynamics and soft tissues stiffness to exercise duration and ambient temperature during running, which both have an impact on muscle temperature. This study aimed to determine GM fascicle and muscle-tendon unit dynamics in vivo during running in temperate and hot conditions. Given that lower-limb stiffness was shown to decrease after running a marathon in hot environment (3), it was hypothesized that soft tissue stiffness would be reduced when running in the heat, potentially decreasing fascicle operating lengths.

METHODS: Fifteen trained runners (8 males, 7 females, 26 ± 3 yr) were tested before (pre-), during and after (post-) a running task (40 min at 10 km.h-1) performed in temperate (TEMP: ~23°C) and hot (HOT: ~38°C) conditions. During running, fascicle dynamics was assessed using ultrafast ultrasound at 2 and 40 min. During pre- and post-testing, we assessed maximal voluntary contraction (MVC) force, passive muscle stiffness (i.e. shear modulus of the triceps surae) and active Achilles tendon stiffness. GM fascicle force-length relationship was built using electrically-evoked contractions and ultrafast ultrasound measurements before the running task.

RESULTS: Core, skin temperatures and heart rate increased from the beginning to the end of the exercise, and in a larger extent in HOT than TEMP ($P < 0.001$). The physiological stress elicited did not alter running mechanics over time and condition, with stride duration from 737 ± 31 to 745 ± 36 ms in TEMP and from 737 ± 32 to 748 ± 41 ms in HOT ($P \geq 0.291$) and elicited unchanged GM fascicle operating lengths over time (2 vs. 40 min; $P \geq 0.248$) and across conditions (TEMP vs. HOT; $P \geq 0.248$). MVC peak force tended to decrease after exercise (from 548 ± 116 to 505 ± 107 N in TEMP, from 565 ± 113 to 467 ± 109 N in HOT; $P = 0.060$), while soft tissue stiffness did not show neither time ($P \geq 0.281$), condition ($P \geq 0.256$) nor time × condition interaction ($P \geq 0.465$) effect.

CONCLUSION: The present findings show that a prolonged running exercise at moderate intensity (i.e. 40 min at 10 km.h-1) did not modify muscle-tendon unit properties and interplay, neither in temperate nor in hot environment. These findings may rule out potential detrimental effects of heat on muscle properties and strongly encourage further investigations on longer and more intense running exercise.

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A 3D ULTRASOUND APPROACH TO ASSESS STATIC LENGTHS AND THE LENGTHENING BEHAVIOUR OF THE GASTROCNEMIUS MEDIALIS MUSCLE AND THE ACHILLES TENDON DURING WALKING IN VIVO – A VALIDITY AND RELIABILITY STUDY

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INTRODUCTION: Gaining information about adaptations in the lengths and lengthening behaviour of the gastrocnemius medialis (GM) muscle and Achilles tendon is important to develop efficient training strategies. However, assessing the tissues' lengths is difficult using 2D ultrasound (US) alone. Therefore, various US approaches exist (1–4), though those have several drawbacks (e.g., lying perfectly still is obligatory, only static measurements are possible, 2D simplification, etc.). Therefore, we developed a 3D ultrasound (3D US) approach for the assessment of the static lengths and dynamic lengthening behaviour of the GM muscle-tendon unit (MTU), muscle belly, and Achilles tendon during ankle dorsiflexion movement (5) and overground walking in vivo. The aim of this study was to evaluate the validity and reliability of the novel 3D US approach.

METHODS: Altogether 16 healthy participants were included in this study. For the evaluation, two US measurement sessions and one magnetic resonance imaging (MRI) assessment were performed. By combining 2D US, 3D motion capture, and vector algebra, the tissues' lengths were assessed in static condition, during passive ankle dorsiflexion movement, and throughout gait cycles. Validity and reliability were determined using Bland-Altman plots, coefficients of variation, standard errors of measurement (SEM), minimal detectable changes (MDC), and intraclass correlation coefficients (ICC).

RESULTS: The 3D US approach slightly underestimated the tissues' lengths in comparison to MRI by 0.7%, 1.5%, and 1.1% for the muscle belly, Achilles tendon, and MTU, respectively. The approach showed excellent reliability with small SEMs (≤

1.3 mm), MDCs (≤ 3.6 mm), and excellent ICCs (≥ 0.94) for assessments under dynamic conditions. Even better reliability was found for assessments of static lengths.

CONCLUSION: The proposed 3D ultrasound approach is valid and reliable to assess the static GM MTU, muscle belly, and Achilles tendon lengths and the tissues' lengthening behaviour during passive ankle dorsiflexion movement and gait. These findings support its potential as useful tool for investigations of the effects of training interventions or therapeutical treatments in the future.

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COMPARISON OF THE EFFECTS OF LONG-LASTING STATIC STRETCHING AND STRENGTH TRAINING ON MAXIMAL STRENGTH, MUSCLE THICKNESS AND FLEXIBILITY IN THE PLANTAR FLEXORS

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INTRODUCTION: Maximal strength measured via maximal voluntary contraction is known as a key factor in competitive sports performance as well as injury risk reduction and rehabilitation. Maximal strength and hypertrophy are commonly trained for by performing strength training programs. However, literature shows that long-term, long-lasting static stretching interventions can also produce significant improvements in maximal voluntary contraction. The aim of this study is to compare increases in maximal voluntary contraction, muscle thickness and flexibility after 6 weeks of stretch training and a conventional strength training intervention.

METHODS: Sixty-nine (69) active participants (f=30, m=39; age: 27.4±4.4 years, height: 175.8±2.1 cm, and weight: 79.5±5.9 kg) were divided into three groups: IG1 stretched the plantar flexors continuously for one hour per day, IG2 performed a strength training for the plantar flexors commonly used to achieve hypertrophy (5x12 reps, three days per week), while CG did not undergo any intervention. Maximal voluntary contraction, muscle thickness, pennation angle and flexibility were the dependent variables. A 2x2 ANOVA with a Scheffé test as post-hoc test was used for data analysis.

RESULTS: The results show significant increases in the intervention groups compared to the control group with significant interaction effects ($p<0.05$) for maximal voluntary contraction ($\eta^2=0.143$-0.572, $p<0.006$), muscle thickness ($\eta^2=0.11$-0.228, $p<0.021$), pennation angle ($\eta^2=0.006$-0.163, $p=0.006$-0163) and flexibility ($\eta^2=0.089$-0.426, $p<0.046$) for both the stretch and strength training group without significant differences ($p=0.37$-0.98, $d=0.03$-0.4) between both intervention groups.

CONCLUSION: It can be hypothesized that mechanical tension plays a crucial role in improving maximal voluntary contraction and muscle thickness irrespective of whether long-lasting stretching or strength training is used. Results show that for the calf muscle the use of long-lasting stretching interventions can be deemed an alternative to conventional strength training if the aim is to increase maximal voluntary contraction, muscle thickness and flexibility. Therefore, since mechanical tension via stretching could be performed without active joint movements, practical applications can be seen especially in the rehabilitation after serious injury and/or surgery leading to prologned times of immobilization, without the possibility to perform a commonly used strength training routine.

KNOWING OR NOT KNOWING - EFFECTS OF A SUSTAINED MVC ON PERFORMANCE FATIGABILITY OF THE CONTRALATERAL HOMOLOGOUS HAND MUSCLE.

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INTRODUCTION: Human performance during exercise is limited by performance fatigability (1). Several studies have investigated cross-over effects of fatigue on non-exercised muscles (non-local muscle fatigue; NLMF). Although physiological mechanisms of NLMF have been extensively studied, little information is available on psychological effects on NLMF (2,3). Hence, in the present study we investigate the effect of prior knowledge of a task on NLMF.

METHODS: Twenty subjects (13 females; mean age 25 ± 3 years old) participated in three sessions, separated by 1 week. Custom-made force transducers measured the index finger abduction force of both hands. Electrodes were placed on the left and right ulnar nerve to evoke superimposed twitches and doublet forces at rest. Visits started with assessing maximal voluntary contractions (MVC), followed by a sustained MVC (2 min) with either the left or right hand (randomized) including 7 superimposed stimulations of the ulnar nerve. After the sustained MVC, doublets were evoked at rest. The first visit served to induce subjects to think that they had to perform a single sustained MVC. However, during the second visit they were ordered to perform a second sustained MVC with the contralateral hand directly after the first sustained contraction. During the third visit, the protocol was the same as the second, but subjects were aware that they had to perform 2 consecutive sustained MVCs. A mixed effect model in which subjects were treated as a random factor was used to analyze the data.

RESULTS: The mean force during the first and last 6 seconds of the sustained MVCs showed that the force was significantly lower in the second sustained MVC (initial 6s: 89.5±0.9 vs. 83.9±0.9 %MVC; p<0.001, last 6s: 30.7±1.3 vs. 28.2±1.1 %MVC; p=0.029). Additionally, the mean voluntary activation was lower in the second sustained MVC (90.3 ±7.1 vs 86.3±8.1 %; p=0.004), but no differences were observed in the post-doublet force (41.5±2.0 vs. 40.4±1.4 %, p=0.46). We found no differences in the force across the second and third visit (initial 6s: 86.1±0.94 vs. 87.3±1.1 %MVC, p=0.30; last 6s: 29.3±1.3 vs. 29.6±1.1 %MVC, p=0.78), mean voluntary activation (89.3±1.4 vs. 87.3±1.4 %. p=0.17) or post-doublet force (40.1±2.0 vs 41.8±1.4 %, p=0.22). No effect of hand-dominance or sex were found on any of the parameters.

CONCLUSION: The additional force decline in the first and last 6 s of the second sustained MVCs provides further evidence of the presence of NLMF. This decline was mainly due to reduced voluntary muscle activation. In contrast to our expectation, we found that prior knowledge of the task did not increase NLMF. Thus, although subjects knew that they had to perform a second sustained MVC they did not use pacing strategies to reduce their force decline.

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ONE-WEEK QUERCETIN INTERVENTION ALTERS THE MOTOR UNIT ACTIVITIES IN YOUNG ADULTS.

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INTRODUCTION: Ergogenic aids, such as caffeine, can improve physical performance. Quercetin, found in onions, has effects similar to caffeine and improved endurance performance [1]. Quercetin and caffeine affect the neuromuscular system by promoting neurotransmitter release. A high dosage of quercetin glycosides modulates motor unit firing patterns [2]. Investigating the impact of chronic low-dose quercetin ingestion on the neuromuscular system is important for quercetins potential use as an ergogenic aid. This study aims to investigate the impact of a one-week low dosage of quercetin on motor unit and muscle properties, hypothesizing a decrease in recruitment threshold and an increase in neuromuscular efficiency.

METHODS: Twenty young adults were randomly assigned to either quercetin (QUE) or placebo (PLA) groups, in a double-blind study. They performed knee extensor muscle measurements before (PRE) and after (POST) 7 days of either 200mg quercetin or placebo ingestion. The measurements included maximum voluntary torque (MVT), motor unit recruitment threshold (RT) and torque normalized by motor unit firing rate (NFR) by high-density surface electromyography, and force-frequency relationship (FFR) by electrically elicited contraction by skeletal muscle electrical stimulation at 10, 20, 40, and 80 Hz. The sample size was ascertained through a statistical power analysis, which was based on the stated assumptions of an effect magnitude of 0.40, a significance level of 0.05, and a desired power of 0.80, extrapolated from the previous study and taking into account the probability of dropout. Statistical methods were selected based on Shapiro-Wilk test: parametric (t-test) for normal data and nonparametric test (Wilcoxon/Mann-Whitney) for non-normal data.

RESULTS: There was no difference in MVT with intervention in both conditions. From PRE to POST, QUE significantly decreased the RT (29.1±9.1 to 27.1±9.5 %MVT) and increased the NFR (1.06±0.18 to 1.10±0.18 %MVT/pps), whereas PLA remained unchanged (29.8±10.4 to 28.9±9.7 %MVT; 1.06±0.20 to 1.07±0.18 %MVT/pps). Compared to PLA, QUE significantly decreased the RT (QUE: -8.5±14.0 %; PLA: -1.9±10.5 %) and significantly increased the NFR (QUE: 6.2±13.7 %; PLA: 1.9±10.0 %). FFR was unaffected by the intervention in both conditions.

CONCLUSION: The present study indicated that a one-week quercetin intervention in young adults decreases the RT of motor units and increases the NFR. The intervention did not alter muscle contractile properties. These findings imply that the ingestion of quercetin influences the central nervous system, but not the peripheral. The changes in motor unit recruitment patterns and neuromuscular efficiency induced by quercetin ingestion may contribute to the potential mechanisms behind the enhancement of endurance exercise performance.

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Oral presentations

OP-PN07 Fatigue

EXERCISE TOLERANCE IN PATIENTS WITH FRIEDREICH'S ATAXIA

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INTRODUCTION: Friedreich's ataxia (FA) is a rare inherited neurodegenerative disease caused by decreased expression of frataxin, a protein involved in many cellular metabolic processes, including mitochondrial oxidative phosphorylation [1]. In many of these patients, a reduced exercise tolerance and the associated easy fatigability significantly affects quality of life.

Our objective was to assess peak exercise capacity in adults with FA as compared to age-matched healthy controls using the classic open circuit method. Moreover, skeletal muscle fractional O2 extraction was evaluated by near infra-red spectroscopy (NIRS), a non-invasive tool able to detect mitochondrial dysfunction in clinical populations [2,3].

METHODS: Sixteen FA patients, aged 26±8 years, and sixteen healthy subjects (CTRL), aged 26±3 were included. All patients were able to walk without support, and had a mean total score at the Scale for Assessment and Rating of Ataxia (SARA) of 16±1 points [4]. Each participant performed an incremental exercise on a recumbent cycle ergometer up to voluntary exhaustion. Breath-by-breath pulmonary O2 uptake (V'O2), heart rate (HR), and rate of self-perceived exertion (RPE), using the validated Borg's Scale [5] were determined. Concentration changes of deoxygenated hemoglobin and myoglobin (Δ[deoxy(Hb+Mb)]) from resting values, determined by NIRS positioned on vastus lateralis, were considered an index of O2 extraction.

RESULTS: FA patients attained significant lower peak workload and V'O2peak values (57±33 W and 19.2±5.8 ml*kg-1*min-1, respectively) compared to CTRL (194±64 W and 34.3±9.4 ml*kg-1*min-1, respectively; both $p<0.001$). A significant ($p=0.013$) negative correlation was observed between SARA score and V'O2peak. Peak HR was 150±20 b*min1, corresponding to 77±11% of the age-predicted maximum value in FA, suggesting that some of FA patients did not attain maximal effort. By contrast, peak HR was 182±10 b*min1 corresponding to 94±4% in CTRL. RPE was similar between FA (16±3.2) and CTRL (18±1.5; $p=0.063$). Peak Δ[deoxy(Hb+Mb)] was lower in FA (27.8±11.2%) compared to CTRL (56.0±24.9%; $p<0.001$).

CONCLUSION: FA patients showed a reduced exercise tolerance compared to healthy controls, at least partially attributable to impairment in fractional oxygen extraction at skeletal muscle level. A significant negative correlation was observed between SARA score and V'O2peak. However, it should be considered that severe limb coordination deficits in FA disease prevented the optimal execution of the incremental test on the recumbent cycle ergometer up to the maximum effort, thus limiting the interpretation of the results and reducing the applicability of this test as a tool to assess exercise tolerance in FA.

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EFFECTS OF PLYOMETRIC EXERCISES WITH BLOOD FLOW RESTRICTION ON POSTACTIVATION PERFORMANCE ENHANCEMENT IN MALE BASKETBALL PLAYERS

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INTRODUCTION: Plyometric exercises (PLY) have been used as conditioning activity to enhance subsequent performance by eliciting postactivation potentiation (PAP), which is called postactivation performance enhancement (PAPE). Studies also indicated that exercises combined with blood flow restriction (BFR) may increase the PAP response. Therefore, the aim of this study was to examine the effects of warm-up exercise by PLY with BFR (PLY-BFR) on jumping and sprinting performance as well as changes in blood lactate (LA) and creatine kinase (CK) levels as indicators of exercise intensity. We hypothesized that PLY with BFR would have better performance enhancement than PLY or BFR only, and the intensity of this exercise is similar to the others.

METHODS: Fourteen male basketball players (19.57 ± 1.55 yrs, 184.57 ± 10.26 cm, and 82.86 ± 12.27 kg) were recruited into the study. A crossover and counterbalanced manner was used to investigate the PAPE after warm-up by PLY, BFR, and PLY-BFR. The PLY consisted of 40 drops of ankle hops, hurdle hops and drop jumps. In BFR, the cuff pressure of 80% arterial occlusion pressure was applied to subjects' quadriceps of dominant leg. The venous blood samples were drawn before and 15 min after warm-up exercises to analysis the blood levels of LA and CK. Performance of countermovement jump (CMJ) and 14 m sprint were measured before and 5, 10, 15 min after warm-up exercises. A two-way ANOVA with repeated measures was used to compare differences among trials and time points. Statistical significance was set at $\alpha = .05$. All data are expressed as mean ± SD.

RESULTS: The CMJ heights at the 10-min time point in BFR trial was significantly higher than before exercises [40.21 ± 7.31 vs. 38.41 ± 5.87 cm, $p < .05$, effect size (ES) = 0.27]. Moreover, the CMJ heights at the 5-, 10- and 15-min time points in both PLY-BFR and PLY trials were significantly higher than before exercises (PLY-BFR: 39.55 ± 7.36, 40.66 ± 7.44 and 39.50 ± 6.95 vs. 37.71 ± 6.37 cm, respectively, $p < .05$, ES = 0.27, 0.43 and 0.27, respectively; PLY: 40.00 ± 7.98, 40.10 ± 7.82 and 39.77 ± 7.21 vs. 37.60 ± 6.72 cm, respectively, $p < .05$, ES = 0.33, 0.34 and 0.31, respectively). However, there were no significant difference among trials. No significant difference was observed in 14 m sprint among trials or time points. Furthermore, there were no significant changes in blood levels of LA or CK after 15 min of warm-up exercises among trials.

CONCLUSION: The results of present study indicate that the exercise intensity of plyometric exercises with blood flow restriction is similar to plyometric exercises or blood flow restriction only. Plyometric exercises with blood flow restriction could enhance subsequent jumping performance of male basketball players for 15 min, with a medium effect size after 10 min of rest. However, it had no effect on 14 m sprint.

A PRIOR HIGH-INTENSITY INTERVAL OR CONSTANT-LOAD WORKOUT DOES NOT ALTER CENTRAL AND PERIPHERAL FATIGUE RESPONSES AT TASK FAILURE

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INTRODUCTION: Performance fatigability – an exercise-induced decline in central motor drive and/or muscle contractile properties (1) – is a key determinant of exercise performance. Numerous athletic and professional events require consecutive exercise tasks, the intensity of which can determine acute neuromuscular and perceptual consequences. Based on the 'critical threshold of peripheral fatigue' theory (2), the central nervous system should stop exercise to avoid surpassing a level of catastrophic muscle function impairment, yet it is unknown how this threshold is modulated by pre-inducing a fatiguing task, and whether the intensity of such prior task can affect this relationship. We hypothesized that following a fixed moderate-intensity (MOD) compared to high-intensity interval training (HIIT), more work will be performed in a subsequent time to task failure (TTF) trial , but measures of performance fatigability at the end of TTF will show the same results.

METHODS: Following a cycling ramp incremental test to determine peak power output (PO), 17 participants (8 females) completed 3 experimental sessions in randomized order whereby a TTF trial at 80% PPO was performed following HIIT, MOD, or rest (CTRL). HIIT consisted of 10×2-min work intervals at 80% peak PO separated by 2-min at 25% PPO, whereas MOD was set at a fixed-PO to match work and duration completed in HII. Isometric maximal voluntary contraction (MVC) force of the knee extensors, coupled with evoked superimposed and resting femoral nerve stimuli, was performed prior to exercise, after work-matched tasks, and post-TTF to measure voluntary activation (VA; central fatigue) and twitch force (Qtw; peripheral fatigue). Ratings of perceived exertion, dyspnea, and leg pain were also assessed at the same timepoints.

RESULTS: TTF duration and work performed were greater in CTRL (10±2min; 112±47kJ) than MOD (4±2min; 46±32kJ), which was greater than HIIT (2±1 min; 20±18kJ) ($P<0.05$). Immediately after the work-matched tasks, MVC force (HIIT: -26±10%, MOD: -15±7%; $P=0.005$) and Qtw (HIIT: -44±18%, MOD: -21±18%; $P<0.001$) declined more in HIIT. After the TTF trial, despite no changes for MVC, Qtw still remained lower in HIIT than MOD ($P=0.008$), with neither differing from CTRL. VA declined similarly for all conditions at work-matched and task failure. All perceptual responses were exacerbated following HIIT compared to the other conditions ($P<0.001$), but ended at similar levels after the TTF trial.

CONCLUSION: HIIT exacerbated neuromuscular and perceptual attributes of fatigability; however, these measures demonstrated similar responses after a TTF trial for all 3 conditions. This suggests that the central nervous system processes ensembled sensory feedback generated during exercise to ensure exercise cessation prior to reaching a critical level of peripheral fatigue that may become homeostatically catastrophic.

1. Enoka & Duchateau, 2008, JPhysiol

2. Amann et al., JPhysiol, 2007

INFLUENCE OF INCREASED VALINE INTERMEDIATE 3-HYDROXYISOBUTYRIC ACID IN BRAIN TISSUES ON THE ENDURANCE EXERCISE ABILITY IN RATS

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INTRODUCTION: Branched-chain amino acids (BCAAs) are catabolized for energy substrates in the skeletal muscles to fulfill high energy demands during endurance exercise. In the BCAA catabolic pathway, a small molecule 3-hydroxyisobutyric acid (3HIB) is produced in the mitochondria as an intermediate of valine, some of which is released from the skeletal muscle into the blood circulation, dependently on endurance exercise activity. Severe brain damage has been observed in the patients with 3-hydroxyisobutyric aciduria as an inherited deficiency of an 3HIB catabolic enzyme, 3-hydroxyisobutyryl-CoA dehydrogenase. So, we hypothesized that the 3HIB released from the skeletal muscle during the endurance exercise might be also transported into the brain, and have inhibitive effect roles on exercise performance. The present study evaluated the dynamics of 3HIB concentration in the brain during endurance exercise and the effect of the increase of 3HIB concentration in the brain on exercise performance.

METHODS: Wister male rats were divided into the Control and Injected groups; saline and 3HIB (60 mg/kg body weight) were intraperitoneally injected, respectively. After 15 min, the rats in both groups were loaded on a transit treadmill running at 20 m/min for 0 min, 120 min, or until exhaustion (n=7/condition). Thereafter, 3HIB concentration in serum, brain (cerebrum, cerebellum, and hippocampus), liver, and skeletal muscle (gastrocnemius) was measured by LC-MS/MS system.

RESULTS: In the Control group, 3HIB concentration in the brain tissues increased significantly in an exercise time-dependent manner, along with its significant increase in serum and skeletal muscle. In the Injected group, brain 3HIB concentration increased significantly after the 3HIB injection, and then, further increased depending on the exercise time. In serum, liver, and skeletal muscle, 3HIB concentration was also significantly increased by the injection, but no more increased by the exercise. Exercise time to exhaustion was significantly shorter in the Injected group than in the Control group, and the exhaustion was dependent on increased 3HIB concentrations in the brain, not in other tissues.

CONCLUSION: The exercised rats were exhausted when the 3HIB concentration in the brain tissues reached a higher certain level. Therefore, the present results suggest that 3HIB in the brain might induce central fatigue in endurance exercise.

Oral presentations

OP-PN06 Hormonal Biology I

URINARY EXCRETION OF ANABOLIC STEROID HORMONES DURING THE MENSTRUAL CYCLE IN TRACK AND FIELD ATHLETES

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RUHR UNIVERSITY BOCHUM

INTRODUCTION: The menstrual cycle (MC) is characterized by fluctuations of the sex steroids estrogen and progesterone. However, the cyclic fluctuations of anabolic steroid hormones such as testosterone and its metabolites, which are secreted from both ovaries and adrenal cortex, and the influence of hormonal oral contraception (OC) are largely unknown in elite female athletes. As the phases of MC might have influence on athletic performance and strength training adaptations (1), a deeper understanding of the secretion and metabolism of anabolic steroid hormones through the MC is needed. The aim of the present study was to investigate the urinary profiles of these hormones during the MC in elite athletes with and without OC (wOC/noOC).

METHODS: 22 elite track and field athletes participated in a longitudinal study of MC monitoring in sports. 10 athletes with normal MC (n=18 cycles) and 5 athletes with OC (n=10 cycles) (26±6 y, 172±5 cm, 68±7 kg) were included in the analysis. Intravaginal body temperature was measured daily for 24-h to detect ovulation. Further, athletes collected morning saliva and urine, and capillary EDTA blood prior to training every day or every second day. Urinary steroid hormones were analyzed by GC-MS/MS. Linear mixed models were used to compare Testosterone (T) and the sum of 5α-diol, 5β-diol, 5α-dion, 5β-dion, androsterone and etiocholanolone (SUM) during different phases of MC/noOC (4(7)-phases: menstruation, follicular phase (FP, mid and late), ovulation, and luteal phase (LP, early, mid and late)) and wOC (7-"phases": 28 days/ 7). The average of T and SUM was used for statistical comparison between noOC and wOC using Mann-Whitney-U test.

RESULTS: Neither T nor SUM showed any MC phase dependencies in the 4-phase model. In the 7-phase model, however, T and SUM were significantly higher during ovulation compared to mid LP (T: ovulation: 7.11±6.15 ng/ml; mid LP: 4.08±2.71 ng/ml; 95% CI [0.70 4.69], p=.048; SUM: ovulation: 4856±3049 ng/ml; mid LP: 3342±1858 ng/ml; 95% CI [391 2286], p=.034). Further, steroid hormone concentrations in wOC did not differ between the respective "phases". Mean T concentration was higher in noOC compared wOC (noOC: 4.84±3.71 ng/ml; wOC: 2.55±2.91 ng/ml; 95% CI [-2.67 -1.80], p<.001), while mean SUM did not differ between both groups.

CONCLUSION: In regular menstruating athletes urinary T concentrations and the sum of T-metabolites were about 45 % higher around ovulation compared to the mid luteal phase. This result and findings of higher serum T concentrations around ovulation support the rationale for a periodization of the training according to MC. Results between athletes without and with OC are contradictory concerning T and its metabolites. Hormonal changes in the MC were highly variable and require individual analysis and interpretation. This project was funded with research funds from the Federal Institute for Sports Science based on a decision by the German Bundestag.

(1) Alexander et al., 2022, Eur J Sport Sci, 22(7), 1035–45.

THE INTRA- AND INTER-VARIABILITY OF MENSTRUAL CYCLES IN PROFESSIONAL FEMALE FOOTBALLERS; THE USE OF DAILY HORMONE MEASUREMENTS TO DETERMINE OVULATION.

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INTRODUCTION: Menstrual cycle (MC) variability exists in the general population [1], but it's variability within athletic populations has not been reported. Advances in technology enabling a practical method of assessing daily reproductive hormone concentrations provide an avenue for such research. Accurate determination of ovulation is necessary to identify follicular (FP) and luteal phase (LP) lengths, which are pivotal to assess the impact of the MC on performance and health metrics [2]. Although a range of methods have been proposed to assess ovulation day and subsequent MC variability, agreement between methods remains unknown. Hence, the first aim of this study was to compare three methods of determining ovulation: (1) positive urinary luteinising hormone (LH) test, (2) sustained rise in progesterone above critical difference, and (3) countback regression equation (CRE). The second aim was to assess the variability in MC length, phase length, and concentrations of oestradiol and progesterone for each method.

METHODS: Eight professional female footballers provided morning saliva samples, daily, for three consecutive MCs; the start of each cycle was characterised by the onset of bleeding. Samples were analysed to measure oestradiol and progesterone concentrations. Each MC was separated into the FP and LP relative to the day of ovulation, using three different methods (as above). To make comparisons between the sub-phases, both the FP and LP were normalised to 14 d each

and split into early (first 4 d), mid (middle 6 d), and late (last 4 d). An ANOVA and Tukeys HSD post hoc was used to compare between methods and phases. The significance level was set at $p < 0.05$. All data are expressed as mean ± SD.

RESULTS: MC length (all cycles) ranged from 16-43 (29.3 ± 5.7) days; the intra-CV (16.3%) was greater than the inter-CV (11.4%). Ovulation determined using method 2 (17.4 ± 3.0 d) was significantly later ($p < 0.001$) than method 1 (13.3 ± 2.0) and 3 (14.1 ± 1.8), thus longer FP and short LP lengths were established when using method 2 ($p < 0.001$). Mean oestradiol and progesterone concentrations were significantly different between sub-phases ($p < 0.001$). For methods 1 and 3, progesterone was highest in the mid-LP. For method 2, progesterone was highest in the early-LP and mid-LP. For all methods, oestradiol was lowest in the early-FP and highest in the late-FP, early-LP, mid-LP, late-LP, and during ovulation.

CONCLUSION: Day of ovulation was later when determined using a sustained rise in salivary progesterone compared to both the positive urinary LH test and the CRE. Given the importance of identifying when ovulation occurs, the misalignment of methods observed here underlines the need for more research to establish the efficacy of current practice. Furthermore, intra and inter-variability in MC length, phase length, and concentrations of oestradiol and progesterone challenge the narrative for generic MC recommendations in elite sport.

[1] Fehring et al. (2006), [2] Elliott-Sale et al. (2021)

EFFECTS OF TRAINING PERIODIZATION ON CONDITION CHANGES WITH MENSTRUAL CYCLE IN FEMALE ATHLETES

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INTRODUCTION: Athletes are expected to perform at important competitions, but it has been reported that many athletes fall ill with the common cold before international competitions and other events. To avoid such a situation, it is important to evaluate the condition of athletes. One of these is the use of immune function evaluation indices. Athletes also train on a daily basis based on training periodization, which can be divided into two main periods: the preparation period and the competition period. In addition, it has been reported that the condition of female athletes changes with the menstrual cycle. However, the effect of training periodization on menstrual cycle-related condition fluctuations in female athletes has not been determined. The purpose of this study was to investigate the effects of training periodization on menstrual cycle-related changes in condition in female athletes using secretory Immunoglobulin A (SIgA).

METHODS: The subjects were 15 college female track and field athletes (jumper and thrower, age 20.0±1.1 years, height 162.6±5.2 cm, weight 55.9±6.5kg). The subjects were asked to collect saliva samples in a fasting state after waking up during the menstrual, follicular, and luteal phases of the competition period and preparatory period. From subject's saliva samples, saliva flow rates and SIgA concentrations were determined and SIgA secretion rates were calculated.

RESULTS: A two-way repeated ANOVA showed a significant difference in the interaction effect on salivary secretion rate ($F(2,28)=3.648$, $p=0.039$, partial $\eta 2=0.207$), and a simple main effect test showed that salivary secretion rate during the menstrual phase was significantly lower in competition period ($p=0.006$) and in the preparatory period were significantly lower in the follicular phase than luteal phase ($p=0.029$). SIgA concentrations did not show significant differences in menstrual phases or training periods ($F(2, 28)=2.144$, $p=0.136$, partial $\eta 2=0.133$). SIgA secretion rates showed a significant difference in the interaction effects ($F(2,28)=3.891$, $p=0.032$, partial $\eta 2=0.217$), and a simple main effect test showed that SIgA secretion rates in the preparatory period were significantly lower in the follicular phase than luteal phase ($p=0.013$).

CONCLUSION: In female athletes, training periodization was found to influence SIgA changes with the menstrual cycle.

HORMONAL FLUCTUATIONS IN WOMEN ARE ASSOCIATED WITH CHANGES IN NOCTURNAL HEART RATE AND HEART RATE VARIABILITY

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INTRODUCTION: Heart rate variability (HRV) has become a widely used non-invasive tool for monitoring autonomic nervous system activity, which has been shown to reflect a person's recovery and training status (Schmalenberger et al. 2019). The aim of this study was to investigate the differences in nocturnal heart rate (HR) and HRV within a cycle in naturally menstruating women (NM) and women using combined hormonal contraceptives (CU) or progestin-only hormonal contraceptives (PU).

METHODS: Physically active participants were recruited into three groups: NM (n=19), CU (n=11), and PU (n=12). Participants' HR and HRV were monitored using the Bodyguard 2 HRV monitor (Firstbeat Technologies Ltd., Jyväskylä, Finland), and blood hormones were measured during one menstrual cycle (MC) (NM-group) or for 4 weeks (CU and PU-groups). Estradiol, progesterone, and luteinizing hormone were analyzed from fasting blood samples collected four times in the NM (M1 = bleeding, M2 = follicular phase, M3 = ovulation, and M4 = luteal phase) and PU groups (M1 = lowest E2; M2 = M1+7 days; M3 = M1+14 days; M4 = M1+21 days) and twice in the CU group (active and inactive pill phases). After each blood collection, nocturnal HR and HRV (as root mean square of successive differences between normal heartbeats,RMSSD) were recorded and examined as an average of two nights. The effects of the MC or HC phase on HR, HRV variables, and measured hormones were analyzed separately for each of the three groups using generalized estimating equations.

RESULTS: Hormone concentrations differed (p<0.05) between the MC phases in the NM- and PU-groups, but not between the active and inactive phases in the CU-group. In the NM-group, RMSSD values were higher during M2 compared to M3 (p=0.013) and M4 (p=0.009). HR was lowest in M2 and highest in M4. In the CU-group, RMSSD (p=0.014) was higher in M1 compared to M2. Furthermore, HR was lower during M1 compared to M2 (p=0.038) and M4 (p=0.020). In the NM-group, ΔE2 from M1 to M3 was negatively associated with RMSSD (B=-0.05, p<0.001) and positively associated with HR (B=0.01, p<0.001). In the NM-group, ΔP4 was positively associated only with HR (B=0.35, p<0.001). ΔE2 nor ΔP4 were not significantly associated with HC phases in the PU group.

CONCLUSION: In physically active women, the MC and hormonal phases of the cycle influence the autonomic nervous system, as reflected in measures of nocturnal HR and HRV. This study suggests that endogenous and exogenous hormones should be taken into account when assessing recovery data from women.

References

Schmalenberger KM, Eisenlohr-Moul TA, Würth L, et al. A Systematic Review and Meta-Analysis of Within-Person Changes in Cardiac Vagal Activity across the Menstrual Cycle: Implications for Female Health and Future Studies. J Clin Med. 2019;8(11):E1946.

MATCH WORKLOAD IN FEMALE FOOTBALL PLAYERS VARY ACROSS MENSTRUAL CYCLE PHASES

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INSEP

INTRODUCTION: Sex hormones variations seem to impact work load among female football players. Quantitative measures of load parameters across either the menstrual cycle (MC) or combined oral contraception (OC) phases are scarce. We aimed to quantify the players match load across their MC or OC phases of a French National club trough an entire season.

METHODS: 16 elite football players (23.7 ± 4.4 years) volunteered to take part in the study. We followed up their match load trough GPS data and their cycle phases (menstruation, mid and late follicular, early, mid and late luteal), based on a calendar method and an algorithm for phases estimation [1] for MC (n = 12) or according to the pills taking/pause in OC users (n = 4) through 24 games of the 2021-2022 season. For each load variable, a mixed model considering the group and individual players effect was performed to explain each variable according to the cycle's phases in MC or OC. We calculated the odds ratio on the fixed parameters of the models to identify an overall effect of the phases on each load variable.

RESULTS: Among MC players we found a significantly greater total match load, total distance, total acceleration and average velocity in the mid-cycle (mid and late follicular) in comparison with the begging and the end of the cycle (menstruation and late luteal) (p<0.05). The gap between the phases with the greatest and the lowest load ranged from (5 to 13%).

CONCLUSION: The workload among elite football players vary across menstrual cycle phases, displaying a cyclicity, where higher load values were found in the middle of their cycle, around the fertile period, and lower values in the premenstrual et menstrual phases. We have not identified any significant variation between the hormonal phases among OC users. These findings based on quantitative data of a collective sport suggest the interest of more studies investigating the effect of the menstrual cycle on female athletes' performance.

[1] Soumpasis et al., Real-life insights on menstrual cycles and ovulation using big data, Human Reproduction Open 2020.

Oral presentations

OP-AP30 Pacing and Performance

HOW DO WE LEARN TO PACE THE RACE? EXPLORING THE ROLE OF AGE AND COGNITION IN EFFORT REGULATION.

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INTRODUCTION: The self-regulation of effort during exercise (i.e. pacing) is key in sports performance. However, younger athletes seem to struggle to effectively pace their efforts over the full length of an exercise task. Based on the framework proposed by Elferink-Gemser and Hettinga (2017), it was hypothesized this is due to the age-related development of (meta-) cognitive functions involved in pre-exercise planning, including an accurate estimation of the task duration.

METHODS: Groups of 18 adolescents (15.6±2.5 old, 9 female) and 26 adults (26.8±3.1 years, 13 female) performed a 4-km cycling time trial in a well-controlled laboratory environment. The assessment of task duration was calculated as the absolute percentage difference between estimated and actual finish time of the trial. Psychobiological elements of pacing were quantified by the mean power output (PO) per 500m, the rate of perceived exertion (RPE) per 1 km, and the percentage difference between the PO at 3500m and 4000m (i.e. 'end-spurt'). Analyses included between-group (ANOVA) and within-group comparisons (correlation) (p<0.05).

RESULTS: Adolescents were less accurate in their assessment of the task duration (44.4±28.4%), compared to adults (27.7±26.5%) (p<0.05). The adolescents' overestimation of task duration was accompanied by pacing behaviour conform

the expectation of a longer trial (i.e. a more even distribution of PO, lower RPE, larger end-spurt). Within the adolescent group, a higher accuracy in the estimation of the task duration correlated with age ($r = 0.48$, $p<0.05$) and a smaller end-spurt ($r = -0.45$, $p<0.05$).

CONCLUSION: The capability to accurately estimate an exercise task's duration seems to develop during adolescence, which leads younger individuals to struggle with distributing their efforts over the given exercise task. Practice sessions aimed at familiarising younger athletes with the demands of the set exercise task and the exploration of alternative pacing strategies could improve their exercise performance.

HOW ACCELERATIONS AND FORCES CHANGE WITH OF RUNNING SPEED AND TECHNIQUE? A PERSPECTIVE STUDY.

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EPF

INTRODUCTION: The description of running is mainly made using force platforms which provide informations related to the contact phase [1]. Because these systems are restricted to an acquisition zone, the use of these tools makes difficult to study running in real conditions. Thus, many studies have turned to embedded accelerometers. However, the measurements are much more complex to interpret because of the sensitivity to the measurement point and the capacity of the sensors [2]. The objective of this work is to study if a comparison between force and accelerometer signals is possible during running and to understand how running condition (speed, technique and level) influence the signals.

METHODS: Five participants were recruited. Two were considered as elite runner (ER), and three as amateur runner (AR). The participants ran ten times on a straight line of 60m equipped with 6 force platform on the middle. All participants were equipped with a 3D accelerometer mounted on each tibia. Both systems were synchronized. Two speed were tested depending of the level of the participant (ER: V1=16 and V2=20km/h; AR: V1=10 and V2=14km/h) and participants were guided using marks on the track coupled with audio signals. The impact of running speed and technics were observed on the vertical ground reaction force (VGRF) and the longitudinal acceleration only for the stance phase. The stance phase for force and acceleration was extracted based on events observed on the VGRF signal [3]. Three indicators were computed for the VGRF: the passive peak (PP), the active peak (AP) and the loading rate (LR). Only the peak tibial acceleration (PTA) was computed for the acceleration. For each indicator, mean and standard deviation were computed for each group and each running speed.

RESULTS: For ER the results of the different indicators were AP:2.4±0.3BW; PP:1.5±0.2BW; LR:47.4±10.9BW/s and PTA:8.9±3.1g for V1 and AP:2.7±0.1BW; PP:1.8±0.3BW; LR:62.4±17.1BW/s and PTA:13.2±4.9g for V2. For AR the results were AP:3.2±0.1BW; PP:2.6±0.3BW; LR:79.4±13.4BW/s and PTA:15.9±0.4g for V1 and AP:3.4±0.1BW; PP:3.1±0.1BW; LR:105.7±30.9BW/s and PTA:21.8±3.5g for V2.

CONCLUSION: The values of PP, AP, LR and PTA change with increasing speed at all levels. This may suggest that there is a positive correlation between these indicators and speed [2,4]. The variability of PTA for ER between V1 and V2 seems to be explained by a change in stride technique for one runner from a forefoot to a rearfoot stride. A difference in all indicators was observed between the AR and ER groups. This difference can be explained by the difference in speed. However, while the AR seemed to have a rearfoot stride, it was observed that for ER, the running technique changed with speed. It could be hypothesized that elite runners modify their stride to adapt to the increased speed and demands of running. Future studies could consider a larger population to confirm the observations of this prestudy.

[1] Lieberman 2010

[2] Lafortune 1991

[3] Hunter 2005

[4] Keller

GREATER RELATIVE ANAEROBIC CONTRIBUTION TO 1500 M THAN 2000 M MAXIMAL ERGOMETER ROWING PERFORMANCE

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INTRODUCTION: World Rowing recently announced that the official Olympic racing distance for the 2028 Olympic Games will be shortened from 2000 m to 1500 m [1], which has implications for competition preparation and race performances. Previous studies have estimated that the anaerobic energetic contribution to 2000 m ergometer rowing performance ranged 12-30% [2]. The shorter event distance means that energetic contribution to performance may differ compared to the traditional distance, yet has never been quantified. Therefore, this study aimed to compare energetic contribution to 2000 m and 1500 m maximal ergometer rowing.

METHODS: On separate visits (>48 h apart, random order), eighteen trained junior (16.9 ± 0.5 y) male rowers (maximal oxygen uptake: 56.1 ± 5.0 mL/kg/min) completed three trials on a rowing ergometer: 1) 7x4 min graded exercise test to determine the relationship between power output and oxygen uptake; 2) a maximal 2000 m time trial (TT); 3) a maximal 1500 m TT. Respiratory gases were measured continuously by a metabolic cart. The power to rate of oxygen consumption relationship from the graded exercise test was used to determine the accumulated oxygen deficit or each TT. A repeated-measures ANOVA was used to detect differences, with effect sizes (ES) expressed as partial-eta squared, in mean power

output, anaerobic contribution, maximum heart rate, rate of perceived exertion, and post-effort blood lactate concentration between TTs.

RESULTS: Completion times were 6:51.3 ± 0:10.2 and 5:03.6 ± 0:08.0 min for 2000 m and 1500 m TTs, respectively. Mean power output was lower for 2000 m (324 ± 25 W) than 1500 m (341 ± 28 W) TT ($p<0.001$, ES=0.70). Anaerobic contribution was significantly greater for 1500 m than 2000 m TT (15.2 ± 4.7 vs. 9.8 ± 3.6%; $p<0.001$, ES=0.71). Compared to 1500 m TT, heart rate (190 ± 6 bpm vs. 192 ± 6 bpm; $p = 0.032$, ES = 0.24), rate of perceived exertion (18.7 ± 1.3 au vs. 19.3 ± 0.7 au; $p = 0.023$, ES = 0.27) and blood lactate concentration (10.7 ± 2.7 vs 12.9 ± 2.6 mmol/L; $p = 0.003$, ES = 0.41) were all significantly higher for 2000 m TT.

CONCLUSION: This study identified a significantly greater (+5.4%) relative anaerobic contribution to the maximal performance of a 1500 m ergometer TT, which coincided with a ~5% increase in mean power output and approximately 100 s decrease in performance time, compared to a 2000 m TT. In the lead up to the 2028 Olympic Games, these findings may provide evidence for a required change in how elite rowers prepare for optimal performance. Coaches and athletes should consider whether changes to their pacing strategies, technical set up (such as gearing), and training periodisation toward the adoption of more high-intensity training may aid performance in the shorter race distance where anaerobic contribution appears greater. Future research should investigate physiological differences between maximal on-water 1500m and 2000m rowing.

1. Astridge et al. (2022) 2. De Campos Mello et al. (2009)

DOES SHOOTING PERFORMANCE INFLUENCE PACING STRATEGIES IN SPRINT AND INDIVIDUAL BIATHLON COMPETITION?

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INTRODUCTION: The importance of effective pacing strategies within biathlon competition is well documented (1), as is the fact that shooting performance is a key determinant of competitive success (2). Despite pacing and shooting being important performance indicators within biathlon, the interaction between these two performance factors is yet to be investigated. As such, the purpose of the present study was to examine the influence of shooting performance on pacing within sprint and individual biathlon

METHODS: Eight female biathletes (age 27 ± 2 years, International Biathlon Union points 45 ± 18) competing at the 2019 IBU World Championships gave their written informed consent to participate in the study. Global navigation satellite system, shooting accuracy and range time data were collected during the sprint and individual competitions. Shooting bouts within each race and lap were classified as "accurate" or "inaccurate" and "fast" or "slow". For accuracy quartiles 1 and 2 = accurate, quartiles 3 and 4 = inaccurate (sprint <80% prone <80%, standing; individual prone <90%, standing <90%). For shooting speed quartiles 1 and 2 = fast, quartiles 3 and 4 = slow (sprint >24.6 s prone >23.3 s, standing; individual prone >29.3 s, standing >25.9 s). Data were analysed to examine pacing strategies and determine if skiing speed differed following accurate or inaccurate and fast or slow shooting bouts.

RESULTS: Terrain differed across the courses for both sprint and individual competitions ($p<0.001$). In both cases courses were primarily comprised of mixed terrain (~63%), with the remaining ~20%, ~15% and ~2% of the courses being comprised of downhill, incline and severe incline. Effects of terrain were observed for skiing speed (both $p<0.001$), with biathletes skiing fastest downhill and slowest across terrain classified as severe incline. Biathletes skied fastest in the first and final laps of both sprint and individual competitions (all $p<0.05$). No differences in shooting accuracy were observed between laps within sprint and individual competitions. Within the sprint competition biathletes took significantly longer ($p=0.034$) to complete all 5 shots in lap 1 than lap 2. Within the individual competition biathletes took significantly longer to complete all 5 shots in lap 3 than laps 2 ($p=0.041$) and 4 ($p<0.001$). Skiing speed was not different in either event following fast, slow, accurate or inaccurate shooting bouts.

CONCLUSION: Within this small sample of elite biathletes shooting performance did not impact on pacing strategies in sprint and individual competitions. This preliminary data indicates that pacing across laps and within races is independent of shooting performance. Future research should seek to examine this in a larger sample across differing competition formats.

1 Laaksonen et al. (2018), 2 Luchsinger et al. (2019)

Invited symposia

IS-MH02 Muscle plasticity in immobilisation and trauma and inflammation

NEUROPHYSIOLOGICAL ADAPTATION TO IMMOBILISATION

GAFFNEY, C.

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The loss of muscle strength during human volunteer immobilisation is far greater than the loss of muscle mass and the mechanistic basis of this common observation remains unresolved. This presentation will focus on the neurophysiological basis of immobilisation induced muscle functional decline, and novel insight of neuronal morphology changes in an

animal model during space flight. Focus will also be given to the efficacy of repeated bouts of transcranial magnetic stimulation at offsetting functional decline in human immobilisation. Dr Gaffney is a member of the ECSS reviewing panel with research interests in the impact of space flight and immobilisation on physiological homeostasis.

PLASTICITY OF THE MYOTENDINOUS JUNCTION AND MUSCLE IN INJURY AND RECOVERY

MACKEY, A.

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The myotendinous junction is a common site for injury due to the high forces it can experience during exercise. However, understanding of its adaptation to force loading and recovery from injury is poor. This presentation will be delivered by an expert from the field of connective tissue and muscle adaptation to exercise in ageing and injury. The talk will demonstrate the heterogeneity of collagen type in the human myotendinous junction and adaptation in mRNAs, macrophage and satellite cells to exercise, injury and recovery. Dr Mackey is an ECSS Fellow and is highly respected in the areas of satellite cells, myotendinous junction, muscle injury, muscle hypertrophy and muscle ageing.

THE IMPACT OF IMMOBILISATION AND TRAUMA/INFLAMMATION ON THE REGULATION OF MUSCLE MASS AND INSULIN RESISTANCE

GREENHAFF, P.

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Loss of muscle mass and insulin sensitivity are common phenotypic traits of both immobilisation and trauma/inflammation. However, there is a lack of understanding of shared and/or divergent mechanisms responsible for these common physiological traits. This presentation will therefore focus on potential mechanisms responsible for the loss of muscle mass and insulin sensitivity during immobilisation, and whether the impacts of combined immobilisation and increased inflammatory burden are additive in situations such as surgical fixation of ankle fracture. Professor Greenhaff is an ECSS Fellow with research interests in muscle metabolism and physiology in exercise, inactivity, ageing and disease.

Oral presentations

OP-PN21 Strength

ANODAL-TDCS IMPROVES SHORT-TERM STRENGTH TRAINING ADAPTATIONS OF THE KNEE EXTENSORS IN HEALTHY RECREATIONAL INDIVIDUALS.

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INTRODUCTION: Transcranial direct current stimulation (tDCS) is a non-invasive neuromodulation technique capable of altering brain function in a controlled and temporary manner. The acute application of tDCS has been shown to induce ergogenic effect on endurance performance and maximal force production (Chinzara et al., 2022). Despite this, no studies have investigated the potential ergogenic effect of tDCS in addition to lower limb strength training and its neurophysiological adaptations (Angius et al., 2018). As the motor cortex (M1) excitability might be important for strength training adaptations, moderation of this by means of tDCS may provide changes in subsequent training adaptation (Hendy et al., 2015). Given the primary role of lower limbs for daily activity and several sports disciplines, this study aimed to investigate the effect of tDCS combined with lower limb strength training.

METHODS: A total of 24 healthy and recreationally active participants were recruited (mean ± SD age, 30 ± 7 years; stature, 172 ± 8 cm; mass, 72 ± 15 kg; 8 females, 16 males) and randomly allocated to perform either strength training with anodal tDCS (a-tDCS) or strength training with sham tDCS (SHAM) over a 3-week period. Participants completed 3 sets of 10 unilateral isometric knee extension contractions of the dominant limb of 5 s duration, at 75% of the daily maximal isometric voluntary contraction (MVC), three times per week. a-tDCS was applied over the contralateral M1 at 2 mA for 10 min prior to each training session. Outcome measures included: MVC, voluntary activation (VA) assessed by the interpolated twitch technique over the femoral nerve, cortical and spinal excitability, short-interval intracortical inhibition (SICI) and long-interval intracortical inhibition (LICI). a-tDCS adverse effects were evaluated via questionnaire during each training session.

RESULTS: All participants completed the study and none of them reported a-tDCS adverse effects during or after the completion of the training period. The period of training improved the MVC in both groups ($P < 0.001$), with a greater increase for a-tDCS compared to SHAM (6%, $P = 0.043$), which was accompanied by a greater increase in VA (2%, $P = 0.044$) and cortical excitability (9%, $P = 0.047$). No changes in spinal excitability, SICI and LICI were observed in either group (all $P \geq 0.186$).

CONCLUSION: The addition of anodal tDCS over the M1 prior to isometric strength training induced enhancements in maximal force production, motor cortex excitability, and voluntary activation compared to a sham treatment. These results might provide preliminary applications for athletes to facilitate training adaptations. However, further experiments are warranted to examine the long-term effects of anodal tDCS combined with strength training or sport-specific tasks in athletes.

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ACUTE METABOLIC AND NEUROPHYSIOLOGICAL RESPONSES TO HIGH-INTENSITY FULL-SQUAT SESSIONS DIFFERING IN SET CONFIGURATION.

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INTRODUCTION: The manipulation of load parameters significantly affects acute responses to resistance exercise (1). Set configuration allows modifying the intensity of effort, by redistributing sets, repetitions and rest periods (2). Short set configuration reduces mechanical fatigue and the accumulation of metabolites (3). The aim of this study was to compare acute metabolic and neuromuscular responses to training sessions differing in set configuration.

METHODS: 10 healthy men were recruited. 4 different deep squat sessions were performed with equal volume (54 reps) and total rest (20min): 18 sets of 3 reps with 71 seconds between sets (3R), 9 sets of 6 reps with 150 seconds (6R) and 6 sets of 9 reps with 240 seconds (9R) with the 12RM load.

The oxygen uptake (VO2), carbon dioxide production (VCO2), respiratory exchange ratio (RER) and metabolic equivalent (MET) were recorded during the entire session and averaged at three moments: 30min before, during and 30min after exercise. Capillary blood lactate concentration (La) was collected before and 1min after exercise.

Voluntary activation (VA) was assessed before and after exercise by twitch interpolation technique. Subjects performed 2 maximal voluntary isometric contractions (MVC) of 3 seconds in leg extension machine with the right knee at 110º. During each MVC a high-frequency pulse was superimposed in femoral nerve. Then at rest, the same potentiated pulse (Db100p), a doublet low-frequency pulse (Db10p) and a single pulse were applied 2.5 seconds apart.

RESULTS: For VO2 main effect of moment, session and moment×session interaction was detected ($p<0.05$). Greater values of VO2 were observed in 3R compared with 6R and 9R ($p<0.05$). Similar values of VO2 were recorded in pre and post exercise for 3R and 9R but greater were registered in post compared with pre for 6R. Only a moment effect was detected for VCO2 ($p<0.001$) (exercise > pre and post).

Considering METs, greater values were recorded in 3R compared with 6R and 9R ($p>0.01$). METS were higher in post compared with pre only for 6R ($p=0.036$).

Regarding RER, similar baseline values were observed in all sessions ($p>0.05$). 6R and 9R showed higher values in post compared with pre exercise.

For La, lower values were registered in 3R compared with 6R ($p=0.001$) and 9R ($p<0.001$).

For markers of peripheral fatigue, the results in MVC, Db100p and Db10p showed lower values after the three protocols. Changes in VA were not detected.

CONCLUSION: Set configuration may modulate the metabolic response, with shorter sets promoting greater VO2 and METs consumption but lower La compared with longer sets.

Neuromuscular fatigue was similar among sessions due to the high load intensity and performed volume.

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COMPARISON OF REPEATED BOUT PROTECTIVE EFFECT BETWEEN DIFFERENT ECCENTRIC CONTRACTION MODES

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INTRODUCTION: Prior unaccustomed eccentric exercise can provide an adaptive protective effect commonly termed the repeated bout effect (RBE) [1], evidenced by the attenuation of the exercise-induced muscle damage symptoms in subsequent bouts of exercise [2]. As several eccentric exercise modes are frequently used in athletic settings and investigated in research, the purpose of this study was to compare the RBE of downhill running (DHR), drop jumps (DJ), and isokinetic eccentric contractions (ISOK) during maximal voluntary isometric contractions (MVIC) of the knee extensors.

METHODS: Thirty participants were stratified (using knee extensor torque) into three experimental groups (DHR [n = 10], ISOK [n = 10], DJ [n = 10]) with DHR performing a 30 min run at ~70%VO2max and 15% decline, ISOK performing 100 unilateral isokinetic eccentric contractions at 50% MVIC, and DJ performing 100 drop jumps from a height of 0.6 m (5 sets of 20 jumps with 1 min rest between sets). Maximum voluntary isometric knee extensor torque (N.m) was measured during MVIC tests before (Pre) and 24, 48, 72, 96 hr post-exercise [bout 1], with identical exercise and testing repeated a week

later [bout 2]. The index of protection (RBE) was calculated as the change in torque from Pre to 24 hr post-exercise in the first bout, minus the change in the second bout, divided by the change in the first bout, multiplied by 100 [3].

RESULTS: Compared to baseline, there was a significant ($P \leq 0.05$) reduction in knee extensor torque after bout 1 for DJ (24, 48, 72, 96 hr timepoints) and DHR (24hr) but no difference for ISOK. The greatest mean reductions in knee extensor torque occurred after bout 1 for all groups (DJ: $\Delta = 15\%$ at 48 hr; DHR: $\Delta = 8.1\%$ at 24 hr; ISOK $\Delta = 6.1\%$ at 24 hr). There was no significant reduction in knee extensor torque after bout 2 in any group ($\Delta = 0.9\%$ to 3.4%), with a significant difference between bout 1 and 2 percentage change at 24hr ($P \leq 0.01$). The index of protection was greatest for DJ (93%) followed by ISOK (69%) and DHR (62%) groups, but there were no significant differences between groups index of protection ($P \geq 0.05$).

CONCLUSION: This is the first study to compare these commonly used eccentric contraction modes to induce symptoms of muscle damage and assess the index of protection on maximal torque production. Whilst drop jumps reported the greatest mean index of protection, it was not significantly greater than other contraction modes. These data suggest that all contraction modes conferred similar levels of functional protection that may have implications for exercise prescription and injury risk during repeated performance over several days following intense exercise.

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RELIABILITY OF INDIRECT ASSESSMENT METHODS OF RETICULOSPINAL TRACT FUNCTION IN HUMANS.

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INTRODUCTION: The reticulospinal tract (RST) is an important descending pathway for the control of locomotion and generation of high forces. Preliminary evidence from non-human primates suggests the RST might adapt to resistance training (Glover & Baker, 2021), but this is yet to be demonstrated in humans because of the implausibility of measuring RST function directly. A range of methods that exploit the acoustic startle reflex have been shown to hold promise as indirect measures (Furubayashi et al., 2000; Baker & Perez, 2017) but their reliability has not been studied.

METHODS: Twenty-four volunteers (26±5 years) completed familiarisation, and two experimental visits separated by seven days. RST function was measured indirectly via the StartReact protocol (Baker & Perez, 2017), and evoked responses to electrical stimulation of the cervico-medullary junction (CMEP), and transcranial magnetic stimulation of the motor cortex (MEP) paired with conditioning startling auditory stimuli (Furubayashi et al., 2000). Conditioned responses were expressed relative to the unconditioned response. Visual (VRT), auditory (ART), and startle (SRT) reaction times were measured for StartReact. RST gain (the difference in VRT and SRT, with respect to the difference in VRT and ART), and the SRT-ART difference were derived as indices of RST function. Responses were recorded from the elbow flexors and extensors during a light (20% of maximum) isometric action. Paired-samples t-tests were used to assess systematic error. Typical error as a coefficient of variation (CV, %) and intra-class correlation coefficients (ICC) were calculated to assess random error and relative reliability, respectively. All analyses were performed using a published spreadsheet (Hopkins, 2001).

RESULTS: For elbow flexors, StartReact VRT, ART, and SRT showed good reliability (CV=8–10%, ICC=0.75-0.80). For elbow extensors, reaction times were faster on trial 2 for VRT (p=0.03) and ART (p=0.01). However, the reliability of elbow extensor reaction times was similar to flexors (CV=9–11%, ICC=0.75-0.83). Variables derived from reaction times as indices of RST function showed poor reliability for both flexors & extensors (CV=29-51%, ICC=0.28-0.67). CMEP and MEP responses in flexors were more reliable (CV=11 & 13%, ICC=0.64 & 0.66) than in extensors (CV=15 & 20%, ICC=0.72 & 0.00).

CONCLUSION: The StartReact protocol is a reliable measure in elbow flexors and extensors, but measurement in extensors requires multiple practice trials. The relatively high degree of random error observed in the conditioned, evoked responses is consistent with previous assessments of neurological function. The data presented here could be used to estimate appropriate sample sizes for intervention studies aimed at measuring changes in RST function.

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RESISTANCE TRAINING IMPROVES MITOCHONDRIAL FUNCTION IN BOTH YOUNG AND OLD WOMEN

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INTRODUCTION: Introduction: The molecular transducers of benefits from different exercise modalities are unclear. Mitochondria have a main role in providing cellular energy and fulfill a key function in cellular calcium management. Exercise training is known to be the most powerful intervention to increase mitochondrial number, size, and density in a tissue such as skeletal muscle. Traditionally, it has been considered that cardiorespiratory training is appropriate for improving mitochondrial function, while resistance training programs are appropriate for inducing hypertrophy and increases in muscle strength. However, recent research suggests that both training modalities have an impact on mitochondrial respiration.

Objective: To study the mitochondrial adaptations in skeletal muscle and peripheral blood mononuclear cells (PBMCs) after a resistance training program, both in a cohort of young women and in a cohort of older women.

METHODS: Methods: 18 healthy young women and 6 old women followed a strength training program based on 2 exercises that stimulated the quadriceps muscles: leg press and leg extension. Both exercises were performed 2 times a week for a total of 6 weeks. The maximum strength was evaluated for each exercise (test of 1 repetition maximum, 1RM) at the beginning and at the end of the program. Moreover, they were assessed clinically including their body composition and muscle quality. A muscle biopsy of the vastus lateralis muscle of the thigh was performed using the TSK Acecut biopsy needle (11G x 75 mm, 22 mm Type) before and after the training period. Mitochondrial respiratory function of skeletal muscle was measured with high-resolution respirometry (Oroboros O2k-FluoRespirometer) from isolated mitochondria and permeabilised fibres. In addition, mitochondrial respiratory function was measured in PBMCs. Independent and paired t-tests were conducted to compare means between and within groups, before and after the intervention. A value of $p<0.05$ was considered statistically significant.

RESULTS: Results: Here we report that 6 weeks of resistance training significantly improved the muscle strength as assessed by both the leg press and leg extension 1RM tests. Moreover, the mitochondrial respiratory function measured in skeletal muscle and peripheral blood mononuclear cells showed an improvement after training in Complex I, Complex I+II, Complex II, Maximal respiration, and Complex IV.

CONCLUSION: Conclusions: We provide evidence showing that 6 weeks of resistance exercise training results in quantitative changes in skeletal muscle strength and mitochondrial respiration, both locally (skeletal muscle) and peripherally (PBMCs). Thus, resistance exercise training appears to be a means to augment the respiratory capacity and intrinsic function of skeletal muscle mitochondria, even in older people who basally have poor mitochondrial function.

Oral presentations

OP-BM14 Sprinting

RELATIONSHIPS BETWEEN LOWER BODY STRENGTH CHARACTERISTICS AND INITIAL ACCELERATION COORDINATION IN HIGHLY TRAINED TO WORLD CLASS SPRINTERS

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INTRODUCTION: Inter- and intra-limb coordination has recently been described in initial sprint acceleration [1]. From a dynamical systems perspective, coordination patterns emerge from interacting individual, task and environmental constraints [2]. Lower body strength is a key individual constraint in sprinting and influences sprint performance, but the interactions between strength characteristics and movement patterns are not yet known. This study aimed to assess the relationship between lower body strength and initial acceleration coordination in sprinters.

METHODS: Twelve male sprinters (100 m PB: 9.95–11.17 s) performed 30 m sprints on an outdoor track during training. 3D kinematics for the first four steps were recorded using IMUs (250 Hz; Noraxon, USA). Participants then performed countermovement jump (CMJ), isometric squat (ISQ) and repeated hop tests using force plates (1000 Hz; Bertec, USA) and eccentric hamstring tests (NordBord, Vald, Australia). Thigh-thigh and shank-foot coordination were quantified for step 1 and steps 2-4 using a vector coding and binning approach [1]. Relationships between strength measures and the proportion of the step spent in each coordination bin in step 1 and steps 2-4 were assessed using Spearman's (rho) correlations.

RESULTS: ISQ relative maximal force was negatively associated with the proportion of anti-phase leading (-) (rho=-0.67, p=0.02) and positively with anti-phase trailing (+) (rho=0.82, p<0.01) thigh-thigh coordination in step 1, as well as a negative association with in-phase trailing (-) in steps 2-4 (rho=-0.67, p=0.02). ISQ force was negatively associated with in-phase foot (+) (rho=-0.70, p=0.02) and positively with in-phase foot (-) (rho=0.62, p=0.03) shank-foot coordination in steps 2-4. CMJ height was negatively associated with in-phase shank (-) coordination in step 1 (rho=-0.81, p<0.01). Hop test RSI was negatively associated with in-phase leading (-) (rho=-0.58, p=0.05) thigh-thigh coordination and positively associated with anti-phase shank (+) (rho=0.60, p=0.04) and in-phase shank (-) (rho=-0.59, p=0.04) shank-foot coordination in step 1.

CONCLUSION: These findings suggest sprinters with larger maximal strength capacities have more trail leg dominant limb interchange in step 1 and exhibit a pattern indicative of more synchronous "scissoring" of the thighs. Moreover, greater maximal strength was associated with shank-foot coordination patterns exhibiting less in-phase forward rotation in early flight and potentially greater reliance on "shin block" to orientate the shank before touchdown in steps 2-4. Finally,

the current results suggest larger reactive strength capacities may be associated with coordination showing a sequential reversal of foot then shank rotation during "shin block" to prepare for touchdown, as well as reduced shank dominance during simultaneous forward rotation around dorsiflexion. These are novel findings for further understanding acceleration technique.

[1] Donaldson et al. (2022) [2] Glazier (2017)

INFLUENCE OF FOOTWEAR ON F-V PROFILE IN SPRINT ACCELERATION

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INTRODUCTION: The first steps of sprint demand a high propulsive force, playing a key role in performance. The use of different shoes can directly influence the application and orientation of the force applied onto the ground at the foot. We aimed to compare the force-velocity profile during sprint acceleration between wearing sprint spike shoes versus wearing conventional (marathon) shoes.

METHODS: For this study, 24 national and regional level male trained sprinters with age 22.0 ± 3.8 years, stature 178.0 ± 5.9 cm, body mass 73.3 ± 6.7 kg and 100 m time of 11.06 ± 0.40 s were evaluated. Ethics approval was obtained from the Universidade Federal do Rio Grande do Sul (Protocol: 73415817.5.0000.5347). After a 30 min warm-up (10 min of running, stretching and 5 accelerations of 30 m), the sprinters performed four 30-m sprints at their maximum intensity with a 5-min interval between attempts, 2 of them using spike shoes and 2 with conventional shoes in a randomized order. For data collection, a smartphone (iPhone 7+) was positioned on a tripod in the sagittal plane at 10 m from the running track (15 m from the start) and 1 m high. All tests were filmed at a sampling frequency of 120 Hz and the split times were determined at 5, 10, 15, 20, 25 and 30 m using the MySprint app (Apple Inc., USA) for further analysis of the variables: 30 m time (t30m), maximum speed, maximum theoretical speed, maximum theoretical horizontal force, maximum power, peak ratio of force and its decrease, and force-velocity profile slope. We quantify the magnitude of the difference between the two conditions using Glass's delta (Δ) and the following classifications: null (< 0.1), very small (0.1 to 0.19), small (0.2 to 0.49), medium (0.5 to 0.79), large (0.8 to 1.19), very large (1.2 to 1.9), and huge (over 2.0).

RESULTS: The sprinters improved the t30m (Δ = -1.15, large) using spike shoes (4.20 ± 0.10 s) in comparison to conventional shoes (4.35 ± 0.13 s). Similarly, the sprinters improved the physical qualities using spike shoes compared to conventional shoes, resulting in an improvement in maximum velocity (Δ = -0.24; small) of 0.11 m/s and maximum theoretical velocity (Δ = -0.16; very small) of 0.08 m/s, as well as maximum horizontal force (Δ = -1.75; very large) and maximum power (Δ = -1.67; very large). The slope of the force-velocity profile (Δ = 0.80; large) increased from spike shoes to conventional shoes by about 13%. Also, using spike shoes improved mechanical effectiveness with a peak and decreasing rate in the force ratio of 11% (Δ = - 2; huge) and 8% (Δ = 1.14, large), respectively.

CONCLUSION: We can conclude that spike shoes significantly influence sprint performance and mechanical effectiveness. Theoretical force and maximal power are the physical quality variables most relevant to these changes.

HAMSTRING MUSCLE ELECTROMYOGRAPHIC ACTIVITY IN VARIOUS SPRINT DRILLS

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INTRODUCTION: During sprinting, and specifically the swing phase of the leg, hamstring muscles are exposed to high levels of muscle activity as the muscle-tendon unit (MTU) is lengthening and the musculotendinous force is peaking a. These considerable mechanical loads could explain the high prevalence of hamstring muscle injury (HMI) specifically in sprint-related sports. Before maximum sprinting, part of the warm-up is devoted to carrying out sprint drills aiming at loading hamstring muscles' specifically to sprint b. Sprint drills are divided into 4 main categories (A, B, C and D drills), targeting key phases of the gait cycle (Swing phase: (A) early pre-activation and (B) pre-activation, (C) stance phase, (D) swing phase: recovery) c and are assumed to provide a specific mechanical stimulus, notably high hamstring muscles activity. As part of a more global project studying mechanical loads on hamstring muscles, this study aimed to character-ise hamstring muscles' electromyographic (EMG) activity during sprint drills compared to sprint maximal activity.

METHODS: Sixteen athletes, competing in track and field performed A, B, C and D sprint drills and two 40-meter sprints. Hamstring muscles (biceps femoris and semi-tendinosis) electromyographic activity was recorded with EMG (Delsys©, 1000Hz) electrodes. Raw EMG signals were filtered, rectified, and expressed as a percentage of a maximal voluntary isometric contraction (%MVIC). Comparison in maximal EMG activity between sprint and athletic drills was tested with repeated ANOVA.

RESULTS: During maximal sprinting, hamstring muscles were maximally activated at 247.5% ±139%MVIC for biceps femoris and 206% ±100% MVIC for semi-tendinosis. Biceps femoris overall activity level for sprint drills ranged from an average of 132.4%-146.9%, relative to MVIC. Semi-tendinosis overall activity level for sprint drills ranged from an average of 144.8%-177.5%, relative to MVIC. Biceps femoris activity was significantly greater during sprints than during A-Skip ($p < .05$; Cohen's $d = 1.29$); B-Skip ($p < .05$; $d=1.29$); C-Bound ($p < .01$; $d =1.47$), and ABCD-Run ($p < .01$; $d= 1.42$). However, no significant differences were reported between sprints and drills for semi-tendinosis EMG activity.

CONCLUSION: This preliminary analysis revealed that the exercises performed by track and field athletes during warm-up elicit lower levels of biceps femoris electromyographic activity than those reported during maximal sprinting. Further analysis of hamstring muscle-tendon unit lengthening and lengthening velocity is currently underway to draw more definitive conclusions about hamstring mechanical loading reported during sprint drills and to know whether hamstring muscles are prepared enough for sprinting.

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c Howard et al., 2018, Sports Biomechanics

LEG JOINT KINETIC DETERMINANTS OF MAXIMAL SPEED SPRINT RUNNING

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INTRODUCTION: High-speed sprinting is achieved by force production onto the ground, which is generated through joint moment produced by muscle contraction. Differences in leg joint kinetics during the support phase at multiple running speeds have been demonstrated (1,2). However, there is limited information regarding what leg kinetic aspects can be determinants of maximal speed sprint performance. For example, although Bezodis et al. (3) indicated, using four sprinters, that the ankle plantarflexion during the support phase and hip extension during the early support phase can be important for better maximal speed sprint performance, there has been no cross-sectional study investigating the relationship of sprint performance with leg joint kinetics during maximal speed sprinting with enough number of participants. The purpose of this study was to investigate leg joint kinetic determinants of maximal speed sprinting performance using waveform analysis.

METHODS: Thirty-one male sprinters (mean ± SD: age, 21.3 ± 3.9 years; stature, 1.73 ± 0.06 m; body mass, 67.1 ± 5.0 kg; personal best 100-m time, 11.22 ± 0.42 s) ran 60-m with maximal effort, during which ground reaction forces and running motion in the maximal speed phase were recorded using force platforms (1000 Hz) and motion capture system (250 Hz). Joint torque and power at the hip, knee and ankle during the support phase of two steps during the maximal speed phase were calculated using a standard inverse dynamics analysis for both legs. For joint torque and power at each joint, an average of two signals from two support leg were calculated. Mean running speed for two steps during the maximal speed phase was computed. Then, one-dimension statistical parametric mapping for correlation analysis was used to examine relationships of mean running speed with joint torque and power signals during the support phase.

RESULTS: The average running speed for two steps during the maximal speed phase was 9.51 ± 0.29 m/s. The statistical parametric mapping revealed that the average running speed was significantly correlated with ankle plantarflexion torque from 38% to 52% of the support phase ($P = 0.03$) and with ankle negative power (plantarflexion torque with dorsiflexion angular velocity) from 21% to 34% of the support phase ($P = 0.01$).

CONCLUSION: The current results show that ankle plantarflexion torque and power production capability during the middle and early support phases could be important for achieving high sprinting speed during the maximal speed phase.

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MUSCLE ACTIVITY TIMING AND AMPLITUDE IN THE EARLY ACCELERATION PHASE OF CURVE SPRINTING

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INTRODUCTION: Surface electromyography (sEMG) helps understand the muscular origin of sprinting technique. It has been shown that maximal hip flexion and maximal hip extension angles are reached later at maximal velocity in the curve than in the straight (1). The hip flexors and extensors activation timings were shown to influence the step frequency at maximal velocity (2). Since the inside leg step frequency is reduced within the curve (1), this could result from delayed inside leg activation timings. The aim of the present experimentation was to investigate the onset of muscle activity and the sEMG amplitude of hip flexors and hip extensors over the early acceleration phase in straight-line and curve sprinting.

METHODS: 9 (6 male and 3 female) experienced-to-elite curve sprinters (mean ± SD: age = 22.8 ± 3.0 years; body mass = 70.8 ± 5.7 kg; height = 177.3 ± 6.6 cm) volunteered to participate in this study. After a 45-min self managed warm-up, the participants performed 10 and 40-m sprints within two sprinting conditions in a randomized order: straight-line and curve on a reconstructed lane 5 (radius = 41.58 m) of a standard athletics track.

sEMG (Delsys Inc., 2148 Hz) were positioned on the Rectus Femoris (RF) and Biceps Femoris long head (BF) of both left (L) and right (R) legs (3). After full-wave rectification and band-pass filtering (20-500 Hz), the onset timings (% of stance duration) of muscle activity were identified using Teager-Kaiser energy operator (TKEO) and Approximated Generalized Likelihood Ratio (AGLR) (4). Mean sEMG amplitudes were normalised to the maximal activity of the corresponding muscle detected over the straight-line 40-m sprints. Two-way RM ANOVAs were performed.

RESULTS: There were no significant effects for condition or side neither for the onsets of muscle activity of RF ($p > 0.283$) and BF ($p > 0.412$); nor for the sEMG amplitude of RF ($p > 0.718$) and BF ($p > 0.111$).

CONCLUSION: The early acceleration phase of curve sprinting on a reconstructed lane 5 did not result in alterations of neither the onset timings nor the magnitudes of hip flexors and hip extensors muscular activity in comparison to the straight-line. Yet, this analysis only focussed on the first steps of a sprint. As already suggested by Judson et al. (5) regarding the ground reaction forces; the effect of the bend on the muscular activity during the acceleration phase could accumulate with the increasing velocity. Therefore, investigations should aim to investigate whether differences in muscular activity between straight-line and curve sprinting can be found in the later stages of the acceleration phase.

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Oral presentations

OP-MH09 Sedentary behaviour

ONLINE CIRCUIT TRAINING INCREASES ADHERENCE TO PHYSICAL ACTIVITY GUIDELINES: A RANDOMIZED CONTROLLED TRIAL OF MEN LIVING WITH OBESITY

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INTRODUCTION: To examine adherence to the weekly physical activity guidelines (150 minutes of aerobic activities at moderate-to-vigorous intensity or more and two session of strength training or more, and health outcomes during the COVID-19 pandemic for men living with obesity, 46 weeks after being offered an online muscle strengthening circuit program for 12 weeks.

METHODS: Sixty men (age ≥ 18 years) living with obesity (body fat % ≥ 25) were randomly assigned to the intervention group (N=30) or the control condition (N=30) for 12 weeks. The intervention group was offered an online CIRCUIT training, three sessions per week, while the control group received a website helping them to reach the physical activity guidelines. Adherence to the weekly physical activity guidelines was evaluated 46 weeks after enrolling in the program using a heart rate tracker (Fitbit Charge 3) and an exercise log. Health outcomes (e.g., anthropometrics, body composition) were measured at baseline and after 12, 24, and 46 weeks.

RESULTS: More participants in the intervention group adhered to the physical activity guidelines compared to the control group at 46 weeks (intervention 36.8% vs control 5.3%; p=0.02). However, the intervention group did not surpass the health outcomes changes observed in the control group after 12, 24, and 46 weeks.

CONCLUSION: Increasing adherence to exercise in men living with obesity is a challenge. The proposed program increased adherence to the physical activity guidelines after about a year for men living with obesity; however, more studies are needed to understand how to improve health outcomes when following an online delivery exercise program in this population.

PHYSICAL ACTIVITY, SITTING TIME, AND GENERAL HEALTH STATUS: THE IMPACT OF COVID-19 INFECTION

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INTRODUCTION: The covid-19 pandemic negatively impacted physical activity (PA), amount of sitting time (ST) and individual's perceptions of general health status (GHS). However, sex, age and nutritional status are factors that have not yet been considered to understand this impact. Thus, we aimed to examine the impact of covid-19 signals, symptoms, and clinical outcomes on perceptions of GHS and time spent in PA and ST in adults and older adults, considering sex, age groups and nutritional status as confounding variables.

METHODS: This cross-sectional study included adults (≥18 years old) from a northeastern region of São Paulo, Brazil, who received a positive diagnosis of covid-19 between March/2020 and February/2021. Participants were randomly selected according to their telephone information using an oficial list of covid-19 survivors provided by the Health Department of the city of Ribeirão Preto. Through telephone, the short version of the International Physical Activity Questionnaire (IPAQ) was used to collect information on PA and ST, and a questionnaire developed for the purpose of the study was used to gather information on sociodemographic characteristics, body mass index (BMI), GHS, covid-19 signals and symptoms, and

clinical outcomes. Participants were asked to answer the questionnaires considering the week before the covid-19 diagnosis (pre-diagnosis), and the week when the interview took place (post-diagnosis). The Wilcoxon test for paired samples was used to compare the total time of PA (minutes/week), ST (hours/day), and GHS in the covid-19 pre- and post-diagnosis. The Quade's ANCOVA test verified the influence of covid-19 signals, symptoms, and clinical outcomes on the PA, ST, and GHS, controlled for confounding variables (sex, age and nutritional status).

RESULTS: Of the 509 participants, 311 (61%) were female and 397 (78%) aged between 18 and 59 years old. The total time of PA decreased and the individuals perception of GHS worsening in the post-diagnosis for male (Δ%= 46.4; p<0.001; Δ%= 25.0; p<0.001) and female (Δ%= 35.1; p<0.001; Δ%= 0; p<0.001), respectively. ST increased in males (Δ%= 17.1; p=0.010). The signals and symptoms of sore throat for males (F= 4.402; p=0.037), and fatigue/tiredness for females (F= 8.373; p=0.004) influenced PA reduction. The number of days the individuals were intubated significantly contributed to increase ST in males (F= 4.485; p=0.035). Finally, fever, loss of taste, diarrhea for males, and headache, breathing dificulty, loss of smell, sore throat, and fatigue/tiredness negatively influenced GHS for females (p<0.050).

CONCLUSION: Covid-19 infection exerts a negative impact on PA, ST and GHS, even after controlling for age, sex, and nutritional status. Our findings reinforce the importance of interventions to implement PA time spent, reduce ST, and improve the GHS after a positive diagnosis of covid-19.

CEREBROVASCULAR IMPACTS OF BREAKING UP PROLONGED SITTING WITH WALKING AND RESISTANCE ACTIVITIES.

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INTRODUCTION: Prolonged sitting is a frequent behaviour in the workplace, despite the increased risk of developing cardiovascular disease. A decline in middle cerebral artery blood velocity (MCAv), a surrogate marker for cerebral blood flow, has been reported following a period of prolonged uninterrupted sitting; this may impact on cognitive and cerebrovascular health. Frequent walking breaks may attenuate this decline in MCAv, however it is currently unknown whether resistance based activities may better preserve MCAv. Therefore, the aim of this study was to investigate the cerebrovascular effects of breaking up prolonged sitting with walking and resistance-based activities.

METHODS: Desk based-workers (n=11, BMI=27.4kg/m2) were recruited to complete three 8-hour working day trials; 1) Uninterrupted sitting, 2) five-minute hourly self-paced walking breaks (Walk), and 3) five-minute hourly resistance activities (Resistance), incorporating 30 second rotations of squats, lunges and an upright plank. Transcranial Doppler (Spencer Technologies, PMD150 ST3, New England, USA) was used to measure MCAv and posterior cerebral artery blood velocity (PCAv). Resting cerebral blood velocities were measured at baseline and at the end of the day. Data was sampled and averaged across five minutes respectively. Absolute change from baseline was calculated for MCAv and PCAv at both time points. A two-way repeated measures ANOVA was used to determine differences in MCAv and PCAv across time and condition.

RESULTS: There were no baseline differences in MCAv (p=0.9622) or PCAv (P=0.9831). Uninterrupted sitting led to a 9.8cm/s and 5.6cm/s decline in MCAv (p=0.0012) and PCAv (p=0.0881) respectively. Both walking and resistance activity attenuated the sitting related decline in MCAv to a 0.5 and 1.1cm/s decline respectively. Both walking and resistance activity attenuated the sitting related decline in PCAv to a 1.1 and 1.9cm/s decline respectively. No differences between physical activity modalities on MCAv or PCAv was observed.

CONCLUSION: Avoiding sharp declines in cerebral blood velocity observed during prolonged sitting is important maintaining for cerebral health. Regular interruption of sitting using physical activity breaks affords an opportunity to attenuate this decline. Further research is required to develop the mechanistic relationship between alterations in cerebral blood flow velocity, cognitive performance and cerebrovascular health.

ACCELEROMETER-DETERMINED MOVEMENT BEHAVIOURS, SARCOPENIA AND SARCOPENIC OBESITY IN COMMUNITY-DWELLING OLDER ADULTS

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INTRODUCTION: Sarcopenia is an age-related skeletal muscle condition characterized by muscle strength and muscle mass loss [3]. Sarcopenic obesity (SO) is a functional and clinical condition where an excess of fat mass and sarcopenia coexist [2]. Both conditions are considered risk factors for frailty, diverse comorbidities, and mortality [4]. Increasing physical activity (PA) is a relevant strategy for successful aging [5] but there is no consensus about which characteristics of PA might be beneficial to attenuate sarcopenia and SO progression [1]. The aim of this study was to analyse the associations between different intensity accelerometer-determined daily activities and sarcopenia and SO in a sample of older adults

METHODS: 200 high-functioning community-dwelling older adults wore the Intelligent Device for Energy Expenditure and Activity for two consecutive days. All activity types recorded were classified into three intensity categories: sedentary behaviour (SB), light PA (LPA) and moderate-to-vigorous PA (MVPA). For muscle strength measurements included hand grip dynamometer and chair-stand tests were used. Skeletal muscle mass (SMM) and fat mass were estimated by bioelectrical impedance. Associations of daily activities with the study variables were examined using linear regression models.

RESULTS: There were no significant associations between total time spent in SB, LPA, or MVPA and sarcopenia. Nevertheless, SO showed a negative association with total time spent in MVPA [ß (95%CI): -0.28 (-0.41, -0.16)]. Walk at a brisk pace and other MVPA activities were significatively associated with the following SO components: lower limb strength [ß

(95%CI): 1.15 (0.40, 1.91) for walking and 4.65 (0.55, 8.75) for other activities], SMMiweight [ß (95%CI): 1.45 (0.68, 2.22) for walking and 8.59 (4.51, 12.67) for other activities] and fat mass % [ß (95%CI): -2.63 (-4.12, -1.14) for walking and -13.98 (-21.96, -5.99) for other activities].

CONCLUSION: Only MVPA seems to be related to lower levels of SO. No accelerometer-determined movement behaviour was related with sarcopenia.

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PRESCRIBING AN ADAPTED PHYSICAL ACTIVITY PROGRAM (MATCH) AS USUAL CARE TO PREVENT IATROGENIC DECLINE IN HOSPITALIZED OLDER ADULTS: IS IT POSSIBLE AND BENEFICIAL ?

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INTRODUCTION: Hospitalization leads to iatrogenic declines due to bed rest which accelerates the spiral of loss of autonomy (high risk of falls and frailty) and healthcare needs (home care services; readmission). We observed in pilot study settings that implementing as usual care an adapted, unsupervised daily PA program (MATCH) seems feasible, acceptable and effective in geriatric assessment units (GAU) and in COVID-19+ units. However, the reasons for hospitalization of older adults are heterogeneous, and patients may be admitted to various geriatric units (GUs). Thus, we aimed to assess the feasibility, and acceptability of implementing PA (MATCH) as usual care into 2 other GUs (geriatric rehabilitation unit (GRU) & post-acute care unit (PACU)) and explore its health effects.

METHODS: Patients admitted to 2 GUs at the Institut Universitaire de Gériatrie de Montréal (Canada) were examined by the Physicians to evaluate their eligibility. Subsequently, the physiotherapist/kinesiologist assessed the mobility score via a decisional tree and taught one of 5 unsupervised adapted PA programs (the one related to their mobility score). Thereafter, patients should follow this PA prescription by themselves during their hospitalization. Eligibility rates, inclusion rates (care acceptance), time to implementation, adherence and patient & clinician acceptability were assessed and compared across GUs. Moreover, physical performance [handgrip strength (HS (kg)); normal 3-meter Timed Up & GO (TUGn, sec); 4-meter walking speed (WS; m/sec), muscle endurance (30sec Sit-to-Stand (30-STS), repetition number), SPPB (Short Physical Performance Battery; X/12)] and frailty status (SOF questionnaire; X/3) were assessed at admission (Ta) and at discharge (Td). T-test, paired t-tests and Chi-Squared were performed.

RESULTS: Eligibility rate (%: GRU=32.5; PACU=26.6; p=0.12) and length of stay (days: GRU=39.4; PACU=37.6; p=0.33), inclusion rate (%: GRU=80.9; PACU=75.6; p=0.32), implementation delay (days: GRU=5.91; PACU=5.88; p=0.48) and adherence to PA prescription (%: GRU=83.5; PACU=71.9; p=0.15) were similar. Regardless of GUs, acceptability was good for clinicians (%: GRU=78; PACU=76) and for patients (SUS:>75%). Finally, all participants independently of the Gus improved significantly (p<0.001) and clinically their HS (Ta: 19.7±7.4 vs. Td: 21.9±8.5 kg), TUGn (Ta: 36.7±18.5 vs. Td: 23.9±1.7 sec), WS (Ta: 0.44±0.2 vs. Td: 0.62±0.2 m/s), 30-STS (Ta: 6.1±2.8 vs. Td: 7.9±3.2 rep), SPPB (Ta: 4.8±1.8 vs. Td: 6.5±2.5 pts/12) and SOF (Ta: 1.9±0.9 vs. Td: 1.53±1.0/3).

CONCLUSION: Implementing PA as usual care appears feasible, acceptable and beneficial in PACU and GRU. Based on the present and previous findings, MATCH can be assessed in all GU settings. However, before generalizing, further RCT studies are needed to confirm our promising results.

Oral presentations

OP-AP35 Basketball: Training and Testing

MOVEMENT CHARACTERISTICS OF MALE AND FEMALE 3-ON-3 BASKETBALL PLAYERS AT NATIONAL AND INTERNATIONAL TOURNAMENTS

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INTRODUCTION: Despite the increased popularity and number of national and international competitions for 3-on-3 basketball, internal and external movement demands are not well described. Such information is important for coaches and trainers alike to ensure adequate training protocols are used to prepare athletes for competition demands. Therefore, the aim of this study was to quantify the internal and external movement demands of 3-on-3 basketball matches in both national and international competitions using indoor GPS technology (VX Sport, Omni, Wellington New Zealand) and an athlete monitoring system (Health and Sport Technologies Ltd., trading as Metrifit, Millgrange, Greenore, Co. Louth, Ireland).

METHODS: Twelve well trained representative basketball athletes (8 males; 20.8 ± 1.8 yr, 190.3 ± 5.5 cm, 92.4 ± 9.9 kg and 4 females; 20.3 ± 1.5 yr, 171.4 ± 2.3 cm, 72.2 ± 3.8 kg mean ± SD) competed in (n=12) national competition matches and (n=6) international competition matches on a FIBA-sized basketball half-court (15 m x 11 m) with VXSport Omni devices inserted into custom-made pockets in the back of VXSport Smart vests. Measures taken included total duration (mins) total distance (m), relative distance (m/min) covered during games, high intensity distance (m) travelled at ≥ 15 km/h, high intensity sprints (number) at ≥ 15 km/h, maximal speed (km/h), total number of sprints, total number of jumps, high-intensity accelerations, and decelerations (> 3m/s/s), maximum and average heart rate (bpm) and distance travelled at difference speed band zones (0 – 6 km/h, 6.1 – 12 km/h, 12.1 – 18 km/h and 18.1 - 24km/h). Post-game internal demands were recorded on the Metrifit athlete monitoring system on player's phones, which included rate of perceived exertion (RPE), perceived physical, technical, tactical, and psychological performance on a Likert scale ranging from 1 – 10 for RPE and 1 – 5 for the other measures.

RESULTS: When compared to national competition, male and female international competition variables were higher for total duration ($p = 0.008$), total distance ($p = 0.026$), high intensity HR duration ($p = 0.040$), mean HR ($p = 0.048$), maximum HR ($p = 0.040$), and distance at 6.1-12 km/h ($p = 0.003$). Interestingly, the same variables were substantially higher in females compared to males in both national and international competitions. In addition, all post-game psychological variables such as RPE, perceived physical, technical, tactical, and psychological performance were higher in international matches compared to national matches for both males and females.

CONCLUSION: The novel finding of this study was that international external and internal 3-on-3 basketball competition demands showed higher intensities in most variables. Significant differences between genders were also observed highlighting the importance of gender-specific training and coaching strategy prior to and during competitions.

FUNDAMENTAL AND SPECIFIC MOTOR SKILLS PROFICIENCY IN YOUTH BASKETBALL PLAYERS. THE ROLE OF SPECIFICITY AND COMPLEXITY

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INTRODUCTION: Introduction: The most proficiency level of motor development in sport is achieved by the combination and/or modification and mastery of the fundamental motor skills to the sport-specific context. Specificity consists of adapting some elements of FMS pattern to the specific sport context. Complexity depends on the interaction between various elements of motor skill patterns to determine muscle-specific synergy based on the task and the environment in which the task is. The main purpose was to study the relationship between fundamental motor skills (FMS) and sports-specific skills (SSS) in terms of specificity and complexity in youth basketball players.

METHODS: Sixty-two amateur basketball players aged from 6 to 15 years were included in the study (age, 10.8 ± 2.3yr; female,45,2%). Cross-sectional measurements of maturity offset, FMS [sprint (Sp) and change of direction (COD)] and SSS [sprint while dribbling (SpBk) and change of direction while dribbling (CODBk)] were performed in a large basketball indoor court. The tests used were: 25msprint (2Sp), Vcut (COD), 25mSp_BK (SpBk), and Vcut_BK (CODBk). The time of each test was recorded with timing gates (Microgate Witty Wireless Training Timer, Bolzano, Italy). Every test was performed twice with a rest period of 3 min between trials and 5 min between tests. The best trial of each test was used.

RESULTS: Pearson's correlation shows significant associations between skills paired by specificity criterion (from basic to specific): Sprint and Sprint while dribbling ($\beta=0.937$ $p=0.000$), and Change of direction and Change of direction while dribbling ($\beta=0,821$ $p=0.000$). Furthermore, between skills paired by complexity criterion (from simple to complex): Sprint and Change of direction ($\beta=0,937$ $p=0.000$), and Sprint while dribbling and Change of direction while dribbling with ($\beta=0,813$ $p=0.000$). The association also existed between Sprint (basic and simple) and Change of direction while dribbling (specific and complex) ($\beta=0,810$ $p=0.000$). However, the independent predictors of Change of direction while dribbling were: change of direction ($\beta=0.406$ $p=0.001$), maturity offset ($\beta=-0.185$ $p=0.032$), sex ($\beta=0.182$ $p=0.032$), and experience ($\beta=-0.206$ $p=0.005$) explaining 81.5% of its variability.

CONCLUSION: Taken together, these results demonstrate the relation between FMS (Sp and COD) and SSS (SpBK and CODBK) when considering FMS complexity and specificity. Also, FMS (COD), maturity offset, sex, and sport-specific experience (BK) have been taken into consideration to explain SSS (COD_BK) proficiency.

RELATIONSHIP BETWEEN SALIVARY BIOMARKERS AND EXTERNAL LOAD DURING A PROFESSIONAL MEN'S BASKETBALL GAME

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INTRODUCTION: In sports science, external load (EL) refers to the amount of physical work completed by the athletes, while internal load represents an individual physiological response to the amount of work completed during a training session. In response to a single bout of strenuous exercise, testosterone (T), as a hormone associated with anabolic processes, is likely to experience a slight increase or decrease. Alternatively, cortisol (C), as a hormone that works antagonistically to T, is likely to experience a considerably greater increase. When expressed as a testosterone-to-cortisol ratio (T/C), these two hormones serve as a viable measure of the athlete's recovery status. Thus, the purpose of this study was to examine the relationship between EL experienced by basketball players during a game and T, C, and T/C.

METHODS: Six professional male basketball players (x̄±SD; hgt=191.8±11.9 cm, wgt=19.2±14.4 kg; age=28.3±2.2 yrs) volunteered to participate in the present study. After arrival at the gym (12:00h), each participant wore an EL monitoring system composed of compression shorts and a tri-axial accelerometer (StriveTech, Bothell, WA, USA) sampling at 1000 Hz. Upon completion of the warm-up procedure, consisting of a set of dynamic stretching exercises and 15 min of partner shooting, participants proceeded with playing a simulated 5x5 basketball game (4x10 min quarters with Elam Ending). By holding an oral swab (Salimetrics, State College, PA, USA) sublingually in their mouth for 2 min before releasing it into a centrifuge tube, all participants simultaneously provided salivary samples post first (P1Q), second (P2Q), third (P3Q), and fourth (P4Q) quarter. A separate enzyme-linked immunosorbent assay was used for each hormone and all samples were ran in duplicates. Intra- and inter-assay variances for T and C were 5.6% and 5.1%, and 6.2% and 6.9%, respectively. Pearson product-moment correlation coefficients were used to measure the strength of linear regression ($p<0.05$).

RESULTS: The average EL, T, C, and T/C values were 0.450±0.162 [arbitrary unit], 0.954±0.257 [nmol/L], 14.264±6.411 [nmol/L], and 0.076±0.006 [ratio], respectively. Statistically significant correlations were observed between EL and C ($r[22]=0.751$, $p<0.001$; $R2=0.564$), and EL and T/C ($r[22]=-0.729$, $p<0.001$, $R2=0.531$). Despite a tendency to display a weak positive association, the correlation between EL and T did not reach a significance level ($r[22]=0.371$, $p=0.075$, $R2=0.138$).

CONCLUSION: Overall, the findings of the present study reveal a strong positive relationship between EL and C, and a strong negative relationship between EL and T/C. Although further research pertaining to position-specific differences is warranted, we can conclude that as the amount of physical work completed by the athlete during a basketball game increases, the C tends to follow the same pattern. However, T/C, as an indicator of athletes' recovery status, tends to display an inverse trend and progressively decreases throughout a game span.

REPEATED JUMP TEST FOR CHILDREN AND ADOLESCENTS AT VARIOUS STAGES OF BASKETBALL GAMES, AND THEIR RELATIONSHIPS TO AEROBIC CAPACITY

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INTRODUCTION: In basketball, the vertical jump is an important type of activity that is performed as a single or repeated action during different stages of a basketball game (Ben Abdelkrim et al., 2007) Relationships between aerobic fitness and repeated jump test (RJT) performance indices have previously been examined among adolescent male basketball players (Segev & Meckel, 2020), but not among children. The aim of the study was to compare repeated jump tests (RJTs) performance indices of adolescent and prepubertal basketball players during different stages of basketball games, and to examine their relationships to aerobic capacity.

METHODS: The study included 34 male basketball players – 18 children (age 12.1±0.4 yrs) and 16 adolescents (age 17.2±0.4 yrs.) – who were asked to perform RJT (6 sets of 6 consecutive jumps), after a warm-up, at halftime, at the end of a game, and an aerobic capacity test (20m Shuttle Run Test). Performance indices for the RJT were: Ideal jump height (IJH), Total jump height (TJH) of all the jumps, and Performance decrement (PD) during the test.

RESULTS: A significant decrease in IJH between half-time and full-time was seen among the adolescents ($p<0.01$), yet not among the children. Moreover, while the TJH was significantly increased ($p<0.05$) among the children at the end of the game compared to at the warm-up, this significantly decreased among the adolescents ($p<0.01$). Significant correlations were found between the IJH at halftime and full-time and the aerobic fitness, and between the TJH at halftime and the aerobic fitness among the children's group. No significant correlations were found between aerobic fitness and any RJT performance indices in the adolescents' group.

CONCLUSION: The findings demonstrate that prepubertal children are superior in maintaining repeated jumping performance during basketball games compared to adolescents. The findings also suggest that the aerobic system is a significant energy contributor among children, but not among adolescent players, during repeated jump activity. Coaches of young basketball players may allow more breaks for recovery during training sessions that involve repeated jumps.

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TRAINING ON SAND OR ON PARQUET: IMPACT OF A PRE-SEASON TRAINING ON SPEED AND JUMP PERFORMANCE IN PROFESSIONAL BASKETBALL PLAYERS

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INTRODUCTION: The abilities to effectively decelerate, change direction (CoD), accelerate, and jump are crucial physical qualities in modern basketball [1]. Recently, sand as a training surface has received wide recognition in practice for improving these attributes, although scientific evidence is lacking. In particular, the effects of a specific CoD speed training on sand have not been studied so far. Therefore, the present study aims to investigate the effect of CoD speed training on sand compared to a parquet surface with regard to speed and jump performance.

METHODS: Twenty-five male professional basketball players (age: 24.1 ± 4.2 years; height: 192.5 ± 8.0 cm; body mass: 92.6 ± 11.6 kg), from three teams with an equal level of competition, participated in a systematic controlled pre-season intervention study over seven weeks, followed by a taper week. Two teams completed an identical speed training protocol

either on sand (S) or on a hard surface (H), while the third team served as control (C), with all following their pre-season training at the same total training volume. The training protocol was applied twice a week, consisted of CoD drills in combination with plyometrics and followed a weekly progression regarding training volume and intensity. Pre-intervention and post-tapering, subjects were tested for speed (5, 10, 20 m sprint (ST)) and jumping performance (countermovement jump (CMJ), pivot jump (PJ), repeated jumps (RJ), crossover triple hop (CH)).

RESULTS: A repeated-measures ANOVA showed significant interaction effects for the 10 and 20 m ST (10 m: $p = .05$, $\eta2 = .012$; 20 m: $p = .002$, $\eta2 = .028$), the CMJ ($p < .001$, $\eta2 = .079$), and the PJ ($p = .002$, $\eta2 = .025$). Post hoc pairwise comparisons showed differences only for S regarding 10 and 20 m ST (10m: -0.04 ± 0.05 s, pTukey = 0.018; 20 m -0.09 ± 0.08 s, pTukey = <.001) as well as for CMJ (4.88 ± 2.32 cm, pTukey = <.001) and PJ (3.93 ± 2.53 cm, pTukey = <.001). No differences were found for 5 m ST, RJ and CH.

CONCLUSION: The results support the effectiveness of sand as a training surface, primarily for speed and jumps with longer ground contact times that are determined by the concentric force development. This is likely due to the force-absorbing nature of the surface, resulting in increased muscle activation and longer ground contact times. However, the same characteristic leads to a deficiency in reactive force development out of the short stretch-shortening cycle, which is reflected by the lack of improvement in RJ and CH for S.

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Oral presentations

OP-SH06 Psychobiology

VARIATION OF BLINK RATE AFTER ACUTE VERY LIGHT EXERCISE PREDICTS PREFRONTAL COGNITIVE ENHANCEMENT LEVELS

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INTRODUCTION: Acute physical exercise, even very light exercise, elicits the activation of the dorsolateral prefrontal cortex (DLPFC) and improves executive function (EF) (Byun et al., 2014). However, the underlying neurobiological mechanisms of this are not fully understood. Accumulating evidence shows that resting-state spontaneous eye blink rate (rssEBR) is associated with brain states that are linked to arousal, especially modulation of the dopaminergic system (e.g., Jongkees & Colzato, 2016; Demiral et al., 2023). Our previous cross-sectional study demonstrated that higher baseline rssEBR mediates the association between aerobic fitness and prefrontal EF, which leads us to the hypothesis that rssEBR-linked neural substrates explain the neurobiological effects of physical exercise (Kuwamizu et al., 2021). The rssEBR-linked neural substrates may also be associated with the impact of acute exercise on EF, but whether EF enhancement with acute exercise depends on rssEBR upregulation changes remains unclear.

METHODS: Healthy young adults participated in two conditions: 10-minute very light-intensity cycle ergometer exercise (30% Vo2peak) and resting. Twenty-four participants (age = 22.2 ± 1.5) were analyzed. rssEBR was recorded for 3 minutes before and immediately after exercise and rest. To evaluate the EF, a color-word Stroop task was administered before and after exercise and rest. Prefrontal activation was measured using functional near-infrared spectroscopy while performing the Stroop task.

RESULTS: Very light exercise significantly improved Stroop task performance and task-related left-DLPFC activation (all $p < 0.01$). There were no significant differences between conditions in the change in rssEBR ($p = 0.44$). The correlation analyses, however, revealed significant association between the change in rssEBR and improved Stroop task performance ($r = 0.62$, $p = 0.001$).

DISCUSSION and CONCLUSION: Acute very light-intensity exercise does not elicit consistent rssEBR increase. This result does not support the hypothesis that upregulation of rssEBR-linked neural substrates contributes as the primary mechanism of the enhancement with very light-intensity exercise. However, increased rssEBR was associated with higher EF enhancement levels and vice versa. This suggests that rssEBR-linked neural substrates might work as modulators of cognitive enhancement levels following exercise; further study is needed. As a bonus, this finding indicates that blink measurements might provide a new contactless and clearly visible biomarker for predicting brain impact with exercise.

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THE EFFECTS OF NEUROFEEDBACK TRAINING AND PSYCHOLOGICAL SKILLS TRAINING ON PUTTING PERFORMANCE IN EXPERT GOLFERS

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INTRODUCTION: In recent studies, the effectiveness of neurofeedback training (NFT) and psychological skills training (PST) have been evaluated not only in the clinical population, but also for their enhancement of performance in general. The mechanism for the effect may differ based on different effective attention control derived from both trainings. Previous research suggests that Frontal Midline Theta (Fmθ) is an indicator of top-down sustained attention and Fmθ can be used to distinguish an individual's best and worst golf putting performances during the pre-putt period. Thus, this study investigated the effect of NFT and PST on golf putting performance and hypothesized that expert golfers would exhibit enhanced putting performance after both trainings.

METHODS: Twenty-eight expert golfers were recruited and assigned into the NFT group (N = 9), PST group (N = 8), or control group (N = 11). Participants were asked to perform golf putting while electroencephalogram (EEG) was recorded, both before and after intervention. The NFT group participated in eight 1.5-hr sessions of Fmθ NFT in a lab setting. During the Fmθ neurofeedback training, participants had to develop their own strategies for controlling Fmθ amplitude based on the visual or audio feedback in real-life putting. The PST group participated in eight 1.5-hr sessions of Mindfulness-Acceptance-Commitment (MAC) in a lab setting. During this time, the control group did not receive any type of intervention.

RESULTS:The one-way ANOVA showed a significant effect on putting accuracy ($F(2, 27) = 9.648$, $p = .001$). The post hoc analysis showed that the NFT group had better performance than control group ($p = .003$) and PST group ($p = .004$). Fmθ and attention-related cortical indicators did not differ between the three groups.

CONCLUSION:Despite its limitations, this study found that 8-session Fmθ NFT significantly improved putting performance in expert golfers while mindfulness based intervention did not. To the best of our knowledge, this is the first long-term interventional Fmθ NFT study on putting performance and EEG activity. The null finding in the PST group could be attributed to promotion of control over automation in acceptance-based mindfulness training, which may not match the attentional style of these participants. From a practical standpoint, although Fmθ NFT was ineffective in changing EEG-related cortical activities during putting, it is effective in improving putting performance. The mechanism of performance enhancement via NFT and PST still remains a question. Future research could focus on clarifying the underlying mechanism of the effect through NFT and PST.

AUTOMATED STRESS RECOGNITION AND EVALUATION VIA A SELF-DESIGNED INTERACTIVE VIRTUAL REALITY PLATFORM

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INTRODUCTION: Stress is commonly elicited through internal or external stimuli in physical activity, and is assessed using subjective and objective measurements. Traditionally, subjective methods determine the stress level of a person through questionnaires and answers rated on a stress scale. Due to the notable improvements in virtual reality (VR) techniques, virtual reality exposure therapy (VRET) is considered an efficient tool to overcome these weaknesses. VRET assumes the possibility that participants feel real-life stressful situations in a similar magnitude in VR, and succeeds in tracking physiological signals and recognize affective stress states, which provides a method of linking subjective and objective measures of stress recognition.

METHODS: fifty-seven adult athletes (19 males and 38 females) with an average age (±SD) of 20.9 (±1.9) years, were enrolled to participate in this study with written consent. Participants were asked to log in to the system and sit at ease in the chair for 3 min to exclude any other artificial distractions. Later, they entered the three independent VR contents in a random order to experience both low- and high-stress modes from all three scenes for nearly 2 minutes per mode. The whole experiment lasted for approximately 30 minutes (including nearly 12 minutes of virtual experiences) and finished with the completion of the retrospective survey on the Experience Evaluation of Virtual Reality Scene, which provided feedback on the psychometric quality of the self-designed VR platform.

RESULTS: Our findings demonstrate the concurrent variations between physiological data (heart rate, electrodermal activity and eye-blink rate) and self-reported stress ratings, and include the evaluations of the VR system by computing Cronbachs alpha (α=0.72) and Kaiser-Meyer-Olkin (KMO) coefficient (η=0.78) through a retrospective survey, which were subsequently confirmed as reliable on four aspects (sense of presence, sense of space, sense of immersion and sense of reality) via factor analysis. Additionally, we demonstrate the effectiveness of physiology-based stress level classification (no stress, low stress and high stress) and continuous SSAI score prediction, with accuracy (0.742), F1-score (0.709) and recall (0.774) by bagging ensemble learning model and goodness-of-fit reaching 0.44 via multivariate stepwise regression.

CONCLUSION: We have designed an interactive virtual reality platform for stress recognition based on Unity engine and possesses complex interactive functionalities that enable participants to experience stressful scenes. The main contributions are twofold. First, we realize the automation of stress recognition in physical activity using several supervised learning algorithms. Second, this study provides detailed insight regarding the effect of objective physiological measures on the validation of subjective self-ratings, which stimulates the further investigations of stress disorder treatment.

ASSOCIATION OF SCREEN TIME AND PHYSICAL ACTIVITY WITH SLEEP QUALITY IN COLLEGE STUDENTS DURING COVID-19 OUTBREAK

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Background: Sleep is important for physical and mental health. Some epidemiological studies found that excessive screen-based activity and lower physical activity were strongly associated with poorer performance in various aspects of sleep, especially reduced sleep quality. However, the associations between screen time and sleep quality may vary by different types of screen time. Evidence showed that college students had more screen time (ST) and less physical activity (PA) during the COVID-19 epidemic. The associations of specific types of screen time and physical activity with sleep quality remain to be clarified. Therefore, the study aims to elucidate the associations of different types of screen time and physical activity with sleep quality among university students during COVID-19 outbreak .

Methods: A total of 1550 students from universities in Shanghai, China, completed an online survey in May 2022. The data collected included basic information (gender, age, school), self-reported screen time (TV/movie viewing, recreational reading, video gaming, online social media), Pittsburgh Sleep Quality Index (PSQI) score, International Physical Activity Questionnaire (IPAQ) and sedentary time. The screen-based activities in the responses were categorized into three levels (ST < 1h, 1h < ST < 2h, ST > 2h). The moderate to vigorous physical activity was categorized into three levels as well (none of MVPA, MVPA < 150min/week, MVPA > 150min/week). Associations between various types of screen time and physical activity with sleep quality were examined by multiple linear regression.

Results: There were 1453 valid questionnaires received in total (response rate: 93.74%). The percentage of self-reported ST > 2 hours/day was the highest among all types of screen activities. Approximately, a half of the college students had less than 150 minutes of moderate to vigorous physical activity per week. The linear regression revealed that MVPA were not significantly associated with sleep quality during the epidemic. However, the linear regression revealed that TV/movie viewing > 2 h was associated with poorer sleep quality ($\beta = 0.37$, 95% CI: 0.04-0.70, $p = 0.028$) and recreational reading > 2 hours/day was also positively associated with poorer sleep quality ($\beta = 0.67$, 95% CI: 0.33-1.02, $p < 0.001$). However, there were no associations between video gaming and online social media and sleep quality.

Conclusion: The present study indicated that the associations between screen time and sleep quality varied by the types of screen activities. During the COVID-19 pandemic, excessive screen time has a negative impact on sleep quality, particularly the TV/movie viewing and recreational reading. However, physical activity level was not associated with sleep quality. Future interventions for improving sleep quality in college students should consider the types of screen activities and controlling screen exposure.

Keywords: COVID-19, screen time, sleep quality, physical activity

DEVELOPMENT AND EVALUATION OF THE PSYCHOMETRIC PROPERTIES OF A NEW MEASURE OF ATHLETE INSOMNIA: INSOMNIA IN RESPONSE TO SPORTS-RELATED STRESS TEST QUESTIONNAIRE

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INSEP

INTRODUCTION: INTRODUCTION: Impaired sleep is particularly frequent among elite athletes which has been linked to various negative consequences, including lower athletic performance and general health [1]. Several studies have examined potential acute and chronic factors placed on elite athletes resulting in compromised sleep, e.g. training and competition [1]. Candidate risk factors for compromised sleep in elite athletes also include many factors commonly considered to influence sleep in non-athletic individuals and particularly psychological stress and anxiety [2]. The aim of the present study was to develop and validate the Insomnia in Response to Sports-related Stress Test (IRSST) questionnaire, a new specific instrument with the goal of sensitively measuring vulnerability to sport-specific stressful situations among elite athletes.

METHODS: Five hundred and thirty-one competitive elite athletes (mean age = 17.6±4.4 years) completed the Ford Insomnia Response to Stress Test (FIRST) questionnaire, a standardized questionnaire assessing the likelihood of sleep disruption due to common stressful situations (e.g. before having to speak in public, before an important meeting the next day) [3], and the IRSST, a six-item questionnaire developed to assess the level of sleep disturbance in response to the commonly experienced sport-specific stressful situations, i.e. before competition, after daytime competition, after nighttime competition (20:00-21:00), after nighttime training (20:00-21:00), during training camp, after injury. A development and validation process including substantive, structural, and external stages was used in the present study [4].

RESULTS: One eigenvalue of the exploratory factor analyses was greater than 1.0 (i.e., 2.91, 48.52% of explained variance) whereas the scree test provided evidence for a one-factor solution, with all the six items achieving a loading of .40 or higher on the factor. The goodness-of-fit indices of the six-item one-factor confirmatory factor analyses model provided further evidence of the structural stage of IRSST score. The correlation between IRSST and FIRST scores was .47 ($p < .001$, moderate effect size).

CONCLUSION: These results provide strong evidence for construct validity, indicating that the IRSST is a promising scale for assessing the likelihood of sleep disruption due to sports-related stressful situations. The results of reliability and correlational analyses provided further evidence of the promising psychometric properties of the IRSST. We believe that the IRSST could provide to the sport and sleep science communities a sleep screening tool for use in this unique population.

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METHODS: RESULTS: CONCLUSION: Oral presentations

OP-AP15 Coaching Strategies

TRAINING PRACTICES AND COACHING PHILOSOPHY OF SUCCESSFUL NORWEGIAN NATIONAL COACHES IN ENDURANCE SPORTS

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INTRODUCTION: While performance development in endurance sports typically is described by the interaction of loading factors such as training volume, frequency, and intensity distribution, practitioners themselves highlight indicators of training quality – the how and why – as the most important factors leading to success. In this context, successful coaches are highly systematic in collection of training data, and carefully experimental regarding training adjustments. Somewhat surprisingly, the practices, knowledge and experience of the very best coaches have received minimal systematic attention in research literature. The mysteries and secrets of the training process are challenging to quantify and require an integrative and multidisciplinary approach. Therefore, the aim of this study was to explore the training practices and coaching philosophy of successful coaches in endurance sports.

METHODS: Twelve male Norwegian coaches with a track record of coaching endurance world-class athletes (total of >320 Olympic, World and European Championship medals; mainly Norwegian athletes) in cross-country skiing, biathlon, speed skating, rowing, road cycling, swimming, long-distance running, and triathlon participated. Individual semi-structured interviews on planning, organization and periodization of training, competitive activity, training load and quality indicators, load monitoring, testing, and athlete follow-up provided approximately 180 min audio recording per respondent. The transcripts were approved by the respective coach, formally translated to English and analyzed thematically.

RESULTS: Preliminary analyses reveal a high-volume approach, with the majority of training at low-intensity and with training volume and intensity distribution periodized using a traditional model as common features among the coaches' training philosophies. This includes 2-3 days (2-5 sessions) weekly as the cornerstones of the training program and that other training sessions are built around these. The key sessions become gradually more competition-specific in all characteristics towards the competition period. There are clear sport-specific differences in the training content, driven by differences in competition demands, mechanical and muscular load during specific training sessions, as well as access to facilities and environmental conditions. All coaches described that a coach-driven and athlete-centered coaching philosophy was essential to create trust, mutual understanding, and provided the foundation for optimizing the training process and execution of sessions for each athlete. The factors involved in this process will be described and discussed in the presentation.

CONCLUSION: This study presents a holistic picture of "state-of-the-art" endurance training, including novel qualitative information about training and coaching philosophies from successful Norwegian coaches in endurance sports.

THE PERCEIVED VALUE OF ATHLETE MONITORING TO ELITE SPORT PRACTITIONERS

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INTRODUCTION: Athlete monitoring systems (AMS) can aid performance optimisation and injury prevention, but recently their efficacy has been questioned. The perceived value of monitoring matters, because if practitioners lack confidence in their monitoring systems, their ability to positively influence training programming is diminished. To address this, researchers have primarily sought to improve AMS metric-related factors e.g. measure reliability. In comparison however, the impact of socio-environment factors e.g. stakeholder buy-in on AMS, has received less attention. This study explored the perceived value of athlete monitoring by elite sport practitioners focussing on socio-environment factors.

METHODS: Seventy-five elite sport practitioners (response rate: n= 30) who worked with tier 3-5 athletes (1) were invited to take part in an online survey about their athlete monitoring practices. The practitioners represented 14 different sports and 599 athletes. The survey took approximately 20 minutes to complete, with questions primarily answered by checkboxes, Likert scale responses or short answers. Spearman's correlation coefficient was used to test the strength of Likert relations and Bonferroni corrected to $p < 0.017$.

RESULTS: Fifty-two percent (n=13) respondents were confident in the sensitivity of their athlete self-report measures (ASRM) to detect meaningful change, with 64% (n=16) indicating their ASRM was underpinned by scientific studies. Such scientific evidence was linked with improved feedback to athletes ($r(23) = 0.487$, $p = 0.014$); and improved feedback correlated with better athlete monitoring adherence ($r(22) = 0.675$, $p < 0.001$). If athletes did not complete their monitoring, 52% (n= 13)

respondents felt the athletes' performance might be compromised. However, most respondents 56%, (n= 14) had worked with internationally successful athlete(s) who had reached the podium at major international events and did not complete their monitoring.

CONCLUSION: While AMS can be a useful tool for performance optimisation, its potential value isn't always realised. The difference between some practitioner's beliefs; (a lack of monitoring compromises performance) versus reality; (some internationally successful athletes do not complete monitoring) indicates that the efficacy of monitoring should be regularly reviewed to ensure it is providing value. Practitioners should also consider simultaneously addressing socio-environment and metric-related factors in order to improve AMS efficacy.

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USE THE 'ARTISTIC LENS': EXPLORING YOUNG PEOPLE'S LEADERSHIP PERCEPTIONS

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Introduction

There is a lack of theories that explain how young people can develop as leaders, and how existing theories can be applied to young adults and children. The purpose of this study is to explore how leadership skills are taught to potential young leaders.

Methods

Data consists of 7 observations and fieldnotes from two leadership programs for youth: one program in a sport-club context with 20 participants and the other in a higher education setting with 60 participants. Furthermore, 4 semi-structured interviews with leaders from sport-clubs and from the field of leadership was conducted. Questions focused on leadership, leaving out personal background or life-stories.

Results

The interviewees underline the importance of getting youth engaged in leadership trainings, in problem-solving, how to handle and cope challenges, the ability to reflect and learn from actions (instead of focusing on performance and results), creating, and developing relations. They also emphasize the importance of consciously affirming young participants in their learning processes, share experiences through dialogue and most importantly, listening. Yet, observations show that although the young participants attended the programs voluntarily, they were inactive during lectures and workshops. Participants explained: "not having the courage", "not understanding what leadership is", not knowing what to do", and "not knowing how to engage and speak in a group". Roleplay and improvisations engaged young participants more than for example discussions.

Discussion

There is a need for more knowledge on leadership training and young people and how to increase participation. One way to meet the challenge is to use the 'artistic lens', including flexibility and openness to discovery, as well as embracing the chaos which enters in the reflective process of exploration. This implies asking potential young leaders how they perceive leadership. There is also the need to understand how leaders and practitioners in the field of leadership uphold their leadership and training methods. Young people are valuable members in their communities and though they may not hold positions of authority, they possess the potential to exercise leadership in meaningful ways.

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Oral presentations

OP-PN23 Immobilization and Recovery

DOES HUMAN SKELETAL MUSCLE POSSESS A NEGATIVE MEMORY OF ATROPHY?

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INTRODUCTION: Skeletal muscle (SkM) size and function are compromised during prolonged periods of disuse. It is evident that SkM possesses a positive memory of exercise-induced hypertrophy. However, it is unknown whether human SkM has a negative memory of disuse atrophy. The present study therefore examined the physiological response to repeated atrophy in human SkM.

METHODS: Ten young healthy males (n=7) and females (n=3; 27 ± 4 yrs, BMI 26.4 ± 5) underwent 2 weeks of atrophy via unilateral limb immobilization followed by 7 weeks of recovery and another 2 weeks of repeated atrophy. Before and after each atrophy period, measures of leg lean mass (DXA), anatomical cross-sectional area (aCSA, ultrasound) of the vastus lateralis (VL) and rectus femoris (RF) muscles, alongside isometric knee extension torque (dynamometry) across 3 knee flexion angles (90-, 60- and 30-degrees) were assessed. SkM biopsies were obtained for future downstream molecular analyses. A one-way ANOVA with Tukey HSD post-hoc analysis enabled detection of significant changes ($p<0.05$). All data are presented as mean ± SD.

RESULTS: Firstly, there was no significant difference between baseline and recovery for any of the parameters assessed, suggestive of a full recovery following the initial period of disuse-induced atrophy. A significant loss of leg lean mass (-3.4 ± 2%, p=0.01) and VL aCSA (-9 ± 3.8%, p=0.0003) occurred after atrophy that was comparable to the reductions in lean leg mass (-2.9 ± 1.9%, p=0.003) and VL aCSA (-8.9 ± 4.5%, p=0.0003) experienced after repeated atrophy. Importantly, a significant reduction in RF aCSA only occurred following later repeated atrophy (-3.5 ± 2%, p=0.02) with no change after the earlier atrophy period (-0.5 ± 2.2%, p=0.6). In terms of muscle function, there was a similar reduction in knee extension torque at 90-degrees after atrophy (-14.3 ± 11.4%, p=0.02) and repeated atrophy (-13.8 ± 11.7%, p=0.02). However, loss of muscle strength at 60-degrees was exacerbated after later repeated atrophy (-14.3 ± 8.8%, p=0.002) relative to the loss observed after earlier atrophy (-12.5 ± 10.5%, p=0.02). There was also a trend towards a greater strength loss at 30-degrees after repeated atrophy (-9.6 ± 14.4%, p=0.1) versus earlier atrophy (-7.5 ± 18.7%, p=0.5), however this was not statistically significant.

CONCLUSION: Overall, both periods of atrophy evoked comparable reductions in parameters related to muscle size (leg lean mass and VL aCSA) and function (knee extension strength at 90-degrees knee flexion). However, a significant reduction in RF aCSA only occurred in response to later repeated atrophy even following full recovery from earlier atrophy. This was associated with a greater loss of muscle strength at 30- and 60-degrees after later repeated atrophy. To delineate the possible mechanisms underpinning these physiological responses to repeated atrophy, we will conduct unbiased genome-wide epigenetic and transcriptomic analyses on the muscle biopsies derived from this study.

UNEXPECTED HYPERTROPHIC, PHENOTYPICAL, AND OXIDATIVE METABOLISM TRANSCRIPTIONAL ADAPTATIONS IN RESPONSE TO RESISTANCE TRAINING FOLLOWING 10 DAYS OF MUSCLE DISUSE

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INTRODUCTION: Physical inactivity is a main curse of modern society, characterised by neuromuscular decline with progressive loss of muscle mass, strength, and power and by an increased risk of major chronic diseases. Exercise countermeasures seem to be highly beneficial for contrasting neuromuscular impairments; however, as most studies have employed nutritional or exercise during unloading periods, there is a paucity of data regarding recovery programs right after muscle disuse. We aimed to study the functional, structural, molecular and transcriptional responses to a 21-day active recovery program based on resistance training (RT) following 10 days of muscle unloading intervention.

METHODS: Eleven healthy males (22.1±2.9 y) underwent a 10-day unilateral lower limb suspension (ULLS) period, followed by 21-day of active recovery, consisting in a RT program for the knee extensors performed at 70% of the 1RM. The data collection was performed at baseline (BSL), at the end of the ULLS (LS10), and at the end of the exercise recovery period (AR21). Quadriceps femoris (QF) and vastus lateralis (VL) volume and isometric maximum voluntary contraction (MVC) were evaluated. VL muscle architecture and body composition were assessed by ultrasonography and BIA. Histological data (i.e., fibre CSA and type, glycogen content) were evaluated from VL biopsies and transcriptomic profile was investigated by RNA-seq.

RESULTS: Following ULLS, QF and VL volume decreased (-3.7% and -3.5%, $p<0.05$ and $p=0.05$, respectively) as did MVC (-29.3%, $p<0.001$) and pennation angle (-3.85%, $p<0.05$). After the 21-d AR period, MVC and pennation angle were fully restored (+42% and +4.4%, compared to LS10, respectively) whereas QF and VL volume showed a surprising overshoot (+18.6% and +24.2%, $p<0.001$, compared to LS10, respectively). These changes at whole muscle level were not matched by fibre CSA, as no such changes were observed for both fibre types. However, glycogen staining intensity increased after AR (+16.1%, $p<0.001$) as did whole body water content (+3.1%, $p<0.05$). Transcriptomics analyses showed that the most

differentially expressed genes, showing a dampened enrichment after ULLS and a strong re-enrichment following AR, were identified in the hallmarks and pathways related to oxidative phosphorylation, glucose and fatty acid metabolism. These data were accompanied by a reduction of fibre type II distribution at AR21 (-21%, p<0.05) and an increase in fibre type I (+34%, p<0.05).

CONCLUSION: RT successfully recovered functional and structural muscle properties after 10 days of disuse, but in contrast with what usually observed in response to RT, oxidative metabolism and slow fibre type were mostly affected by disuse and recovery, suggesting that muscle could enhance metabolic recovery before hypertrophy per se in response to RT following disuse. Further studies should clarify the responses of such exercise countermeasures after muscle disuse scenarios.

SHORT-TERM IMMOBILIZATION LOWERS MUSCLE CONNECTIVE PROTEIN SYNTHESIS RATES IN HEALTHY YOUNG ADULTS

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INTRODUCTION: Short periods of limb immobilization lower myofibrillar protein synthesis rates. Within skeletal muscle, the extracellular matrix of connective proteins is recognized as an important factor determining the capacity to transmit contractile force. Little is known with regards to the impact of immobilization and subsequent recovery on muscle connective protein synthesis rates. This study examined the impact of 7 days of leg immobilization and 14 days of subsequent ambulant recovery on daily muscle connective protein synthesis rates.

METHODS: Thirty healthy, young (24±5 y) men were subjected to 7 days of one-legged knee immobilization followed by 14 days of ambulant recovery. Deuterium oxide ingestion was applied over the entire period and muscle biopsy samples were collected before immobilization, after immobilization, and after recovery to measure muscle connective protein synthesis rates and mRNA expression of key extracellular matrix proteins (collagen I, collagen III), glycoproteins (fibronectin, tenascin-C), and proteoglycans (fibromodulin, and decorin). A two-way repeated measures (time x leg) ANOVA was used to compare changes in muscle protein synthesis rates during immobilization and recovery. Data represent mean±SD.

RESULTS: During immobilization, muscle connective protein synthesis rates were lower in the immobilized (1.07±0.30 %/d) compared with the control (1.48±0.43 %/d; P<0.01) leg. When compared to the immobilization period, connective protein synthesis rates in the immobilized leg increased during subsequent recovery (1.47±0.63 %/d; P<0.01). Following recovery, skeletal muscle collagen I, collagen III, fibronectin, fibromodulin, and decorin mRNA expression increased when compared to the post-immobilization timepoint (all P<0.001).

CONCLUSION: Short-term immobilization lowers muscle connective protein synthesis rates. Muscle connective protein synthesis rates increase during subsequent ambulant recovery, which is accompanied by increased mRNA expression of key extracellular matrix proteins.

CROSS-EDUCATION EFFECT BY ECCENTRIC VS CONCENTRIC RESISTANCE TRAINING OF THE ELBOW FLEXORS IMMOBILISED BY A CAST

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INTRODUCTION: Muscle strength gain conferred by a unilateral limb resistance training is transferred to a non-trained homologous muscle of the contralateral limb, which is referred to as the cross-education effect. The magnitude of increase in muscle strength of the contralateral limb was 35% (95% CI: 20.9%–49.3%) of that of the ipsilaterally trained limb (Munn et al. J Appl Physiol 2004). Interestingly, the magnitude of the cross-education effect appears to be greater after eccentric (ET) than concentric resistance training (CT). The magnitude of muscle damage induced by maximal eccentric exercise of the elbow flexors was reduced when the second bout of the same exercise was performed by the contralateral homologous muscle within 4 weeks (Chen et al. Med Sci Sports Exerc 2016). However, no previous study has compared the effects of ET versus CT of the non-immobilised arm on the immobilised arm for muscle strength, atrophy and damage. The present study tested the hypotheses that ET would attenuate decreases in muscle strength and cross-sectional area (CSA) of the immobilised arm greater than CT, and ET would provide greater protective effects against muscle damage induced by maximal eccentric exercise after immobilisation than CT.

METHODS: Sedentary young men were placed to ET, CT or control group (n=12/group), and their non-dominant arms were immobilised for 3 weeks. During the immobilisation period, the ET and CT groups performed 5 sets of 6 dumbbell curl eccentric-only and concentric-only contractions, respectively at 20-80% of maximal voluntary isometric contraction (MVCiso) strength over six sessions. MVCiso torque, root-mean square (RMS) of electromyographic activity during MVCiso, and bicep brachii muscle CSA were measured before and after immobilisation for both arms. All participants performed 30 maximal eccentric contractions of the elbow flexors (30EC) by the immobilised arm after the cast was removed. Several indirect muscle damage markers were measured before, immediately after, and for 5 days following 30EC.

RESULTS: ET increased MVCiso (17 ± 7%), RMS (24 ± 8%), and CSA (9 ± 2%) greater (P<0.05) than CT (6 ± 4%, 9 ± 4%, 3 ± 2%, respectively) for the trained arm. The control group showed decreases in MVCiso (-17 ± 2%), RMS (-26 ± 6%), and CSA (-12 ± 3%) for the immobilised arm, but these changes were attenuated greater (P<0.05) by ET (3 ± 3%, -0.1 ± 2%, 0.1 ±

0.3%, respectively) than CT (-4 ± 2%, -4 ± 2%, -1.3 ± 0.4%, respectively). Changes in all muscle damage markers after 30EC were smaller (P<0.05) for the ET and CT than control, and ET than CT group (e.g., peak plasma creatine kinase activity, ET: 860 ± 688 IU/L, CT: 2,390 ± 1104 IU/L, control: 7,819 ± 4,011 IU/L; peak muscle soreness, ET: 17 ± 16 mm, CT: 40 ± 14 mm, control: 60 ± 26 mm).

CONCLUSION: These results showed that ET of the non-immobilised arm was effective for eliminating the negative effects of immobilisation and attenuating muscle damage induced by eccentric exercise of the pre-immobilised arm.

HEAT THERAPY TO ACCELERATE MUSCLE REGENERATION

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INTRODUCTION: Muscle injuries represent one of the most common type of injuries encountered by health professionals. Cold based therapies are considered the gold standard solution to treat muscle injuries. But no evidence has shown the efficacy of cold application in the regeneration of human skeletal muscle following soft tissue injuries. Animal studies showed that cold application delayed muscle regeneration and increased muscle fibrosis (1). In contrast, heat-based therapies applied on muscle injury have been shown to improve and shorten the regeneration in rats (2). The aim of this study was to investigate the effects of three distinct thermal therapies applied by water immersion on human skeletal muscle regeneration.

METHODS: Healthy males (n=36, age: 33.7 ± 3.5yrs) performed an electrically stimulated eccentric exercise of the right leg followed by 11 days of supervised recovery with daily legs water immersion. Immediately after the exercise, participants were distributed in a counterbalanced way in 3 groups of water immersion: 1) Cold with 15 min at 12°C, 2) Neutral (sham/control) with 30 min at 32°C and 3) Hot with 60 min at 42°C. First bath was initiated an hour after damaging exercise completion. Blood was collected on 3 occasions for Myoglobin and creatine kinase (CK) analysis. Maximal voluntary contraction (MVC), rate of force development (RFD), peak twitch (PT) and pain were monitored.

RESULTS: No significant differences in the level of work done during the exercise were found across the groups, suggesting a consistent damage creation across the groups. Muscle temperatures (3cm depth) reached respectively 33.2 ±2.3°C for Cold, 35 ±1°C for Neutral and 38.9 ±0.4°C for Hot group at the end of each bath.

Myoglobin was significantly lower in the hot group 4 days after the damages (Hot= 991±574 vs Cold= 2134±1123 and Neutral= 1823±972ng/mL) with a significant interaction between treatment and time (p<0.02, p-eta2= 0.217) but not after 8 days (hot= 91±32 vs cold= 130±50 and neutral= 132±57 ng/mL). CK was significantly lower in Hot compared to Cold 8 days after damages (Hot= 1928±924 vs Cold= 4667±3010 and Neutral= 3937±2447 U/L) (p<0.02, p-eta2= 0.224). No significant differences in myoglobin and CK results were found between Cold and Neutral groups. Although the interaction did not reached significance for MVC (p=0.073), post-hoc analyses showed significantly higher MVC for Hot than Cold at day 2 and 4 (p<0.05).

CONCLUSION: The lower values in blood markers of muscle damage measured for Hot group suggest a faster removal of intra-muscular damages with the Hot treatment. Furthermore, MVC appeared to recover faster with Hot treatment. In contrast, the cold treatment had no significant effect on the muscle recovery indices. Heat-based therapies could represent a novel therapy to accelerate muscle regeneration after an injury.

1-Takagi (2011)

2-Shibagushi (2016)

Oral presentations

OP-SH26 Well-being and sport

WHY ARE YOU DOING THIS? THE RELATIONSHIP BETWEEN MALTREATMENT HISTORY AND SPORTS MOTIVATION USING THE SELF-DETERMINATION THEORY.

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UNIVERSITÉ DU QUÉBEC À CHICOUTIMI

A regular sports practice is associated with many positive health effects, and this is even more true for adolescents (Gómez-Baya et al., 2020). Sports participation motivation is increasingly studied using the Self-Determination Theory (SDT). This theory displays motivation on a continuum, from extrinsic to intrinsic; suggesting that undertaking an activity with more self-determined motivation is associated with more positive outcomes, while less self-determined motivation is associated with more dropouts and negative outcomes. Another facet of the SDT suggests that three basic psychological needs (autonomy, competence, relatedness) must be fulfilled to be intrinsically motivated (Ryan & Deci, 2017). On a different note, a disturbing rate of the population reports a history of child maltreatment (i.e., neglect, sexual, physical, and psychological abuse), which is associated with serious health issues (WHO, 2019). A promising avenue to prevent its negative outcomes is by promoting sports participation in youth, which should ideally be intrinsically motivated. To our

knowledge, no study has focused on sports participation in adolescents with a history of maltreatment, through the lens of SDT. The present study aimed to 1) compare adolescents with and without a history of maltreatment, all involved in a sport, on SDT factors and psychological outcomes, and 2) test the mediating role of basic psychological need satisfaction in the context of sports on the relationship between cumulative experiences of maltreatment and intrinsic motivation. A sample of 1,384 adolescents (M=14.69, SD=0.81) was retrieved from a larger sample. Participants completed questionnaires on sports participation, SDT factors, psychological outcomes, and maltreatment. First, group comparisons showed that adolescents with a history of maltreatment reported significantly lower self-esteem, life and body satisfaction, and more internalized and externalized symptoms. They also reported similar amounts of time devoted to sports, but significantly lower intrinsic and higher extrinsic motivation, as well as a lower satisfaction of all three basic psychological needs (<.01). Then, results of a path analysis showed significant indirect effects for autonomy [B=-0.037, 95% C.I. (-0.056, -0.02), p<.05], competence [B=-0.027, 95% C.I. (-0.042, -0.014), p<.05], and relatedness [B=-0.017, 95% C.I. (-0.032, -0.004), p<.05]. These findings suggest that the negative relationship between maltreatment history and intrinsic motivation was partly explained by the level of satisfaction of basic psychological needs. The present results highlight the relevance of considering the satisfaction of autonomy, competence, and relatedness in sports programs, to increase youths' self-determined motivation, particularly among those who have experienced maltreatment and hopefully create an environment where they can experience its positive effects.

CONFLICTING OR ENRICHING? WEEKLY FOLLOW-UP OF THE RELATIONSHIPS BETWEEN STUDENT-ATHLETES' ROLE INTERACTIONS AND WELL-BEING

LEFEBVRE DU GROSRIEZ, S.1, ISOARD-GAUTHEUR, S.1, BALK, Y.2, SARRAZIN, P.1

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Introduction

Due to the multiple demands of each career, student-athletes are especially at risk of well-being impairment. By meeting the demands, resources consumed in one role (e.g., athlete) may not be available in the other role (e.g., student): this is role conflict (Greenhaus & Beutell, 1985). Alternatively, the experiences lived in one role could provide resources usable in the other role: this is role enrichment (Greenhaus & Powell, 2006). Role interactions (i.e. conflict and enrichment) are likely to influence student-athletes well-being. Thus, the purpose of the present study was to examine the within-subject relationships between resources (i.e., mental rest), contextual demands, role interactions and contextual well-being indicators among student-athletes.

Method

Participants were thirty-three French student-athletes (women = 15) who responded to a weekly online questionnaire across five months, assessing their perceived mental rest, role interactions, demands, stress, and satisfaction in academic and athletic contexts.

Results

Multilevel analyses showed that after controlling for contextual demands, mental rest, age and gender, both school and sport stress were predicted (β = [.11 to .14], p <.05) by sport-to-school and school-to-sport conflicts. In addition, sport-to-school enrichment was also negatively related to sport stress (β = -.18, p <.001). School satisfaction was negatively predicted by sport-to-school conflict (β = -.13, p = .011) and positively by school-to-sport enrichment (β = .26, p <.001). Finally, sport satisfaction was negatively predicted by school-to-sport conflict (β = -.12, p <.05) and positively by sport-to-school enrichment (β = .23, p < .001). The four models predicted between 16% and 38% of the within-subject variance in contextual well-being.

Discussion

The results of this study contribute to research on student-athlete well-being by showing (1) that contextual stress and satisfaction vary significantly across weeks at the within-subject level, and (2) that sport-school role interactions predict contextual well-being, just as work-family role interactions predict organizational and family well-being. From a practical perspective, evidence of the relationships between demands, role interactions, and well-being could help student-athlete supervisors become aware of the need for specific dual-career management and help student-athletes manage their dual careers more effectively.

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IS A COACH INDUCED EMPOWERING CLIMATE A PROTECTIVE FACTOR AGAINST (PEER) INTERPERSONAL VIOLENCE IN SPORT GROUPS?

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GERMAN SPORT UNIVERSITY COLOGNE

Introduction

Research shows that a coach induced empowering climate is helpful for fostering intrinsic motivation in athletes. On the other hand, persons affected by sexual violence often report power inequalities between themselves and their aggressors within qualitative studies. As a strong empowering climate created by the coach has the effect of reducing power inequalities by empowering the athletes, the question arises if a coach induced empowering climate can also be a protective factor against different forms of interpersonal violence in sport? Furthermore, a particular focus within this study was on interpersonal violence between peer athletes, as previous studies show that for example one third of all incidences of sexual violence were caused by peer athletes (Ohlert et al., 2018). The question was how an empowering climate generated by the coach would also affect violence among the athletes?

Method

In this manner, an online survey with 648 athletes from 58 different kinds of sport was conducted. Participants answered to the German version of the "Empowering and Disempowering Motivational Climate in Sport Questionnaire" (EDMCQ; Ohlert, 2018). Furthermore, their observations and experiences of physical, psychological, and sexual violence were assessed with the German Version of the "Interpersonal Violence in Sport Questionnaire" (IViS; Vertommen et al., 2016).

Results

Different MANOVAs revealed that for all forms of interpersonal violence, athletes who had observed or experienced any form of this violence reported lower empowering climate and higher disempowering climate scores on some subdimensions. The differences were most evident for psychological violence, but held also true for sexual violence by the coach and by peer athletes.

Discussion

Our results indicate that a coach induced empowering climate (and less disempowering climate) is a promising aspect when clubs are looking for protective factors against all forms of interpersonal violence. Therefore, educating coaches in inducing an empowering climate can not only promote intrinsic motivation, but also seems to prevent interpersonal violence, including violent behavior among the athletes.

ASSOCIATIONS BETWEEN BELIEFS REGARDING INSTRUMENTAL EFFECTS OF MALTREATMENT AND COACH PSYCHOLOGICAL MALTREATMENT AND NEGLECT BEHAVIORS

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UNIVERSITÉ LAVAL

Purpose: Given the magnitude of maltreatment toward athletes, evidence-based coach education is necessary to prevent those behaviors. Some coaching practices that constitute maltreatment are seen as necessary to drive performance of athletes, deter failure, test resilience and so on. The present study aims to examine if those beliefs are associated with psychological maltreatment and neglect behaviors in coaches.

Method: The sample consists of 732 adult Canadian coaches involved in organized sport. They completed an online questionnaire assessing their beliefs regarding instrumental effects of maltreatment (Perceived Instrumental Effects of Maltreatment Scale - PIEMS) and their behaviors regarding maltreatment (adapted version for coaches of the Violence Toward Athlete Questionnaire - VTAQ). A multiple logistic regression was performed to ascertain the effects of age, sex at birth, years of coaching experience, level of athletes they are coaching and mean PIEMS score on the likelihood that participants committed psychological maltreatment or neglect towards athletes.

Results: The logistic regression model was statistically significant, $\chi 2(11) = 52.614$, $p < .001$. The model explained 9.2% (Nagelkerke R2) of the variance for psychological maltreatment and neglect behaviors. Of the five predictor variables, only two were statistically significant: increasing number of years of coaching experience and mean PIEMS score were associated with an increased likelihood of perpetrating psychological maltreatment or neglect towards athletes.

Conclusion: Our results show that beliefs regarding instrumental effects of maltreatment are linked with psychological maltreatment and neglect behaviors of coaches. Targeting those beliefs in coach education programs will contribute at preventing maltreatment toward athletes.

BULLYING IN SPORT: A CASE STUDY OF HUNGARIAN SWIMMING

SZEKERES, D.1, WHYTE, I.2, SOOS, I.1

1. HUNGARIAN UNIVERSITY OF SPORTS SCIENCE, BUDAPEST, HUNGARY 2. INTERNATIONAL NETWORK OF SPORT AND HEALTH SCIENCES, FRANCE

INTRODUCTION

Bullying is a hostile and deliberate behaviour. Recent work on 'black pedagogy' (Borosan et al., 2022) highlighted areas of concern in Hungarian schools, however, it also raised issues in sport. The literature evidences incidences of psychological, physical or sexual abuse across a variety of sports, from recreational to elite performers, and across the globe such as in the UK, USA and France, among other countries. Hungarian Swimming came under the spotlight as a result of the Túri case. Significant abuse against swimmers was proven. Apart from 'black pedagogy' research, there is little published work on this topic in Hungary. This paper aimed to kickstart the process by interrogating the international literature on one key area of abuse, namely bullying, and compare the findings with Hungarian swimmers' experiences.

METHOD

A search of the literature was conducted using key words of elite sport, bullying, and swimming,followed by comparison with transcripts of swimmers' statements. Theoretical models were applied for fit.

RESULTS

The literature showed that bullying in sport is a worldwide phenomenon, with coaches, parents, and peers being the protagonists. Performance demands were instrumental in bullying by coaches and parents. Bullying from peers seems more likely to reflect social interactions. In terms of Hungary's elite swimmers, bullying was mainly led by coaches, with verbal bullying being endemic. Critical comments about athletes' capacities or talents or for relatively poor training or competition performances predominated, often shouted at the athletes, regularly in public. At times, the verbal abuse was accompantied with physical punishment. Subsequently, Bronfenbrenner's Socio-ecological framework was identified as a sound model to explain the phenomenon.

DISCUSSION

A conclusion can be drawn that bullying may be existed in elite Hungarian swimming, mirroring in part the international literature. But, at this level and age of particpants, peer-based bullying was limited. These investigations led to changes with respect to safeguarding policies and operations. Progress is now needed. Bullying is one abusive behaviour and work is needed across the full spectrum. First, a full systematic review of the literature is required embracing all global sport, at all ages, levels and abilities, and including legal and grey literature from varying jurisdictions. Secondly, there is a need to identify what policies have been developed to safeguard children and vulnerable adults across sports and national boundaries. Finally, studies must be undertaken to investigate the efficacy of policy and strategy directives at all levels as new procedures, education, training, and accreditation opportunities are pointless unless they make a difference. Identifying whether this is happening should be the ultimate aim of future research.

Keywords: elite swimming, bullying, abuse, socio-ecological framework, Hungary

09:30 - 10:45

Invited symposia

IS-PN07 Mitigating the effects of heat stress during the 2024 Paris Olympics

PRACTICAL APPROACHES TO MINIMISE THE IMPACT OF DEHYDRATION ON ATHLETE PERFORMANCE

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For athlete hydration, much debate centres on how (mainly laboratory-based) research is translated into drinking recommendations for athletes, with strategies mainly described as falling into two categories: 'planned' or 'thirst driven/ad libitum' drinking. Whilst a 'thirst driven/ad libitum' approach will likely suffice in many settings; some specific situations may require a deliberate plan.

With elite athletes undertaking prolonged high-intensity exercise, particularly in the warm/hot environments likely at Paris 2024, sweat rates will be high and often far greater than the volume of drink feasible to ingest during exercise. For example, an elite runner weighing 60 kg and sweating at an average of 3 L/h over a marathon taking 2 h 10 min, would need to consume ≥5 L of drink during the race to prevent dehydration equivalent to 2% body mass. This means dehydration (sometimes significant) can develop, and performance may be negatively impacted. In contrast, it is important to recognise that in some settings, sweat rate will be low and fluid availability plentiful, meaning over-drinking, and exercise-associated hyponatraemia may present a risk to athlete health/performance.

Randomised cross-over experiments consistently demonstrate the negative impact of dehydration on athletic performance, particularly endurance performance. The mechanisms underpinning these impairments are multifactorial, likely acting in combination depending on the individual athlete, the athletic endeavour, and various environmental factors. Situations where dehydration is likely to develop should be carefully considered and planed for to give the athlete the best chance of minimising performance deficits. Even if the plan is simply to drink to thirst/ad-libitum. It must also be recognised that it may not always be possible to fully replace sweat losses or even maintain dehydration below a certain threshold. As such, athletes/support staff may consider other strategies during the short- and long-term pre-event preparation to minimise dehydration-induced performance deficits.

This presentation will outline how athletes' performances at Paris 2024 may be impacted by dehydration and cover practical approaches to allow athletes/support staff to make decisions about when and when not to plan fluid intake during exercise. Other potential strategies for minimising dehydration-induced performance impairments and considerations for overlap between hydration and other fuelling/nutrition strategies will also be considered.

COOLING STRATEGIES FOR ELITE ATHLETES: BENEFICIAL EFFECTS ON EXERCISE PERFORMANCE AND PRACTICE CONSIDERATIONS

BONGERS, C.

RADBOUD UNIVERSITY MEDICAL CENTER

Cooling strategies prior to (pre-cooling) or during exercise (per-cooling) are known to improve exercise performance in the heat due to reductions in thermal strain and an increased heat storage capacity. Pre-cooling can be described as the rapid removal of heat from the body before exercise to create a larger heat storage capacity, whereas per-cooling is defined as any opportunity to reduce thermal stress during exercise by applying a cold stimulus. Possible cooling interventions include cold water immersion, cold water/ice slurry ingestion (also known as internal cooling), wearing a cooling/ice vest or cold packs, water spray or water dousing, and the application of menthol on the skin or by using a mouth rinse. Previous studies demonstrate that pre- and per-cooling improve exercise performance in the heat by 4.7% and 5.3%, respectively, with greater performance benefits for endurance exercise compared to intermittent sprint exercise protocols. Along with its effects on exercise performance, cooling reduces the risk of exertional heat-illness and may facilitate safer exercise performances during the Paris Olympics of 2024. Therefore, athletes and their coaches should focus on cooling interventions and practise different interventions in competitive settings to optimise performance and increase the chance of winning a gold medal! Sport-specific regulations, practical considerations and local environmental conditions are important determinants for the effectiveness and implementation of cooling interventions. For example, event-specific regulations do not always permit per-cooling strategies such as wearing a cooling vest or cooling packs. This suggests that athletes should adopt a customised cooling strategy that complies with the regulations, practical considerations and environmental conditions of their sport and event. This presentation will outline the effectiveness of different times (i.e. pre- or per-cooling) and types (i.e. internal and external) of cooling interventions on exercise performance and thermophysiological outcomes (i.e. core temperature, skin temperature, heart rate), and explain the different approaches that can be used by athletes during competition, while taking into account the effectiveness of the intervention and the practical feasibility. Physiologist, coaches, and athletes will benefit from this presentation by gaining a deeper understanding of the nuances associated with implementing cooling strategies into the pre-event preparation, warming-up and/or during competition of elite athletes.

HEAT ACCLIMATION AND THE ELITE ATHLETE: BENEFITS AND INTEGRATION INTO THE TRAINING PROGRAMME

PÉRIARD, J.

UNIVERSITY OF CANBERRA

Heat acclimation and the elite athlete: Benefits and integration into the training programme Abstract: Heat acclimation has been suggested to be the most important intervention one can adopt to reduce physiological strain and optimise performance in the heat. The adaptations stemming from regular exposure to heat stress enhance thermoregulatory capacity, improve fluid balance and increase cardiovascular stability. The functional benefits associated with heat adaptations lead to improvements in endurance performance and comfort in the heat, and reduce the risk of exertional heat illness and thermal injury. Although the benefits of heat acclimation are well established, a key question for elite athletes regarding the implementation of heat training is when to schedule it in the overall training programme. Prior to a major competition, most athletes will undertake a block of training in which volume and/or intensity are increased, followed by a period of taper. Supplementing the intensified training period with exercise-heat exposures may lead to suboptimal training adaptations due to fatigue accumulation and inadequate recovery, particularly when adopting more traditional and rigorous laboratory-based heat acclimation regimens (e.g. 10-14 consecutive days of exercise in the heat for 90 min). Moreover, while exercise-heat exposure during the taper may help maintain the benefits of heat acclimation, it may also interfere with the goal of reducing overall training load. As such, this presentation will outline the time course of human heat adaptation, detail the performance benefits conferred by acclimation when exercising in hot environmental conditions, and explain the different approaches that can be used to induce heat acclimation. These different approaches, including the controlled heart rate and post-exercise passive heat exposure approaches, will be contextualised to the different training periods leading up to a major competition. Examples of which approaches to use and when to implement these will be provided. The benefits of heat re-acclimation will also be outlined, along with timelines for its implementation for the re-induction of adaptations. The different heat acclimation approaches will also be discussed in relation to the availability of resources and arrival timeline of the athlete at the competition venue. Physiologist, coaches and athletes will benefit from this presentation by gaining a deeper understanding of the nuances associated with implementing heat acclimation into the training programme of elite athletes.

Oral presentations

OP-PN15 Muscle Metabolism I

NIRS ASSESSMENT OF MICROVASCULAR FUNCTION AND MUSCLE OXIDATIVE CAPACITY IN PATIENTS WITH FRIEDREICH'S ATAXIA

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NATIONAL RESEARCH COUNCIL

INTRODUCTION: Friedreich's ataxia (FA) is an inherited autosomal recessive disorder caused by the reduction of frataxin protein and affecting central and peripheral nervous systems, skeletal muscle and myocardium. In FA patients, reduced levels of the frataxin protein cause iron overload, increased oxidative stress and impairment of mitochondrial function [1]. FA patients show progressive gait disturbances, limb ataxia, lower extremity weakness and early fatigue which have been correlated to mitochondrial disfunctions. Decreased oxygen delivery and microvascular impairments as secondary effect of muscle disuse may also contribute to exercise intolerance [2]. In this study we aimed to evaluate microvascular function and muscle oxidative capacity in FA patients by near infra-red spectroscopy (NIRS), a non-invasive technique which has been demonstrated effective in highlighting mechanistic insights into different diseases [3].

METHODS: Eighteen FA patients (26±8 years) and fourteen age-matched healthy subjects (CTRL) were recruited. All patients were able to walk either without support or with walker and had a mean total score at the SARA Scale of 17±6 points [4]. NIRS measures were performed on gastrocnemius medialis (GM) by a continuous-wave device. Adipose tissue thickness (ATT, mm) was measured by a skin caliber. Microvascular responsiveness was evaluated analysing tissue saturation index (TSI) changes during the first 30 s of reperfusion (Slope30) immediately following 3-min occlusion of popliteal artery [5]. Muscle oxidative capacity (mVO2) of GM was estimated by NIRS from recovery rate constant (k) of TSI changes during brief intermittent arterial occlusions [6]. Within-subject test-retest reproducibility of k was tested as intraclass correlation coefficient (ICC) and Pearson's coefficient.

RESULTS: ATT was 6.9±2.8mm for FA patients and 5.9±2.3mm for CTRL. During 3-min ischaemia, TSI difference between the minimum and maximum was similar between FA (19.2±9.8%) and CTRL (20.9±10.9%, p=0.66). Slope30 was significantly lower in FA (0.46±0.24%*s-1) compared to CTRL (0.74±0.43%*s-1, p=0.03). The individual test-retest reliability of k in both FA and CTRL was good (ICC=0.74; r=0.74). k was lower in FA (1.19±0.53 min-1) compared to CTRL (2.36±0.82min-1, p<0.001).

CONCLUSION: FA patients, compared to healthy controls, showed lower microvascular responsiveness and muscle oxidative capacity. Thus, FA patients may have muscular exercise impairment due to deficit of both O2 delivery and O2 uptake at skeletal muscle level. Present data also suggest that NIRS can represent a non-invasive tool to identify pathophysiological hallmark of FA, suggesting potential future applications for monitoring disease progression or response to rehabilitative interventions.

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NEAR-INFRARED SPECTROSCOPY MUSCLE OXYGEN SATURATION AND HEART RATE IN MAXIMAL EXERCISE: COMPARISON BETWEEN TREADMILL, ELLIPTICAL TRAINER AND CYCLE ERGOMETRY

ABRANTES, C.1,2, MACHADO, I.1, SANTARÉM, D.1

1 RESEARCH CENTER IN SPORTS SCIENCES, HEALTH AND HUMAN DEVELOPMENT

INTRODUCTION: Maximal exercise intensity is widely used to assess physiological responses in a variety of populations. Determine muscle oxygen saturation (SmO2), using the emerging easy-to-use technique of near-infrared spectroscopy (NIRS), combined with the heart rate (HR) in response to different exercise modes (or ergometers), remains unclear. The aim is to compare the changes in SmO2 in the gastrocnemius medialis (GM) and vastus lateralis (VL) muscles, and the HR response at maximal exercise intensity performed on a treadmill, an elliptical trainer and a cycle ergometer.

METHODS: Fourteen healthy volunteers (age=34.9±9.1 years; height=169.4±8.6 cm; weight 69.7±9.8 Kg) performed three incremental tests to maximum intensity in a treadmill, an elliptical trainer and a cycle ergometer in different days and in a random order. During the incremental tests, the HR (Garmin, Soft Strap Premium, USA) and the SmO2 (Moxy 3, Fortiori Design LLC, Hutchinson, USA) of VL and GM were collected. The data of the last intensity level with one-minute duration was used to determine average HR (HRavg), peak HR (HRpeak), average SmO2 (SmO2avg) and minimum SmO2 (SmO2min) in VL and GM muscles.

RESULTS: Repeated measures ANOVA revealed an exercise mode effect on HRavg (F2,26=12.44, p=0.001, n2=0.150) and HRpeak (F2,26=13.15, p=0.001, n2=0.170). Higher values were found on HRavg on treadmill vs. cycle (177.2±7.5 vs. 167.5±13.4 bpm, p=0.005) and on elliptical (175.0±9.3 bpm, p=0.018) vs. cycle. A similar pattern was found on HRpeak with higher values on treadmill vs. cycle (183.9±2.1 vs. 172.9±3.7 bpm, p=0.004) and elliptical (180.5±2.5 bpm, p=0.017) vs. cycle. An exercise mode effect of SmO2min in VL (F2,20=5.24, p=0.015, n2=0.230) showed lower values on elliptical vs. cycle (15.0±10.7 vs. 37.6±18.2%, p=0.035). An exercise mode effect was also found in GM on SmO2avg (F2,24=27.19, p<0.001, n2=0.530) and on SmO2min (F2,24=18.35, p<0.001, n2=0.450). Lower values were found on SmO2avg on treadmill vs. cycle (27.3±9.4 vs. 57.6±14.9%, p<0.001) and on elliptical (33.0±12.1%, p<0.001) vs. cycle. Similarly, the SmO2min was lower on treadmill vs. cycle (21.8±9.0 vs. 48.3±15.2%, p<0.001) and on elliptical (25.3±13.2%, p=0.002) vs. cycle.

CONCLUSION: The treadmill and the elliptical trainer promoted an higher HR response at maximal intensity, probably justified by the amount of active muscle mass and for being body-weight support exercises. The SmO2, as a local variable, shows that the technique and body-position in the elliptical trainer requires more the VL, and the treadmill requests more of the GM. This exercise mode expertise is crucial for exercise prescription.

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INFLUENCE OF EXERCISE DURATION AND TRAINING ON THE FUNCTIONAL RESERVE DURING SUPRAMAXIMAL EXERCISE TO EXHAUSTION

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INTRODUCTION: A partial recovery of exercise capacity is possible despite applying total ischaemia at the end of high-intensity exercise to exhaustion. Thus, some "functional reserve" (FR) or capacity to produce power at the same or higher level than at exhaustion exists at task failure. However, little is known about the factors that determine the FR. We aimed to determine if FR is higher when a given supramaximal exercise bout is stopped before task failure. Secondly, we aimed to determine the effects of sprint interval training (SIT) on the FR. We hypothesized that FR would depend on the level of fatigue at exhaustion and that SIT would increase the FR.

METHODS: After familiarization and VO2-relationship assessment, 29 healthy volunteers (22M/7F) performed 4 bouts of supramaximal exercise (120%VO2max) to exhaustion interspersed by 20s of ischaemia application (FRtest). On another visit, the duration of the 1st bout was limited to 40% of the time to exhaustion (TTE), followed by the 3 remaining bouts at 120%VO2max until exhaustion (shortened FR, SFR). A subgroup of 7 males followed SIT (4-6 30s sprints, 4min rest, 6 sessions in 2 wks). Leg lean mass (LLM, DEXA), performance (Lode Exc.) and cardiorespiratory variables (Vyntus) were assessed.

RESULTS: In FRtest, TTE during the 1st bout was 246±90 and 234±104 (P=0.72), work/kg LLM was 3.6±1.5 and 3.6±1.4 kJ/kg (P=0.974), O2deficit (df) was 3666±1388 and 2005±580 mL (P=0.001) in M and F, respectively. The FR (sum of 2nd and subsequent bouts) was 1.42±0.6 and 1.92±0.8 kJ/kg LLM (P=0.078), O2df was 1408±835 and 897±506 mL (P=0.14) during the FRtest, in M and F, respectively. In the SFR, FR was 3.3±1.6 and 3.4±1.8 kJ/kg LLM (P=0.91), O2df was 2656±1484 and 1476±474 mL (P=0.050) for M and F, respectively. The sum of O2df incurred in all 4 bouts was almost identical in FRtest and SFR in both sexes (4573±2111 and 4591±2192 mL, P=0.94). After training, performance in the 1st bout was largely improved (TTE by 33%, work/LLM by 33%, O2demand by 48% and O2df by 65%, all P<0.05), causing a remarkable performance enhancement during the whole supramaximal test (sum of all bouts). Training did not significantly alter the FR (P>0.05).

CONCLUSION: This research indicates that the FR is a limited and measurable variable in young, healthy males and females. These results show that the determination of the FR using repeated supramaximal bouts to exhaustion is robust, i.e., it is not influenced by a lower initial degree of fatigue in the first bout, provided that the subjects perform until task failure in the subsequent bouts. Two weeks of SIT do not augment the amount of FR, despite a marked performance enhancement during the supramaximal test. It remains to be determined whether differences in FR are present in elite athletes or modified by other training programs.

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CARDIORESPIRATORY FITNESS MEDIATES ISOMETRIC AND ISOKINETIC STRENGTH EFFECTS IN MAXIMAL FAT OXIDATION IN TYPE 2 DIABETES.

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INTRODUCTION: There is a loss of muscle mass in type 2 diabetes mellitus (T2DM) patients. Consequently, this population has decreased muscular strength and cardiorespiratory fitness (CRF). In addition, T2DM is associated with impaired fat

oxidation, a biomarker of metabolic flexibility related to muscle health. However, it remains unknown if this impairment in fat oxidation is more due to muscle strength or CRF loss. Hence, this study aimed to analyse the influence of muscular strength and CRF on maximal fat oxidation (MFO) capacity in T2DM.

METHODS: Sixty-six volunteers with T2DM (41 men, age 55±7) of the Edugution/Apetex study were evaluated in the same visit to the laboratory for testing. Body composition assessment by bioimpedance analysis was used to assess fat and lean mass. Indirect calorimetry during 30 min in a supine position at rest was used for the metabolic calculation of resting fat oxidation. Then, an incremental exercise protocol in a cycle ergometer with two consecutive phases was performed for MFO and VO2max. The first phase aimed to determine MFO, and it consisted of 3 min steps of 15W increments with a cadence of 60rpm. The test was stopped when RQ ≥1. After 5 min rest, the second phase to detect VO2max began with steps of 15W/min until exhaustion. Moreover, an Isometric knee extension test (Isom) for 6 seconds, three repetitions at 60° per second (Iso60), and 15 repetitions at 120° per second (Iso120) of knee concentric flex-ext were performed in an isokinetic dynamometer for peak and average torque. The maximal fat oxidation was estimated by interpolating the rest metabolic test, the incremental 3min step 15W test, and the VO2max test points. Linear stepwise regression and mediation analyses were performed to explain the relationship between muscular strength, CRF, and MFO with a significance of 95%.

RESULTS: The analysis by Baron and Kenny criteria shows that the Isom Peak Torque/Lean mass (Indirect Effect(I.E.): 0.189; C.I: 0.063-0.358), Iso60 Average Flexion Torque/Lean mass (I.E: 0.175; C.I: 0.073-0.313) and Iso120 Average Flexion Torque/Lean mass (I.E: 0.241; C.I: 0.110-0.409) have an indirect effect on MFO/Lean mass, and is mediated by VO2max/Lean mass. When the analysis considers only the legs for lean mass, Iso60 Average Flexion Torque/Legs lean mass (I.E: 0.193; C.I: 0.088-0.341) and Iso120 Average Flexion Torque/Legs lean mass (I.E:0.246; C.I: 0.112-0.421) have an indirect effect on MFO/Legs lean mass mediated by VO2max/Legs lean mass.

CONCLUSION: The Isom, Iso60, and Iso120 leg strength have an indirect effect on MFO and are mediated by VO2max when normalised by total and leg lean mass. CRF and lean mass are determinants of fat oxidation, and the results suggest that muscular strength needs to be considered as a complementary factor in the T2DM population. Grants: 1) PID2019-110063RA-I00. 2) PID2020-120034RA-I00. 3) LI19/21IN-CO09

Invited symposia

IS-BM02 Strategies for musculoskeletal loading modification to reduce injury risk in running

SELF-OPTIMIZED RUNNING STYLES: SHOULD WE CHANGE THE WAY WE RUN?

VANWANSEELE, B.

KU LEUVEN

Watching people run, it is evident that there is a substantial variability in how we move forward. Although the movement is very similar as everyone adopts a bipedal gait and puts one foot in front of the other to move forward, each runner runs with their own preferred running style including a self-selected speed, stride frequency and foot strike pattern. This preferred running style adapted by runners is metabolically optimal for them, i.e. the pattern that allows minimal energy consumption. Hence, energy minimization is often assumed to be one of the major neuromuscular mechanisms underlying the preferred gait. In addition, good exercise economy is beneficial for performance in endurance running. Changing to a forefoot strike pattern increases the gastrocnemius medialis muscle force, indicating larger metabolic cost. However as these muscles are working at a lower contraction velocity they do not consume more metabolic energy. In addition, preferred stride frequency reflects a trade-off between minimizing metabolic rate during stance by a high stride frequency, without excessively increasing the cost of leg swing or reducing the available time to produce the necessary forces.

In contrast, recommendation were made over the last decade to change the running pattern to reduce the musculoskeletal load on specific parts of the human body and reduce injury risk. A multitude of these retraining strategies can be founded in the literature (including changing foot strike pattern, increasing stride frequency and increasing duty factor) and have the ultimate goal to reduce the number of running injuries. However, as running injuries are a complex multifactorial interplay between intrinsic and extrinsic factors, a first step is to investigate what the effect of changing the running style is on musculoskeletal loading in the short-term term and to demonstrate that these changes can be learned and retained over time. There is conflicting and limited evidence for the short-term effect of gait retraining on the loading of the targeted joint. In addition, changing the load in one joint could affect the load in adjacent joints. In addition, if the metabolic energy is increased the runner might fatigue faster which could lead on itself to changes in running style and increased injury risk. It is therefore important to get a more holistic (load on the complete lower legs) overview of the effect of changes in running patterns and how these might change due to fatigue throughout a training session. This talk will present an overview of evidence on the short and long-term effects of gait retraining on reducing the loading on the targeted and the adjacent joints, and what evidence there is on potential changes during the training.

Trainers and sport medical staff could benefit from more holistic insight in the effects of running retraining.

EFFECT OF WEARABLE-BASED REAL-TIME FEEDBACK ON MUSCULOSKELETAL LOADING TO REDUCE INJURIES

VAN HOOREN, B.

MAASTRICHT UNIVERSITY

Repetitive tissue loading during the ground contact phase of running leads to microdamage. This microdamage can accumulate and eventually lead to a running-related injury when accompanied by insufficient time for remodelling and adaptation. Tools that can provide (real-time) feedback on the load applied to common injured tissues may therefore be helpful to reduce running injury risk.

Due to the importance of load in the development of running injuries, an increasing number of wearables is estimating biomechanical loading variables such as the ground reaction force or ground reaction force correlates (e.g. tibia shock, vertical loading rate) based on the assumption that these measures provide useful estimates of the forces experienced by tissues within the body such as bones and tendons. However, these surrogate measures do not always accurately reflect the force experienced by tissues within the body, and therefore, the use of these surrogate measures to predict or prevent injuries can be misleading. Further, since tissue load has a non-linear relationship with tissue damage, measures of tissue load also need to be translated to tissue damage to more accurately inform on potential adjustments to training.

The main purpose of this talk will be to discuss 1) research on quantifying loading and damage at common running injury locations using wearable technology and 2) the effect of wearable-based real-time feedback on this load to reduce injury risk in-field. The talk will finish with a discussion of the limitations to current approaches for quantifying load and damage at common injury locations and highlight some future research requirements to overcome such limitations.

Overall, the quantification of tissue loading with wearable technology and the provision of real-time feedback to reduce loading on certain tissues may be useful to reduce injury risk. However, further research is required to better individualize the load and damage estimations by incorporating individual-specific tissue characteristics such as tendon stiffness and/or bone cross-sectional area. Finally, feedback models should also incorporate the process of adaptation and re-modelling and be able to differentiate between different training levels to ensure appropriate recommendations.

The target audience includes individuals interested in running injury prevention, biomechanics and sports performance.

THE RUNNING SHOE AS A STRATEGY TO MODIFY MUSCULOSKELETAL LOADING AND PREVENT RUNNING-RELATED INJURIES

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Running can be practiced almost everywhere and requires mainly a pair of "appropriate" running shoes. However, the term "appropriate" is ambiguous, and the properties of running shoes has always generated hot debates among clinicians, coaches and athletes, whatever the level of practice. Indeed, the main drawback of regular running practice is the high incidence of musculoskeletal injuries, which is considered a major barrier to continued participation. The running shoe may potentially play an important role in injury prevention as it represents the main interface between the foot and the ground. Consequently, some shoe features may influence the burden of repetitive external and internal mechanical load applied to the musculoskeletal system. Over the last decades, running shoes have been prescribed based on matching shoe features to foot morphology. Furthermore, shoe cushioning technology is expected to protect runners against repetitive loading of the musculoskeletal system. Conversely, some schools of thought have promoted the use minimalist footwear. Overall, it is a popular belief that footwear is one of the main extrinsic factors influencing running-related injury risk. Despite the constant progress in running shoe technology, injury rate seems to remain high. The main purposes of this talk will be 1) to clarify what scientific evidence is available for clinicians and coaches to provide the runners with advice for the choice of "appropriate" running shoes with the view to reducing injury risk, and 2) to explore the underlying mechanisms that may explain the possible protective effect of some shoe features.

Overall, it is still too early to formulate evidence-based prescriptions regarding the choice of running shoe features. Nevertheless, some results suggest that certain shoe features may be of benefit to specific subgroups of runners. The few randomised trials conducted so far still need to be confirmed before any shoe prescription guidelines are scientifically justified. Caution should be taken when generalizing these preliminary findings from research, as well as when facing simplistic explanations and common sense. The impact of the biomechanical modifications induced by shoes features on injury risk has also been poorly investigated. Furthermore, inappropriate biomechanical variables have been used, especially when investigating shoe cushioning. More studies investigating the effect of shoe features on both running biomechanics and subsequently on injury occurrence are needed. Indeed, the size of the effect of shoe features on running biomechanics may be small and considered not "clinically relevant", but the accumulated effect over the thousands of steps of each running session may represent a substantial difference in the cumulative load applied to the musculoskeletal system. The consequence on the health of the athlete can only be assessed through a prospective collection of complaints.

Oral presentations

OP-AP39 Running Physiology

RUNNING ON ROAD OR TRAIL, WHAT IS THE DIFFERENCE IN ENERGY COSTS AND PERCEIVED EXERTION

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INTRODUCTION: Over the last decade trail running has become popular and more and more runners cross-train on both surfaces (1,2). Although several studies have described the differences between road and trail running, as well as the associated risk of injury (3), relatively little is known about the differences in physical demands and subjective perceptions during road and trail running and especially during running uphill and downhill running. Therefore, the aim of this study was to determine if physiological responses and ratings of perceived exertion differ between running on tar (road) or gravel (trail).

METHODS: An a priori sample size of twenty well-trained runners (25±5 yrs) who were accustomed to both trail and road running participated in the study. All participants completed a peak treadmill running speed (PTRS) test as well as 4 sub-maximal outdoor runs. All subjects performed 2 trail and 2 road runs, one at 50% add the other one at 60% of PTRS. The profile of the trail and road course were identical and existed of 500m of downhill running and 500m of running uphill (11%). Heart rate (HR) and oxygen consumption (VO2) were captured during the run, while a rating of perceived exertion for the uphill and downhill section was captured directly after each run. Data were analysed with a 3-way ANOVA (condition, speed, gradient), while a posthoc Tukey test was performed when significance was found.

RESULTS: No differences in any of the physiological responses or the ratings of perceived exertion were between running on trail or road. However, significant differences were found when running downhill, at both 50% and 60% of PTRS. Mean HR (10±6 bpm at 50%PTRS & 10±4 at 60%PTRS, p<.0001)) and VO2 consumption (3.9±1.6 ml·min-1·kg-1 at 50%PTRS & 3.8±1.2 ml·min-1·kg-1 at 60%PTRS, p<.0001) were higher and running economy was poorer(17.1±9.2 ml·min-1·km-1 at 50%PTRS & 16.0±8.0 ml·min-1·kg-1 at 60%PTRS, p<.0001) when running downhill on trail. Interestingly RPEs were similar for both the uphill and downhill sections between the road and trail condition at both speeds.

CONCLUSION: The costs of running downhill at the same speed on trail are significantly higher than on a road (Heart rate: 7 to 8%; VO2: 17 to18%, running economy: -17 to -18%). However, runners report similar ratings of perceived exertion when running on trail or on road. This mismatch of higher energy cost and similar subjective perceptions might result in trail runners over-pacing themselves while running downhill in trail running. In addition, this mismatch might increase the risk of injuries as runners might also not be aware of faster-rising levels of accumulated fatigue while running downhill on trails.

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EFFECTS OF NIKE VAPORFLY NEXT% SHOES ON RUNNING ECONOMY, BLOOD LACTATE CONCENTRATION, AND ENERGY EXPENDITURE – A SINGLE CASE FIELD STUDY

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LEISTUNGSSPORT AUSTRIA

INTRODUCTION: Since several years carbon plate shoes are commonly used in long distance races and also the fastest marathon ever was performed with these shoes. Recent works suggest that high-level runners notably benefit from wearing carbon plate shoes compared to traditional lightweight shoes [1], however, results for sub-elite and recreational runners are controversial [2]. The major limitation of recent studies is that the running tests were performed on a treadmill which clearly lacks ecological validity. Therefore, we performed a field test to assess running economy and metabolic response.

METHODS: A 40-year-old age-group triathlete (stature: 1.82 m, body mass: 74 kg, VO2max: 57 mL/min/kg) performed four 1,200 m runs on a 400-m outdoor athletics track. Two runs were performed at 3.33 m/s wearing either Nike Vaporfly Next% (NEO) or Asics DS Trainer (TRAD). After that two additional runs at 4.17 m/s were performed using NEO and TRAD. All runs were performed below critical speed in order to ensure steady state conditions in oxygen uptake. Passive rest periods between the 1,200-m runs were 15 min. During all runs respiratory gases and ventilation were measured breath-by-breath using a mobile gas analyser (MetaMax-3B, Cortex Biophysik GmbH, Germany). After each run a blood sample from the earlobe was obtained to assess blood lactate concentration. Samples were analysed subsequently using an automated lactate analyser (Biosen_C, EKF diagnostics, Germany).

RESULTS: Respiratory exchange ratio was below 1.00 in all runs (range: 0.83 to 0.95). Running economy at 3.33 m/s was 219 and 207 mL/kg/km (-5.5%) for TRAD and NEO, respectively and at 4.17 m/s was 212 and 197 mL/kg/min (-7.0%) for TRAD and NEO, respectively. Similar to running economy, blood lactate concentration was lower in NEO at 3.33 m/s (2.0 vs. 2.1 mmol/L; -5.0%) and also lower for NEO at 4.17 m/s (5.8 vs. 6.2 mmol/L; -6.9%) compared to TRAD. Total energy

expenditure at 3.33 m/s was 1066 J/s and 1036 J/s (-2.8%) for TRAD and NEO, respectively. At 4.17 m/s total energy expenditure was 1274 J/s and 1197 J/s (-6.0%) for TRAD and NEO, respectively.

CONCLUSION: The results of this single-case overground running study suggest that amateur athletes can benefit from wearing carbon plate shoes to a greater degree at higher speeds. Independent of running speed, running economy was notably superior when wearing the carbon plate shoe compared to the traditional lightweight shoe. Furthermore, muscle metabolic stress (i.e., blood lactate concentration) and total energy expenditure (i.e., oxidation of fat and carbohydrates) were considerably lower when using the carbon plate shoe. The findings of this field study are in accordance with recent findings obtained from treadmill running tests which recommend the use of carbon plate running shoes when aiming to elevate running performance by enhancing running economy and lowering muscle metabolic stress.

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BRIDGING THE GAP BETWEEN CRITICAL VELOCITY AND MAXIMAL LACTATE STEADY-STATE

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INTRODUCTION: The ability to sustain a high metabolic rate for an extended period of time is essential for endurance performance and reflects the interplay between the aerobic and anaerobic metabolism [1]. The most frequently used parameters in that regard are the onset of blood lactate accumulation (OBLA), maximal lactate steady-state (MLSS) and critical velocity (CV). These concepts have been discussed extensively in recent reviews [2,3]. Despite the overwhelming general observation that CV overestimates MLSS, the origin of this discrepancy is still unknown [3]. This study examines the CV-MLSS difference and analyses whether physiological parameters may help to bridge the gap between concepts.

METHODS: A total of n=19 well-trained runners/triathletes performed several lab tests to determine maximal lactate accumulation rate (ċLamax), maximal oxygen uptake (V̇O2max), fractional utilization (%V̇O2max), running economy (RE), maximal fat oxidation rate (MFO), OBLA and MLSS. Furthermore, time trials (TTs) over 1, 2 and 3 km were performed on an outdoor track to determine CV and D' by the linear t(d) model [4]. Post-exercise lactate concentration was recorded immediately after the TTs as well as 3 and 6 min afterwards. Repeated measures ANOVA and Bland-Altman plots were used to analyse differences between OBLA, MLSS and CV. The absolute difference between CV and MLSS was correlated with several physiological parameters.

RESULTS: TTs were performed in 174±10, 385±25 and 607±47 s, respectively. The corresponding maximal post-exercise lactate concentrations were 14.8±2.8, 13.8±2.9 and 12.3±2.28 mmol/L, respectively. OBLA (4.25±0.49 m/s), MLSS (4.15±0.49 m/s) and CV (4.66±0.42) differed significantly among each other. Limits of agreement for CV-MLSS ranged between +0.13 and +0.88 m/s, while the mean relative difference was 12.5±5.6%. CV and MLSS shared ~85% of their variance. The only physiological parameters that significantly correlated with the CV-MLSS difference were maximal post-exercise lactate concentrations following the 2 km (r=0.558, p=0.013) and 3 km (r=0.645, p=0.002) TTs. RE demonstrated a positive tendency (r=0.409, p=0.082).

CONCLUSION: Our findings show that individuals with higher post-exercise lactate concentrations after the 2 and 3 km TTs demonstrate larger CV-MLSS differences. High concentrations might reflect the participants' effort during the TTs which result in a higher estimation of CV. Previous research in soccer players found no significant difference between OBLA and MLSS and a lower mean relative CV-MLSS difference of ~10% [5]. This might be due to the applied TTs (1.5 and 3 km) and/or their lower performance levels in terms of MLSS (3.64±0.36 m/s). Future research should expand the selection of physiological parameters and perform such analyses for the relative CV-MLSS differences.

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PERSPECTIVES OF DETRENDED FLUCTUATION ANALYSIS (DFA) OF HEART RATE VARIABILITY (HRV) FOR EXERCISE PRESCRIPTION AT THE BOUNDARY OF MODERATE TO HEAVY INTENSITY

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INTRODUCTION: The non-linear index alpha 1 of DFA (a1) of HRV has been shown to be a promising biomarker especially for the transition between moderate to heavy intensity domain and for real-time exercise intensity feedback [1,2,3]. However, since validation data on prescribed prolonged exercise bouts are still scarce the true significance for exercise prescription remains to be fully elucidated. Therefore, the present pilot study aims to evaluate its ability to prescribe and monitor exercise intensity at the transition between moderate and heavy domain during a continuous running bout.

METHODS: 21 moderately trained endurance athletes (9w, 12m; age: 25.9±3.6years, height: 178.4±9.9cm, body weight: 70.8±8.7kg, body fat: 12.2±4.4%, maximum heart rate: 198.4±7.9bpm, maximum oxygen consumption (VO2peak): 59.0±8.3 ml/kg/min) performed an exhausting ramp test in which running speed (RS) at first ventilatory threshold (RSVT1)

and at DFAa1=0.75 (RSa1) were determined. Afterwards, a 20-min continuous running bout at RSa1 (20minRSa1) was administered. Blood lactate concentration (BLC) was assessed after 20minRSa1 and VO2, HR and DFAa1 (window width: 120s, grid interval: 10s) were continuously recorded and statistically evaluated.

RESULTS: The prescribed external load of RSa1 (10.6±2.0km/h) was similar to RSVT1 (10.8±1.7km/h; p=0.209) and yielded mean HR of 154.6±12.3bpm, mean VO2 of 38.1±6.0ml/kg/min, mean DFAa1 of 0.84±0.24 and BLC of 1.56±0.59mmol/l at the end of 20minRSa1. In comparison of start and end of 20minRSa1 HR showed a significant increase from 152.2±12.2 to 158.4±13.0bpm (p<0.001, d=0.51), while VO2 and DFAa1 remained rather stable with 37.9±5.7 vs. 38.5±6.3ml/kg/min (p=0.06, d=0.10) and 0.85±0.29 vs. 0.78±0.23 (p=0.112, d=0.24), respectively. Linear regression slopes supported these results with 0.0724±0.0447 for HR, 0.0083±0.0130 for VO2, and -0.0009±0.0028 for DFAa1, respectively.

CONCLUSION: Our data in endurance running supports the general notion that DFAa1 of 0.75 is promising for internal load-based exercise prescription at the boundary of the moderate to heavy intensity domain [3]. Inter-individual differences and the fact that RSa1 target led to reduced values of DFAa1<0.75 in some participants (n=5) implies the need for internal load-based real-time monitoring and intra-individual internal-to-external load analysis as a regular biological calibration procedure. Furthermore, future studies should compare continuous exercise bouts of different exercise intensity domains to elucidate possible decoupling mechanisms of DFA a1 and other internal load measures in relation to external load, as this may also bear potential for durability assessment of endurance exercise performance.

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INDIVIDUALIZED LOW-INTENSITY JOGGING WITHIN RECOVERY ZONE 1 INCREASES THE ABILITY OF ENERGETIC RECOVERY IN PROFESSIONAL SOCCER PLAYERS

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INTRODUCTION: This study aimed to investigate whether individualized low-intensity jogging (ILIJ) within the recovery zone 1 (RZ1) before lactate threshold 1 (LT 1) increases energetic recovery and general endurance capacity (zones 1, 2, and 3) in Korean professional soccer players.

METHODS: Twenty-four professional soccer players in the Korea professional Football League (n = 24, age: 24.53 ± 4.85 years, height: 180 ± 6.30 cm, body mass: 75.86 ± 8.01 kg, body fat: 12.19 ± 2.69%) participated in the study. During a free season, the 1-h ILIJ intervention involved 27 sessions spanning nine weeks and jogging speed corresponding to 72% of LT 1 (7.15 ± 0.95 km·h−1). Pre- and post-LT testing parameters determined within 9 weeks included blood lactate concentrations (La−) and heart rate (HR) at certain exercise intensities during LT test. The jogging/running speeds (S), delta (Δ) S, HR, and ΔHR were analyzed at 1.5, 2.0, 3.0, and 4.0 mmol·L−1 La−, respectively.

RESULTS: Levels of La− and HR at the same exercise intensities (5.4–16.2 km·h−1) in the post-LT test compared with pre-LT test were significantly reduced ($P < 0.05$ and $P < 0.01$, respectively). Moreover, S at all specific La− levels (1.5, 2.0, 3.0, and 4.0) were significantly increased, while HR at 2.0, 3.0, and 4.0 La− decreased significantly ($P < 0.05$ and $P < 0.01$, respectively). Low to moderate positive associations were found between ΔS and ΔHR at 1.5 and 2.0 La− ($r = 0.52$; $R2 = 0.27$ and $r = 0.40$; $R2 = 0.16$, respectively).

CONCLUSION: The nine-week ILIJ within RZ1 increased energetic recovery and general lactate exponential curve (rightward shift) in professional soccer players. This effect relates to repeated high-intensity intermittent sprints during the 90-min soccer game.

Oral presentations

OP-BM07 Neuromuscular Physiology: Fatigue II

PERIPHERAL ALTERATIONS AND INCREASED PERCEIVED FATIGUE CONTRIBUTE TO ACUTE CROSSOVER FATIGUE AFTER A UNILATERAL SUBMAXIMAL ECCENTRIC KNEE FLEXOR EXERCISE

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INTRODUCTION: After a unilateral muscle exercise, the performance of the non-exercised muscle of the contralateral limb may also be impaired. Although previously evidenced, this phenomenon known as "crossover fatigue" [1] is still debated in the literature. The variability of the study designs (e.g., age, sex, training status, upper vs lower body muscles…) participates to this debate [2]. While often used in resistance training and/or rehabilitation programs, only four studies have investigated the influence of eccentric contractions (ECC) on crossover fatigue and have reported discrepant outcomes. Therefore, this study was designed to assess the etiology of crossover fatigue of the non-exercised contralateral knee flexor muscles after a unilateral submaximal ECC fatiguing exercise of the ipsilateral muscles.

METHODS: Seventeen healthy young men were evaluated before (PRE), immediately after a unilateral submaximal ECC knee flexor exercise (POST) and 24 hours later (POST24). ECC exercise was performed in the exercised limb (EL) until a 20% decrease in maximal voluntary isometric contraction (MVIC) was reached. Neuromuscular function (i.e., MVIC, voluntary activation and electrically muscle contractions evoked at high and low frequency [Dt100Hz and Dt10Hz, respectively]) were measured in both the EL and non-exercised limb (NEL). Perceived muscle soreness was measured in both the EL and the NEL and global perceived fatigue was also assessed.

RESULTS: At POST, the reduction in maximal voluntary isometric contraction observed in the EL was -28.1 ± 6.5% ($p < 0.001$) and a crossover fatigue occurred in the NEL (i.e., maximal voluntary isometric contraction decrease of -8.5 ± 16.2%; $p < 0.05$). At POST, voluntary activation decreased in the EL only (-6.0 ± 8.2%; $p < 0.05$) while electrically muscle contractions evoked at high and low frequency were impaired in both limbs (i.e., -11.6 ± 17.9% and -8.07 ± 24.2%, respectively; $p < 0.05$). Global perceived fatigue was significantly increased at POST ($p < 0.001$). Although the maximal voluntary isometric contraction of both limbs had returned to PRE values at POST24, perceived muscle soreness scores were higher than PRE values in the EL ($p < 0.05$) whereas perceived muscle soreness did not change in the NEL.

CONCLUSION: This study is the first to highlight the occurrence of crossover fatigue on the knee flexors (-9%). In the EL, both central (i.e., reduced VA) and peripheral (i.e., impaired muscle evoked contractions) alterations accounted for the observed reduction in maximal voluntary isometric contraction. In contrast, given the significant reductions in muscle evoked contractions in the NEL, only peripheral alterations possibly involving systemic adaptations participated to the crossover fatigue observed at POST. Finally, increased global perceived fatigue could be involved in the impairment of maximal voluntary isometric contraction in both limbs.

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REPEATED EXPLOSIVE CONTRACTIONS OF DORSIFLEXOR MUSCLES AFFECT THE MAXIMAL VOLUNTARY FORCE, RATE OF FORCE DEVELOPMENT AT MAXIMAL AND SUBMAXIMAL LEVELS, MAGNITUDE AND COMPLEXITY OF FORCE FLUCTUATIONS

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INTRODUCTION: The loss of maximal voluntary contraction (MVC) is considered the most valid and widespread approach to measuring muscle fatigue. However, in many daily and sporting activities, the time required to develop maximal or submaximal force is longer than the time available to develop it. The rate of force development (RFD) is considered a valid indicator of neuromuscular fatigue (1) measured in explosive contractions targeting both maximal and submaximal force levels. Moreover, the changes in the magnitude and complexity of force fluctuations may have important functional consequences, given that the accuracy of voluntary movements is often more important for successful performance than maximal force-generating capacity (2). Considering the relevance of daily life and sports gestures to quickly produce maximal and submaximal forces, the aim is to understand fatigues effect on quick contractions targeting submaximal forces and the magnitude and complexity of force fluctuations.

METHODS: 14 male adults (32±6 yrs) visited the laboratory for familiarization and assessment. The participants were seated with the ankle inserted in the dynamometer with 64-channel HDsEMG placed over the tibialis anterior. PRE and POST fatiguing task an MVC and 12 ballistic isometric contractions at 30, 50, and 70% of MVC were performed. The fatiguing task consisted of a series of explosive contractions, interspersed by 4s, with a holding phase of 6s at 70% of MVC until failure. We considered the submaximal explosive contractions assessed PRE and POST and the first three and last three contractions of the fatiguing task for analyses.

RESULTS: PRE vs. POST fatiguing task the MVC, peak force and RFDpeak decreased respectively by 37, 21 and 40%. Time to peak force and time to peak RFD increased respectively by 43 and 18%. RFD assessed at 50, 100, and 150 ms decreased respectively by 36, 47 and 46% (all $p \leq .05$). RMS at 50, 100 and 150 ms assessed PRE and POST showed no statistically significant changes. The coefficient of variation changed from 1,6 to 2,7% and the mean force changed from 267,8 to 226,3 N·m. Approximate entropy decreased from 0.174 to 0.132 and the detrended fluctuation analysis changed from 1.57 to 1.73 (all $p \leq .05$). ANCOVA showed after the fatiguing task an RFD decreased at 50, 100 and 150ms during contractions at all submaximal levels.

CONCLUSION: The fatiguing task worsened the force production capacity and control overall which was evidenced by a decreased MVF, a longer time to peak force, a lower RFD, greater force fluctuations and lower force complexity. Of note, RFD, and time to peak force were evidenced also in explosive contractions targeting submaximal force levels. Overall, these results showed that fatigue reduces the neuromuscular systems adaptability over various dimensions.

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NEUROMUSCULAR FATIGUE IMPROVEMENTS AND HEAT ADAPTATIONS CAN BE PRESERVED 20 DAYS AFTER HEAT-ACCLIMATION.

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INTRODUCTION: Adaptations to short-term (<7 exposures) heat-acclimation (HA) decay rapidly and are lost within 2 weeks, likely compromising pre-competition/deployment training [1]. 6-days of post-exercise hot water immersion (HWI) has been suggested to retain heat adaptations for 2 weeks [2]. However, the effects of this method on overall fatigue (e.g. neuromuscular, cognitive and perceived) remains unknown and may compromise training. This study aimed to i) investigate the effect of 6-days post-exercise HWI on neuromuscular, cognitive and perceived fatigue pre and post exercise in a hot environment; ii) examine the effect of one maintenance session of post-exercise HWI per week on overall fatigue during 20 days of HA decay.

METHODS: 10 healthy males (22±3 yrs, 78±18 kg) completed HA: 6-days of post-exercise (running at 65% VO2max for 40min, 22°C) HWI (40min, 40°C). A Heat Tolerance Test (HTT = running 30min at 9km.h-1 2% slope at 40°C, 40% humidity) [3] was performed pre and post HA. Every 6 days post HA, a maintenance post-exercise HWI session was performed and a HTT was completed post10 and 20 days. Maximum voluntary contraction of the quadriceps (MVC), central [voluntary activation (VA)] and peripheral alterations [high-frequency doublet (Db100), twitch (Pt)] were evaluated pre and post each HTT. Cognitive performances (accuracy, reaction time, omission) to response inhibition (Stroop) and working memory (3back-letter) were performed pre and post each HTT. Perceived fatigue (ROF scale) was evaluated each day. Two-way repeated measure ANOVAs and Holm correction for post-hoc tests were performed.

RESULTS: Increase in rectal temperature and heart rate at rest and during the HTT were lower post HA compared to pre and sustained post20 (all $p<0.001$). Expansion in plasma volume and sweat rate, observed post HA, were not sustained post10 (respectively, $p=0.02$ and $p=0.04$). VA pre-post HTT was better preserved post HA and sustained post20 ($p=0.002$). Decrease in MVC, Db100 and Pt due to HTT was not different pre and post HA (respectively, $p=0.3$, $p=0.3$ and $p=0.2$). Accuracy to cognitive tasks was not impacted by HTT ($p=0.7$) but reaction time was faster post HTT compared to pre ($p=0.002$). All cognitive performances were improved after HA and post20. Perceived fatigue was stable during HA to post20 ($p=0.4$).

CONCLUSION: HA of 6 days post exercise HWI induced beneficial HA related adaptations (lower rectal temperature and heart rate, higher plasma volume and sweat rate); re-trained once a week, some of these adaptations were sustained for 20 days. HTT alterations on central component were limited by HA, and it was preserved for 20 days, while peripheral alterations were not. This simple, practical and effective HA strategy does not induce additional fatigue, and may preserve central function, during an exercise in a hot environment.

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ACCELERATED RECOVERY OF NEUROMUSCULAR FUNCTION FOLLOWING LOW-LOAD CONTINUOUS BLOOD FLOW RESTRICTION EXERCISE COMPARED TO HIGH-LOAD RESISTANCE TRAINING

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INTRODUCTION: Low-load resistance training with blood flow restriction (BFR) can elicit skeletal muscle adaptations that are similar in magnitude to high-load (HL) training, albeit with much less mechanical loading (1). However, there is limited understanding of the acute fatigue and recovery timelines with BFR exercise, and how these compare to typical HL training practices. Such insight would inform practitioners and coaches in successfully implementing BFR exercise in athletic cohorts.

METHODS: Twelve strength-trained males (22.3 +/- 3.2 years; height: 182.1 +/- 6.3 cm; body mass: 84.1 +/- 9.0 kg) performed four sets of squat-based exercise under four different conditions: (a) low-load resistance exercise (LL, 30%1RM); (b) high-load resistance exercise (HL, 70%1RM); (c) LL with intermittent blood flow restriction (BFR-I); and (d) LL with continuous blood flow restriction (BFR-C). LL conditions performed four sets of 30, 15, 15 ,15 repetitions, whereas HL performed four sets of 10 repetitions. Neuromuscular fatigue was evaluated by quantifying repetition velocity during exercise, and changes in isometric strength and jumping performance following exercise. The twitch interpolation technique was utilised during isometric contractions to investigate the origin of fatigue. Perceptions of effort were recorded before and after each set of exercise using a modified Borg exertion scale (CR-10).

RESULTS: Peak and average repetition velocities progressively slowed across the four sets with HL and BFR-C (~−5-8%) and this was significantly different to LL and BFR-I (~+4-7%; $p<0.05$). Perceptions of effort increased with exercise in all trials (all $p<0.01$), however this increase was greatest with BFR-C and HL equally (all $p<0.01$). At 60 minutes post-exercise, peak voluntary torque (PVT) and peak twitch torque (PTT) remained significantly below baseline levels with HL only ($p<0.05$). Jump height was also significantly impaired only following HL (~−15%; $p<0.01$) post-exercise. Rate of force devel-

opment (RFD) during the isometric and jumping tasks were similarly impaired in HL and BFR-C (~−18%; p<0.01). Voluntary activation (VA) did not change following any of the exercise trials (all p>0.05).

CONCLUSION: In conclusion, both BFR-C and HL squat exercise appears to induce significant neuromuscular fatigue during exercise, which resulted in slowed repetition velocities and greater perceptions of effort. However, unlike HL, it appears that several markers of neuromuscular fatigue are diminished within 60 minutes following continuous BFR exercise with LL. In particular, the PTT responses suggest that fatigue of peripheral origin may persist at 60 minutes post-exercise with HL but not BFR-C. The outcomes of this investigation may provide benefit to coaches within the competitive season, when caution is taken to balance the effects of fitness and fatigue on athletic performance.

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PHYSICAL FATIGUE IN SPRINTING FORCE-VELOCITY PROFILE: EFFECT OF MATURATION IN RUGBY PLAYERS

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INTRODUCTION: The effects of fatigue on neuromuscular function in adolescence are poorly researched, despite the potential impact on managing training loads and recovery in maturing children 1. Impaired sprint performance is commonly used as an indicator of fatigue but does not provide information on underlying biomechanical parameters of theoretical maximal force and velocity (F0 and v0) which are also impacted by growth and maturation. Only a few studies have investigated the effect of physical fatigue on force-velocity-power qualities of sprinting in rugby players 2,3. Furthermore, neuromuscular fatigue differs according to maturation. This study aimed to assess the effect of maturation on the impact of physical fatigue on F-v profile and sprint performance.

METHODS: This study involved 15 prepubertal (Pre) (155 ± 8 cm; 46.2 ± 8.6 kg) and 17 post-pubertal (Post) (179 ± 7 cm; 75.3 ± 8.9 kg) rugby players, who underwent 2 experimental sessions separated by at least 24 hours. Anthropometric characteristics and maturity status were assessed in the first session. In the second session and after a standardised 15-minute warm-up, subjects performed 7 blocks consisting of a 30m sprint and 5 minutes of high-intensity exercise (accelerations, decelerations, etc.) with one minute of passive recovery. Raw speed-time data for 7 maximal 30m sprints were measured with a radar (Stalker ATS II). The decrement in performance was assessed through a fatigue index (FI) computed from 30m times4. To analyse the effect of physical fatigue on the F–v profile, technical parameters, and sprint performance according to maturation and block (B1 to B7), a mixed two-way repeated measures analysis of variance was performed.

RESULTS: Significant main effects of block were found for Pmax, v0, 30m time, RFmax, and DRF ($p < 0.0001$ for all) with no significant differences between groups. For Pre and Post, deltas (Δ %) between B1 and B7 for Pmax, v0, 30m time, RFmax and DRF were -15% and -20%; -11% and -10%; +10% and +11%; -5% and -9%; +8% and +5%, respectively. They were all non-significant. Only F0 showed a significant main effect of block ($p < 0.0001$) and maturation ($p = 0.02$). Deltas were -5% and -12% for Pre and Post without significance. The intensity of the fatiguing task was controlled using the rate of perceived exertion and FI for which there was no significant effect between groups.

CONCLUSION: The results showed a decrease in all parameters for both groups due to the fatiguing protocol, with no significant differences between Pre and Post (except for F0). However, none of the deltas was significantly different. The differences in F0 did not impact Pmax and sprint performance. Finally, both groups experienced similar fatigue kinetics, regardless of maturation (similar FI).

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Oral presentations

OP-AP23 Interval Sprint Training

EFFECT OF DIFFERENT EXERCISE-TO-REST RATIOS DURING REPEATED-SPRINT TRAINING IN HYPOXIA INCLUDED IN A CLASSICAL ALTITUDE CAMP

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INSEP

INTRODUCTION: Repeated-sprint training in hypoxia (RSH) is a popular and effective way of improving physical performance compared to similar training in normoxia. Repeated sprint training consists of "all-out" efforts of short duration (<

30 s) interspersed with short incomplete recoveries (<60 s) [1]. RSH efficiency relies on hypoxia severity, but also on effort duration and exercise-to-rest ratio [2,3]. However, the responses to RSH when combined with prolonged altitude exposure remain scarce. The aim of this study was therefore to assess the effect of two RSH training protocols with different exercise-to-rest ratios during a classical altitude camp.

METHODS: 16 players from the French national female rugby sevens team completed a 3-week natural "live high-train high" altitude camp at Font Romeu (1800 m asl) in preparation of the 2022 Rugby World Cup sevens. This camp included 5 RSH sessions performed on a bicycle ergometer in a hypoxic room (simulated altitude of 3000 m asl) with varying exercise-to-rest ratios of 1:2 to 1:3 (velocity-based group, n = 7) or 1:2 to 1:5 (aerobic-dominant group, n = 9) based on players' physical profile. Heart rate, peripheral oxygen saturation (SpO2) and rating of perceived exertion (RPE) were monitored during the first and last RSH session, as well as peak power output (PPO), mean power output (MPO) and sprint decrement score (Sdec).

RESULTS: PPO and MPO significantly improved from the first to the last training session (main effect, PPO: from 895 ± 104 to 977 ± 127 W, $p < 0.001$, Cohen's d = 0.70; MPO: from 690 ± 74 to 744 ± 93 W, $p < 0.001$, Cohen's d = 0.63), irrespective of the training protocol (interaction effect: $p > 0.05$). Sdec remained unchanged from the first to the last session (22.5 ± 5.7 vs 23.4 ± 7.6%, main effect: $p > 0.05$, Cohen's d = 0.13). The acute decrease in SpO2 remained similar throughout the training period despite a large effect size (82 ± 4 vs. 79 ± 5%, $p > 0.05$, Cohen's d = 0.75), without any group nor interaction effects (both $p > 0.05$). Interestingly, the velocity-dominant group perceived RSH training as harder than the aerobic-dominant group (RPE: 18.1 ± 0.8 vs. 16.6 ± 1.8 AU, $p < 0.01$, Cohen's d = 1.12), without any evolution over the training period ($p > 0.05$).

CONCLUSION: Adding five sessions of repeated-sprint training in hypoxia results in performance improvements during a classical altitude camp, independently of the imposed exercise-to-rest ratios. Whether manipulating exercise and recovery duration results in different beneficial effects of the metabolic pathways under hypoxic stress needs further investigations, as well as their combination with chronic hypoxia-induced haematological adaptations.

IMPROVEMENTS IN MAXIMAL OXYGEN UPTAKE PLATEAU AFTER TWO WEEKS OF SPRINT INTERVAL TRAINING.

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INTRODUCTION: Previous interventional studies ranging from 2 to 12 weeks of sprint interval training (SIT) have reported significant and consistent improvements in maximal oxygen uptake (VO2max) (1). The physiological adaptations behind these improvements tend to occur early within the training program and involve principally peripheral-related changes such as increased oxidative capacity due to a better muscle capillarization, and/or upregulation of enzymatic activities (2). However, although exercise intensity seems to be a key factor for mediating most of the improvements (2), no clear relationship between the length of the training programs and the magnitude of improvements has been identified for SIT (1). This study aimed to determine whether a positive association exists between total training time and the gains in VO2max induced by a SIT program.

METHODS: 13 non-active and healthy individuals performed three all-out training sessions per week involving 15 s sprints interspersed with 2 minutes of recovery on a cycle ergometer. The 6-week training program was divided into three 2-weeks blocks in which training volume was increased from 10 to 14 repetitions over the first four sessions and was reduced to 8 in the last session of each block. The power output (PO) during the sprints was recorded in every session. Isometric maximal voluntary contraction of the knee extensors (iMVC), power-force-velocity profile (PFVP), and VO2max were assessed every two weeks from the baseline to examine the time-course of training-induced changes (Pre, Week2, Week4, Week6). An additional evaluation was performed one week after the end of the training period (Week7).

RESULTS: A significant increase in VO2max (8.7 ± 4.2%; $p<0.001$) was observed at Week2 compared to Pre with no further differences observed at the subsequent time points. The iMVC and the maximal power output obtained from the PFVP did not change throughout the training program ($p=0.21$ and $p=0.68$, respectively). The maximal theoretical force obtained from the PFVP was significantly increased at Week2, Week6 and Week7 compared to Pre. In contrast, the maximal theoretical speed decreased at Week7 compared to Pre. The mean PO per sprint increased significantly with training.

CONCLUSION: These results suggest that five sessions of SIT might be enough for upregulating the physiological mechanisms mediating the adaptations behind the increases in VO2max. Moreover, and even though the training program lasted four more weeks after Week2, no additional gains were observed suggesting that there is not a positive association between longer training all-out programs and improvements in VO2max for a given training frequency. In contrast, the gains observed for the parameters of the PFVP and the mean PO per sprint showed that, despite the aerobic function tended to a plateau, other functions can still be further developed with additional training.

SEMITENDINOSUS HYPERTROPHY IS LINKED TO IMPROVEMENT IN SPRINT PERFORMANCE AFTER ONE YEAR OF SPRINT-BASED TRAINING: AN OBSERVATIONAL STUDY

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INTRODUCTION: It is still questionable as to which muscles are most important for achieving fast sprint running velocity in sports and academic fields. Researchers have demonstrated that sprinters with large sizes of the rectus femoris (1), se-

mitendinosus (2), gluteus maximus (3), and psoas major (4) showed high sprint performance in cross-sectional studies. However, little is known about the impacts of hypertrophy of these muscles on intra-individual changes in sprint performance. This study aimed to examine the impacts of the hypertrophy of each trunk and thigh muscle on the intra-individual changes in sprint performances during one year of sprint-based training.

METHODS: Twenty-three male sprinters (the personal best record for the 100-m race: 11.36 s ± 0.44 s) at a university's athletics club participated in this study. They continued their sprint-based training for one year without our intervention. Before and after the one-year observation period, the participants performed two 100-m sprints with their maximal effort on a synthetic track. Mean sprint velocities at 0–100 m and 50–60 m intervals and spatiotemporal variables (e.g., step frequency and step length) at 50–60 m interval were measured with timing gates and a high-speed camera, respectively. The volumes of 14 trunk and thigh muscles were also measured by magnetic resonance imaging. Muscle volumes were normalized to their body mass at each time point.

RESULTS: Sprint velocities at 0–100 m ($p < 0.001$) and 50–60 m ($p = 0.018$) intervals, stance time ($p = 0.015$), and flight distance ($p = 0.013$) at 50–60 m interval were significantly increased after the observation period. Additionally, the absolute and relative volumes of the tensor fasciae latae, sartorius, biceps femoris long head, biceps femoris short head, semitendinosus, and iliacus were significantly increased (all $p < 0.05$). Among the above six muscles, the changes in the absolute and relative volumes of the semitendinosus were positively correlated with the change in sprint velocity at 50–60 m interval ($p = 0.013$ to 0.015), but not with the changes in any spatiotemporal variables ($p = 0.119$ to 0.898).

CONCLUSION: The present result is in line with that in the previous cross-sectional study showing a positive correlation between the semitendinosus volume and the sprint velocity at 50–60 m (2). The semitendinosus was reported to be highly activated at the late swing phase during high-speed running (5). Thus, the semitendinosus hypertrophy may increase the angular velocity of the hip extension, and thereby might contribute to the increase in sprint velocity. The present finding suggests that semitendinosus hypertrophy has an important role to enhance sprint performance within individuals.

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SHOULD I REST OR SHOULD I GO NOW? A COMPARISON BETWEEN FIXED AND SELF-SELECTED REST DURATIONS IN HIGH-INTENSITY INTERVAL TRAINING CYCLING SESSIONS

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INTRODUCTION: In high-intensity interval training (HIIT), the rest durations between intervals are commonly prescribed using a fixed approach (e.g., 30 seconds between intervals). An alternative is the self-selected (SS) approach, in which trainees select their resting durations. Studies comparing the two approaches report mixed results. However, in these studies, trainees in the SS condition rested for as little or as long as they wished, leading to dissimilar total rest durations between conditions. Here, for the first time, we compare the two approaches while controlling for total rest duration.

METHODS: Twenty-four amateur adult male cyclists completed a familiarization session, followed by two counterbalanced cycling HIIT sessions. Each session was composed of nine, 30-second intervals, in which the goal was to accumulate as many watts as possible on an SRM ergometer. In the fixed condition, cyclists rested for 90 seconds between intervals. In the SS condition, cyclists had 720 seconds (i.e., 8x90 seconds) of rest to allocate in any way they wished. We measured and compared watts, heart rate, electromyography of the knee flexors and extensors, rating of perceived effort and fatigue, perception of autonomy and enjoyment. Additionally, a subsample of ten cyclists completed a retest of the SS condition.

RESULTS: With the exception of perception of autonomy, which was higher in the SS condition, both aggregated and across-interval outcomes were highly similar in both conditions. For example, the average aggregated differences were: 0.57 (95% CI -8.94, 10.09) for watts; -0.85 (95% CI -2.89, 1.18) for heart rate; and 0.01 (95% CI -0.29, 0.30) for rating of perceived effort (on a 0-10 scale). Additionally, the retest of the SS condition resulted in a similar rest allocation pattern across the intervals and in similar outcomes.

CONCLUSION: Given the similarities between the fixed and SS conditions, both can be equally utilized based on coaches' and cyclists' preferences and training goals.

THE EFFECT OF OVERSPEED TRAINING ON MAXIMUM VELOCITY IN TRAINED INDIVIDUALS- A PILOT STUDY

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THE UNIVERSITY OF TAMPA

INTRODUCTION: Maximum velocity is among the most critical performance attributes for many athletes [1]. This performance measure is often quantified in field or laboratory-based settings using sprint assessments. Past research investigated resisted and assisted sprint training to improve velocity in trained individuals [2]. However, there is limited evidence

investigating the effects of overspeed treadmill training (OTT) on maximum velocity. The purpose of this pilot study was to investigate the effects of OTT on maximum velocity in trained individuals.

METHODS: Two college-aged participants (control: 21 y/o, 79.1 kg, 171.5cm; OTT: 23 y/o, 67.3 kg, 165 cm) completed OTT. The duration of this study lasted seven weeks. Week one included familiarization with the treadmill protocol. Pre and post-measurements on the treadmill (TRE) and track (TRA) occurred at weeks two and seven. All TRE sessions were completed using the h/p/cosmos locomotion treadmill system, which allowed subjects to sprint at 80% of their body weight. TRE testing measured the peak velocity that the participant was able to maintain for five seconds. TRA testing measured 40m time using timing gates (Brower), peak velocity, and average velocity using a radar gun (Stalker ATS II). TRE and TRA testing sessions were separated by at least 48 hours. During the protocol, subjects trained twice per week. The control group trained at the average velocity from their best 40m time trial (100%), while the OTT group trained slightly above the average velocity of their best 40m time trial (105%). The number of sprints increased from three (weeks three and four) to four (week five) to five (week six), while the velocity remained constant. Post-testing mirrored pre-testing measurements taken at week two. Percent changes from pre to post for each subject were analyzed using Excel.

RESULTS: For the OTT subject, peak velocity increased by 1.42% (29.4 to 29.8 Km/h), average velocity decreased by 2.49% (28.3 to 27.6 Km/h), and 40m time increased by 2.55% (5.09 to 5.22s). For the control subject, peak velocity increased by 3.02% (34.6 to 35.7 Km/h), average velocity decreased by 0.46% (33.2 to 33.0 Km/h), and 40m time increased by 0.46% (4.34 to 4.36s).

CONCLUSION: Both subjects showed improvements in peak velocity. However, OTT showed no effect on average velocity or 40m time. These findings suggest that training at or above average 40m velocity could potentially improve peak velocity. Additionally, declines in average velocity and 40m time performance may have been due to a lack of acceleration training. Further research is needed to investigate different magnitudes of assistance, as well as the effects of OTT with acceleration training on sprint performance.

1. Cecilia-Gallego et al. (2008) 2. Leyva et al. (2017)

Oral presentations

OP-BM24 Motor control

SPORTS INFLUENCE ON MANUAL DEXTERITY DEVELOPMENT: AN OBSERVATIONAL STUDY ON A YOUNG HEALTHY POPULATION

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UNIVERSITY OF PALERMO

INTRODUCTION: Manual dexterity allows us to manipulate objects, perform activities of daily living and achieve good motor function development1,2. At the basis of this skill, there are neuromotor processes involving the coordination of the central and peripheral nervous systems. Alternated manual dexterity is associated with learning or attention disorders in the developmental age. Understanding which sports activity is most effective in stimulating this skill could be useful in ensuring its normal development and accompanying the rehabilitation of pathological subjects in an inclusive context: interventions aimed at restoring adequate manual dexterity have the characteristics of some sports activities such as Basketball but are carried out in isolated settings where disability is enhanced3. However, there are no studies to date investigating the effect of specific sports on manual dexterity development in youth 8-15 years old, so this is the purpose of our study.

METHODS: 78 subjects were recruited and divided into a basketball group (BG), a dexterity sports group (DG), and a no-sports group (NG). Manual dexterity was assessed by three methods all administered on the same day and on both dominant (D) and non-dominant (ND) hands: grooved pegboard test (GP), coin rotation task (CRT), and handgrip test (HG).

RESULTS: MANCOVA analysis, performed considering age as a covariate, showed a significant difference between BG, DG, and CG groups in the GP and HG performance, with no significant and significant covariate for age. The Scheffé post-hoc comparison highlights that the BG scored significantly higher than NG on GPD (p:0.01) and GPND (p:0.02) but no significant difference was found between NG and DG for GPD (p>0.05) and GPND (p>0.05). In addition, BG showed a better performance than NG and DG in both HGD (NG p:0.01; DG p:0.01) and HGND (NG p:0.02; DG p:0.03). No groups effect on CRTD and CRTND performance (p>0.05) was found. However, age was significantly correlated with performance on the CRTD (r:0.27; p:0.17) or CRTND (r:0.36 p:0.00). The correlation analysis showed a negative correlation between both CRTD and CRTND and GPD (CRTD r:-0.43, p<0.001; CRTND r:-0.45, p<0.001); between CRTD and CRTND and GPND (CRTD r:-0.43, p<0.001; CRTND r:-0.44, p<0.001); between HGD and HGND and GPD (HGD r:-0.35, p:0.00, HGND r:-0.33, p:0.00). A positive correlation was found between CRTD and CRTND and HGD (CRTD r:0.27, p:0.02; CRTND r:0.38, p<0.001) and between CRTD and CRTND and HGND (CRTD r:0.27, p:0.02; CRTND r:0.37, p<0.001).

CONCLUSION: All variables of manual dexterity correlate with each other; age does not influence GP performance, which is instead influenced by playing a sport. BG has better absolute values in all scores. Specifically, significantly higher than the NS group in all tests. In contrast, there are no statistically significant differences between DG and NG. Playing basketball might be more helpful in improving manual dexterity deficits than other sports and a sedentary lifestyle

PUTTING YIPS IN GOLF NOVICES. PREVALENCE AND TASK DEPENDENCY

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TECHNICAL UNIVERSITY OF MUNICH

INTRODUCTION: Yips in golf are involuntary muscle contractions that typically occur during short distance putts and that result in target misses. About 40 % of professional golfers experience yips that are a very significant threat for the career. The causes for yips are still unknown with focal dystonia, anxiety, stress and behavioral peculiarities being considered to contribute. We and others have recently observed that yips may also occur in golf novices. In the present study, we investigated putts in a larger sample of golf novices to determine the prevalence of yips and how different modes of putting modulate the yips.

METHODS: 73 golf novices got a short introduction into putting and were requested to perform 2.5 m putts with a one-handed grip (1H) and with both hands under normal conditions (2H), with closed eyes (2HnoFB) and without a ball (2HnoBall). Ten trials were performed per condition and kinematics of the golf club movement was determined using the SAM PuttLab device (Science and Motion GmbH). Yips was measured as changes of the acceleration of the club head angle around the moment of impact (200 ms window).

RESULTS: During the one-handed condition (1H), nine novices (12.3 %) yielded yips beyond a threshold of 4000 °/s² (> mean + 2 SD of normal distribution). With the exception of one novice with extraordinary strong yips, modifying the conditions of playing the putts abolished the yips (2H, 2HnoFB, 2HnoBall: yips affected players vs. non-affected players: Mann-Whitney-U Test $p > 0.05$). Kinematic variables that characterized the putt before hitting the ball such as club maximum velocity and backswing time did not differ between affected and non-affected players (1H and all other conditions: Mann-Whitney-U Test $p > 0.05$).

CONCLUSION: Yips were detected in 12.3 % of golf novices. Playing with one hand was the most sensitive condition, while the phenomenon was massively reduced when two hands were used, irrespectively from the exact characteristics. Interestingly, the kinematics of the putt before the impact was not responsible for the yips, suggesting that movement execution was normal until shortly before the impact and only the condition was responsible for the occurrence of the yips. One-handed putts may be particularly vulnerable due to the instability of the hand-arm complex. It remains unclear whether a feeling of instability is critical or the two-handed grip mechanically dampened any muscle jerks. This could be resolved by EMG recordings. The fact that yips in professional players are typically reported in normal two-handed grips could indicate that the type of yips differs or that one-handed symptoms may expand to two-handed symptoms during extensive practice.

THE RETENTION OF EXPLICIT BUT NOT IMPLICIT MOTOR MEMORY CAN BE IMPAIRED BY CARDIOVASCULAR EXERCISE: THE MODERATING EFFECT OF FITNESS LEVEL

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**EQUAL CONTRIBUTION, 1 TECHNICAL UNIVERSITY OF MUNICH, GERMANY, 2 CRIR, CANADA, 3 MCGILL UNIVERSITY, CANADA, 4 UNIVERSITY OF HEIDELBERG, GERMANY*

INTRODUCTION: Cardiovascular exercise (CE) can influence the consolidation of procedural memory, especially when performed immediately after motor practice [1]. Changes in corticospinal excitability (CSE) are discussed as a physiological mechanism signaling or suppressing consolidation, and thus retention [2]. This study examines the effects of CE on the retention of explicitly and implicitly learned motor sequences, CSE changes in response to exercise and their interaction.

METHODS: 56 participants (24.1±3.3, 32 female) practiced a sequence learning task – the Serial Reaction Time Task (SRTT) – either with explicit or implicit awareness of an underlying sequence [3]. Following motor practice, participants either performed a 16 min CE protocol – 3 times 3 min at 90% of individual peak power output (PPO) interspersed with 2 min at 25% PPO – or rested (randomized parallel group design). Retention was quantified as the change in SRTT performance from the end of practice to a 24 h retention test. Before and after learning and 15, 30, 45, and 60 min after CE or rest, CSE was measured by applying transcranial magnetic stimulation over the primary motor cortex (M1).

RESULTS: An ANOVA showed no effects of CE on retention ($F(2,31)=0.56$, $p=0.577$). Exploratory analyses with group assignment based on acquired awareness of the practiced sequence suggested that CE specifically impaired explicit memory content in participants with lower fitness ($R2=0.27$, $F(1,16)=6.03$, $p=0.026$). A global measure of CSE change (Area under the Curve) was associated with retention across participants ($R2=0.58$, $p=0.0014$) with no observed effect of CE on CSE.

CONCLUSION: CE did not show significant effects on retention regardless of whether the SRTT was encoded implicitly or explicitly. Yet, considering the degree of acquired awareness of the sequence, CE appeared to impair consolidation in participants with explicit awareness and lower fitness. This is consistend with the idea of the reticular-activating hypofrontality model [4], extending it to motor practice right before and not only during CE. The observed CSE changes between CSE and memory align with previous literature and emphasize that M1 is crucial in consolidating procedural memories [3].

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INTERNAL PROCESSES OF OUTCOME PREDICTION IN BASKETBALL – AN EEG STUDY

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JUSUS LIEBIG UNIVERSITY GIESSEN

INTRODUCTION: Internal models in the motor system constantly predict effects of motor actions (McNamee & Wolpert, 2019). Behavioral studies show that motor experts can report outcomes of their own actions above chance (e.g. Cañal-Bruland et al., 2015; Maurer et al., 2022), indicating that they have access to these internal processes. The present study aims to confirm this by the example of basketball shooting. It is examined whether verbal predictions of basketball free throws correlate with the neural activity of internal prediction processes, by means of event-related potentials in the EEG (i.e., the error-related negativity, ERN).

METHODS: 20 experienced basketball players (6w, 14m; 24.21 ±4.18 years) verbally predicted their throwing result (hit/miss) in 500 free throws in every second throw without receiving feedback about the ball flight. For this purpose, they wore liquid crystal glass goggles occluding their vision after ball release, and headphones playing white noise. The EEG was recorded with a mobile 64-active electrode system (LiveAmp, BrainProducts, Germany). Muscle and eye movement artefacts were corrected with a combined dipole and cluster analysis via ICA and the ERN was determined synchronized to ball release for the mean difference curves between hits and misses. Prediction accuracy was calculated as the percentage of correct predictions above an individual chance level and normalized with respect to a perfect prediction.

RESULTS: On average, prediction accuracy was 13.54 % (SD = 9.74%) above chance level ($t(19) = 6.22$, $p < .001$, $d = 1.39$). EEG activity of the misses were more negative compared to the hits in the time window 100-200 ms after release ($t(19) = -2.2$, $p = .02$, $d = -.50$), meaning that outcome prediction was internally represented by the ERN.

CONCLUSION: Discussion

As expected, experienced basketball players can verbally predict the outcome of their own free throws above chance. In the EEG, a clear ERN signal of internal prediction processes was observed. Indicating players have access to their predictive internal motor processes.

Literature

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Invited symposia

IS-MH04 Exercise for skeletal muscle ageing: mechanisms and mitigation

EXERCISE REJUVENATES THE MOLECULAR PROFILE OF AGEING IN SKELETAL MUSCLE

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VICTORIA UNIVERSITY

Ageing represents an important health and economic burden on society. Approximately 15% of the world population are over 65, a proportion expected to rise to 22.5% by 2050. Sedentary behaviour and lack of physical activity accelerate the widespread cellular and molecular changes induced by ageing, resulting in the increased prevalence of many chronic diseases.

Epigenetics (particularly DNA methylation) is one of the hallmarks of ageing. The epigenome is effecting gene expression, and is particularly sensitive to exercise, and exercise training programs caused widespread DNA methylation shifts in genes that are relevant for skeletal muscle health, and ageing.

My research group focuses on the development of novel, cross-tissue molecular approaches to identify sex-specific healthy ageing and exercise-related marks in humans. This approach will provide a greater understanding of the multiplicity and complexity of the cellular networks involved in exercise responses and strong translational path. The Gene SMART study, led by our group, is the first of its kind to comprehensively assess genetic and epigenetic markers that contribute to muscle health pre-and-post intense exercise (total of ~1200 human muscle & blood samples at various exercise points). Using data mining, and bioinformatics approaches we combined the Gene SMART cohort, data sets from international collaborators and open access datasets to perform a powerful molecular analyses to uncover robust marks of

ageing in males and females. In my presentation, I will discuss some of the recent research coming from my group on how exercise mitigate the ageing molecular responses.

HIIT TO GET FIT? NOVEL AND TRADITIONAL EXERCISE MODES TO IMPROVE MUSCLE HEALTH IN OLDER ADULTS AND PATIENT COHORTS

MACDONALD, M.

MCMASTER UNIVERSITY

The traditional focus of most exercise programs for older adults and patient cohorts has been on a combination of moderate intensity continuous and resistance exercise training. Generally, this exercise prescription includes 30 minutes per day of moderate intensity aerobic exercise, performed 5 days per week with the addition of resistance exercise training as the program progresses. It has been shown that adherence to the training program is often more important than exercise type and intensity for prediction of survival, and that the physiological benefits of exercise training are not sustained if exercise habits are not maintained. Recent research has suggested that high intensity interval training (HIIT), might be an alternative exercise prescription for older individuals and patient cohorts and might address some barriers to exercise adoption and adherence. This talk will explore the growing literature examining both novel and traditional exercise modes to improve muscle health in older adults and patient cohorts.

NOT SARCOPENIC! SKELETAL MUSCLE IN OLDER EXERCISERS AND MASTERS ATHLETES

HARRIDGE, S.

KINGS COLLEGE LONDON

As we get older, we lose skeletal muscle mass and function. When this process reaches a critical threshold, a disease termed "sarcopenia" can be defined. The underlying cause of this decline is likely to be multifactorial. Factors such as loss of motor units, anabolic resistance to feeding and exercise, impaired recovery from exercise induced damage (relating to stem cell dysfunction), inflammation and cellular senescence have all been associated with tissue loss and declines in strength and power. However, a confounding factor of studies investigating muscle ageing is physical (in)activity. In addition to ageing processes, skeletal muscle is highly sensitive to both mechanical and metabolic signals. Thus, for many older people a resulting aged muscle phenotype is a product of ageing processes interacting with the negative effects of inactivity.

When very active older people are studied muscle mass and function are also lost. The loss of function is clearly even in the most highly trained on individuals as demonstrated by a decline in athletic performance. In masters or veterans' sports there is progressive decline (which accelerates during the eighth decade) in world records in every discipline. These records and performances tell us two things. The first is that there is no denying that an ageing process is taking place. Whilst the second tells us that there is a large potential for exercise to ameliorate the decline in mass and function. The physical capabilities of older athletes relative to age matched non-active counterparts are far superior. Here such active individuals are far removed from being classified as sarcopenic.

This lecture will focus on exploring concepts surrounding ageing muscle phenotypes in the light of what lessons we might learn from older exercisers and masters' athletes.

Oral presentations

OP-AP13 Virtual Reality Training

A COMPARISON OF THE INTENSITY AND PLEASURE EXPERIENCE DURING VIRTUAL REALITY BOXING AND PUNCHING BAG BOXING.

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VRIJE UNIVERSITEIT BRUSSEL

INTRODUCTION: Virtual Reality (VR) exergames are potentially a fun and attractive alternative for traditional sports in contributing to young adults' physical activity, provided that the exercise intensity is comparable. Therefore, the aim of this study was to compare the exercise intensity of VR boxing with punching bag (PB) boxing, in healthy young adults. A secondary aim was to compare the pleasure experience during VR and PB boxing.

METHODS: Using a cross over design, 24 young adults (aged 21.7 ± 1.2 years ; 25% women) participated in a PB boxing session or played the 'KO league – heavy bag DLC' in VR, using an Oculus quest 2 head mounted display. Each trial took 15 minutes each with standardized punching combinations and hitting frequency. Exercise intensity was evaluated through heart rate peak percentage (HRpeak%), difference in blood lactate concentration pre and post exercise (ΔBLa) and rate of perceived exertion (RPE) on a 6-20 Borg scale. Pleasure experience was examined using a 0-10 VAS scale. A one-way repeated measures ANCOVA, with fat free mass percentage as a covariate, was used to compare HRpeak%, RPE scores and pleasure experience, while a Wilcoxon signed rank test was used to investigate the difference in ΔBLa, due to non-normality.

RESULTS: Fat free mass percentage was not a significant covariate (p = 0.06). No significant differences (all p>0.05) were found between both conditions for the intensity parameters HRpeak% (VR: 75.7 ± 12.2%; PB: 78.6 ± 14.9 %), ΔBLa (VR: -0.10 ± 0.09 mmol/l; PB: 0.05 ± 0.26 mmol/l) and RPE (VR: 11.4 ± 2.4; PB: 13.0 ± 1.8). For both conditions a high range in HRpeak% and RPE was observed, indicating intensities from light to vigorous. In addition, no difference in pleasure experience was found (VR: 7.0 ± 2.1; PB: 6.7 ± 2.0; p = 0.42).

CONCLUSION: According to the results of this study, VR boxing is an equally intensive and fun alternative for PB boxing in young adults. Interestingly, exercise intensity showed a high inter-individual variation. Therefore, regardless of using a punching bag or a VR game, boxing can contribute to a more or less extent to young adults their physical activity level.

SENSITIVE EXPERIENCE OF THE HIGH-LEVEL GYMNAST: 3D IMMERSION AND TRAINING IN VIRTUAL REALITY

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UNIVERSITÉ DE REIMS CHAMPAGNE ARDENNE

Introduction

For the 2024 Olympic Games, the gymnastics federation is trying to answer the dilemma concerning the "dose" of training that is conducive to winning medals. This one reaches up to 30 hours per week questioning the physical load and the risk of injuries. The REVEA project (ANR 20-STHP-0004) aims to optimize the performance of the mens group by supplementing the real training time with Virtual Reality (VR) training. The virtual embodiment and the 3D immersive experience is essential to optimize the transfer between what is seen and what is practiced in real life: the self-generated movement would promote the liveliness of the action simulation during the observation of the action (Baudry et al., 2005), while promoting an adaptation to the environment. From the body experience lived in real training, this research aims to model a 3D tool to immerse French gymnasts during training in VR.

Methods

Enaction "places interaction and its dynamics at the center of the knowledge construction phenomenon" (De Loor & Tisseau, 2011). In VR, interaction relies on "the scalability of the coupling between the virtual reality system and the user" (Ibid., 2011), promoting the gymnasts corporeal presence. Eight self-confrontation interviews with INSEP gymnasts in international competition conditions were conducted. The course of experience of the gymnasts was reconstructed using the EAC and the traces of the observatory. More precisely, the components of the hexadic sign (Theureau, 2015) were processed in order to identify similarities and singularities between the gymnasts experiences.

Results

The sensory register of the gymnasts experience is central. Plural and singular, the sensations represent information supporting the mobilized knowledge and stimuli incorporated during their performances: respiratory, visual, auditory, muscular, haptic and kinesthetic.

Discussion/Conclusion

These results contribute to the configuration of the 3D modeling to target the immersion of the gymnast and the optimization of the VR training:

1. Two modes of practice: one competition, the other training (influence the auditory and visual stimuli)

2. Body sensations to be highlighted according to the needs of the training to guide the gymnasts body adjustments (muscular, respiratory, kinesthetic)

3. Time management methods: from the call to the apparatus to the end of the routine, and to optimize the connections between the elements.

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THE USE OF 360° VIDEO IN SWIMMING EDUCATION

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UNIVERSITÉ DU QUÉBEC À MONTRÉAL

Introduction

Drowning is a serious public health problem threat claiming the lives of 372,000 people each year worldwide that can be linked to an individual's ability to swim. Learning to swim requires limited fear of water (Peden & Franklin, 2020). Our exploratory study investigated the potential interests of 360° video use for reducing fear of water to foster learning how to swim. This study is the first stage of a larger funded project.

Methods and participants

The study is situated in the theoretical lens of the Course of Action research approach (Theureau, 2010) used in cognitive anthropology and is part of the enaction paradigm and embodied cognition perspective. This lens aims to consider hu-

man activity according to a double logic of, activity as enaction (Varela et al., 1991) and experience (Poizat et al., 2016). The object of analysis of this program is the activity, accomplished in a real situation that is, in a given physical and social environment. For this exploratory study, we conducted a multiple case study (Stake, 2005) with two volunteer students (non swimmers) from a group of students aged 11–12 years during a PE lesson for learning to swim. At the beginning of the lesson, students viewed 360° videos taken in the swimming pool at different depths. They viewed (with a headset and a smartphone) progressively deeper and deeper 360° videos during viewing situations that were filmed in the swimming pool without pupils in the water. Students' activity with the headset was recorded and this video was used for a self-confrontation interview (Theureau, 2010) that helped elicit their feelings during the viewing experience.

Results

Three main results can be underlined. First, the use of 360° video viewed in an HMD led students to live an original corporeal immersive experience, a kind of immersion in the pool but experienced outside the water. Second, students felt a strong emotional engagement between anxiety and curiosity from exploring the aquatic environment. Third, during the viewing situation, students developed and acquired accurate perceptive cues and knowledge related to the aquatic environment.

Discussion

These preliminary results provide insight into the feelings of swimming students when viewing 360° video and inform us about a decreased fear of water after viewing such videos. These results are in line with Botella et al. (2017) based on virtual reality use. In order to obtain a higher degree of generalization of the findings, we are presently corroborating this data in relation to quantitative data collected (by questionnaires).

ANTICIPATION PERFORMANCE IN VIRTUAL REALITY BOXING: IMPACT OF GAZE-CONTINGENT BLUR ON ELITE BOXERS.

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INTRODUCTION: Perceptual-motor skills are essential to performance in combat sports but remain poorly trained (Romeas et al., 2022), often with a focus on reaction time. Therefore, we studied how the properties of VR (standardization, reproducibility, and perception-action coupling) can facilitate the development of new tools that assess perceptual-motor skills underlying performance. Particularly, we are interested in the impact of a visual blur on anticipation in boxing. The introduction of blur inhibits visual perception of fine details that can act as distractors but preserves essential information such as the kinematics of the opponents limbs. To date, blur has been applied in real word settings using lenses (Mann et al. 2010) or 2D computer blurred displays (Ryu et al. 2015). Using 2D video display and gaze-contingent blur, Ryu et al. reported that novices, but not experts, decision making benefited when a moderate level of blur was applied in peripheral vision. However, these studies did not manipulate the location of blur in a realistic 3D visual task, where normal perception-action coupling was preserved.

METHODS: To overcome these limitations, we used a gaze-contingent gaussian blur within a VR environment. 11 French elite athletes faced a virtual opponent, standing 1 m away in a virtual ring, who launched successive attacks of 20 sequences (10 of 1 punch and 10 of 2 punches). Each participant completed 3 blocks of 60 trials, in a random-blocked order separated by a 2-minute break. In each block, participants performed the task in one of 3 Viewing Conditions. In the control condition, participants were presented with normal vision of the visual display. For the other 2 Viewing Conditions, a gaze-contingent blur manipulation was made relative to the point of fixation, such that participants were presented with a peripheral or a central blur. Participants had to avoid by dodging the incoming punches and counterattack to touch the opponent.

RESULTS: Linear mixed modelling revealed no significant effect of blur on performance but a significant main effect of the sequence type ($p<.0001$). Post-Hoc indicated that performance was better when facing sequences of one punch compared to sequences of two punches ($p<.0001$). The rating mean probabilities revealed that the number of dodges and counterattacks was similar when facing one punch sequences, but the number of counterattacks decreased more when facing a two punch sequences (0.144) compared to dodging response (0.198).

CONCLUSION: Overall, the results showed expert boxers were resilient to blur in this VR anticipation task. Interestingly, however, observation of the individual response data showed individual variability depending on the blur condition. It is envisaged that this new method will enable more consideration of the how blur can be used in the investigation of perceptual-motor learning.

This work is part of REVEA and DIGISPORT projects supported by the ANR in the "France 2030" program (20-STHP-0004 and ANR-18-EURE-0022).

THE EFFECT OF STATIC QIGONG PRACTICE IN TWO TYPES OF CONDITIONS - STANDARD AND USING VIRTUAL REALITY

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INTRODUCTION: The benefits of Qigong exercises practicing have been known since ancient times. The effect of their performance has been studied by numerous specialists [1-4]. The main idea of this paper was combining the ancient qigong practice with modern technological advances. An object of the study is the effect of static qigong practicing. The aim is to compare the psycho-physiological response of the body after performing the same static qigong exercises in

two types of conditions - normal and using virtual reality. According to the research hypothesis, the application of virtual reality during qigong practice will stimulate psychophysical relaxation, which will create conditions for increasing the effect of qigong exercises.

METHODS: Thirty-eight athletes, of which 15 females and 23 males, aged 20-25 years participated in the study. A set of static standing qigong exercises performed by the help of a wall with 20 min duration was prepared. For its performance with VR glasses, a video with natural sights and relaxing music was selected. The indicators studied were heart rate variability, energy expenditure, fingertip temperature, balance abilities, hip joint flexibility, reaction time, movement frequency, accuracy, time perception, attention concentration, etc. Tests like Stand and reach test, Flamingo Balance Test, CPS Test, Reaction Time Test, Time Perception Test, Aim Test, Schulte Test, etc. have been used. The parameters studied before and after the static qigong set practicing under two types of conditions were measured.

RESULTS: The collected data was statistically processed using Descriptive Statistics, Shapiro-Wilk Test and Paired Samples T Test. Significance was set at $p<0.05$. Most of the results were statistically significant. The effect size for 10 indicators using Cohens formula was determined. Several types of comparisons to prove the effect of static qigong exercises in both types of conditions were performed. The study found that the energy expenditure, average and maximum heart rate during the exercise in normal conditions were 58.9 ± 16.5 kcal, 86.2 ± 6.9 bps, 102.5 ± 10.9 bps, respectively. Using virtual reality glasses, these indicators were 54.7 ± 20.9 kcal, 83.8 ± 6.1 bps, 100.0 ± 7.3 bps, respectively. The effect size found under normal conditions was small for 7 parameters, medium for 2 and large for 1 parameter. In virtual reality conditions, a small effect size was achieved for 1 parameter, medium for 6 and large for 3 parameters.

CONCLUSION: The study proved that the use of virtual reality during static qigong practice increases the relaxation effect of these exercises. As a result, a greater growth was found in the most of metrics examined in this type of workout. Nevertheless, we recommend that the use of virtual reality during qigong performance should be moderated and used as a tool providing specialized variety, rather than replacing impacts in normal conditions entirely.

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Oral presentations

OP-MH25 Physical activity/Inactivity

THE EFFECTS OF REDUCING SEDENTARY TIME ON SKELETAL MUSCLE INSULIN SENSITIVITY – A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Sedentary behaviour (SB) and physical inactivity are known to associate with impaired insulin sensitivity. The exercise–induced improvement in whole-body insulin sensitivity rely mainly on the changes in skeletal muscles, but the effectiveness of reducing daily SB in improving skeletal muscle insulin sensitivity remains unknown.

METHODS: Forty-four sedentary inactive adults [mean age 58 (SD 7) years; 43% men] with the metabolic syndrome were randomized into intervention and control groups. The 6-month individualized behavioural intervention supported by an interactive accelerometer and a mobile application aimed at reducing daily SB by 1h compared to the baseline. SB and physical activity were measured with hip-worn accelerometers throughout the 6-month intervention. Skeletal muscle insulin sensitivity in the thigh area (quadriceps femoris and hamstrings) was measured with hyperinsulinemic euglycemic clamp combined with [18F]fluoro-deoxy-glucose positron emission tomography before and after the intervention. The differences between intervention and control groups (group*time interaction) were tested with linear mixed models; and additionally between participants that, according to accelerometry, successfully reduced SB compared to participants that continued to be sedentary during the intervention.

RESULTS: Quadriceps femoris and hamstring muscle insulin sensitivity did not significantly change during the intervention in either group. However, the change in hamstring insulin sensitivity correlated inversely with the change in accelerometer-measured SB ($r=-0.40$, $p=0.024$) and positively with the changes in moderate-to-vigorous physical activity ($r=0.37$, $p=0.036$) and daily steps ($r=0.37$, $p=0.038$). Moreover, insulin sensitivity increased in the hamstrings among the more active participants ($\gtrsim$ 27 min decrease in measured daily SB) compared to the continuously sedentary participants (time*group $p=0.020$).

CONCLUSION: Hamstrings are postural muscles that are activated during standing and light activities, whereas the quadriceps femoris is thoroughly activated during more strenuous and strength-demanding activities. Therefore, reducing SB has potential in improving insulin sensitivity in postural muscles, even if this intervention did not induce any significant changes in muscle insulin sensitivity. However, behavioural interventions targeted to reduce SB may increase insulin sensitivity in the postural hamstring muscles, if the desired behaviour change is accomplished.

ASSOCIATIONS OF DOMAIN-SPECIFIC PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOR WITH BLOOD LIPID PROFILE AMONG JAPANESE CHILDREN: A COMPOSITIONAL DATA ANALYSIS

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INTRODUCTION: Optimizing childhood domain-specific physical activity (PA) and sedentary behavior (SB) for blood lipid profile is not well understood. We aimed to 1) determine the associations between accelerometer-measured PA and SB for each domain (school time and out-of-school time) with blood lipid profile and 2) estimate predicted changes in blood lipid profile with hypothetical time-reallocation between domain-specific SB and PA among Japanese children using compositional data analysis (CoDA).

METHODS: This cross-sectional study included 284 children (147 boys and 137 girls) aged 9–12 years. The times spent in SB, light-intensity PA (LPA), moderate-intensity PA (MPA), and vigorous-intensity PA (VPA) were assessed using accelerometers. Fasting lipid profile was assayed for triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), and non-HDL-C levels.

RESULTS: Time spent in out-of-school VPA relative to the other behaviors was inversely associated with non-HDL-C (boys: βilr1 = -0.096, 95% confidence interval [CI] = -0.184 to -0.008), TG (boys: βilr1 = -0.469, 95% CI = -0.699 to -0.238), and positively associated with HDL-C (girls: βilr1 = 0.087, 95% CI = 0.016–0.158) levels after adjusting for age, body mass index, and time spent in other SB or PA domain. During the out-of-school period, replacement of just 1 minute from the remaining behaviors for VPA was associated with a more favorable lipid profile. In contrast, the associations of SB, LPA, and MPA with blood lipid profile were weak or null.

CONCLUSION: The present study examined the associations of domain-specific PA and SB with blood lipid profile among children using CoDA. We found that the time spent in VPA (particularly out-of-school VPA) was favorably associated with the blood lipid profile, whereas the associations for SB, LPA, and MPA were weak or null. Additionally, our isotemporal substitution analyses suggested that replacing 1 min/day of out-of-school SB and/or lower-intensity PA (LPA and MPA) with out-of-school VPA was favorably associated with non-HDL-C (for boys), TG (for boys), and HDL-C levels (for girls). Our results suggest that increasing VPA levels, particularly during out-of-school time, is important for improving blood lipid profile results among children.

EFFECT OF PHYSICAL ACTIVITY PROGRAM ON SLEEP AND SLEEP-RELATED VARIABLES: A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Chronic exercise is recognized as an effective approach to improve sleep in people suffering from insomnia. However, the underlying mechanisms of interaction between sleep and physical activity are still poorly understood. Therefore, this study investigates the effects of a physical activity program on sleep and sleep-related physiological variables.

METHODS: 24 inactive women (49 ± 6.2 yrs) suffering from insomnia were randomly assigned to either a control group or a physical activity (PA) program. The PA program consisted in a 12-week program with three 1h15 sessions of moderate to vigorous aerobic exercise per week. Sleep was assessed using the Insomnia Severity Index (ISI) and accelerometers. Epworth sleepiness scale, Perceived Stress Scale (PSS), Hospital Anxiety and Depression scale (HAD), hair cortisol, nocturnal heart rate variability (HRV), 24-hour continuous core temperature were also assessed before (T0) and after (T1) 12 weeks in each group.

RESULTS: at T1, PA group showed a lower ISI score ($p<0.001$) and a longer total sleep time ($p<0.05$). Moreover, sleep efficiency tends to be higher ($p=0.058$). PSS score decreased ($p<0.01$). For HR, there is an increase in the RR interval ($p<0.05$). For HRV, in the time domain, there is an increase in SDNN ($p<0.05$). No change was observed in frequency domains. There was no difference for hair cortisol levels and core temperatures, although the amplitude of core temperature tends to be increased ($p=0.087$). At T1, the PA group showed a lower ISI score than the control group ($p<0.01$). When analyzed as score changes (T1 - T0), there was a positive correlation between changes in insomnia severity symptoms and changes in Epworth sleepiness scale ($r=0.794$; $p<0.05$) and PSS score ($r=0.777$; $p<0.05$) and a negative correlation between changes in insomnia severity symptoms and changes in core temperature amplitude ($r=-0.687$; $p<0.05$)

CONCLUSION: Our results suggest that moderate to vigorous aerobic exercise improves subjective sleep quality, objective sleep quantity, heart rate variability and decrease perceived stress in inactive middle-aged women suffering from insomnia. The data provide evidence indicating that changes in insomnia severity have associated to changes in thermoregulation, perceived stress and sleepiness.

TOWARDS A MORE HOLISTIC APPROACH TO DESCRIBE THE DIFFERENCE BETWEEN MEN AND WOMEN IN PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOUR: DATA FROM A NATIONAL SAMPLE IN LUXEMBOURG

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INTRODUCTION: Physical activity (PA) and sedentariness are complex and multidimensional behaviours with many-faceted accumulation patterns. The understanding of an individual's movement behaviour profile requires a holistic ap-

proach that goes beyond the use of standard measures such as time spent in moderate to vigorous PA (MVPA). Our first objective was to identify wearable-specific indicators and their analytical methods used to assess PA and sedentary behaviour. In a second step, we illustrated the potential benefits of these indicators over standard measures through a descriptive analysis of a specific population and the comparison between men and women.

METHODS: A scoping review was conducted to search for articles published in English between 2010 and 2020 by screening three databases. Only indicators that assessed PA and sedentary behaviour using data from triaxial accelerometers were retained. The identified methods to calculate these indicators were applied using data from an observational study (2016-18) that included Luxembourg residents aged 18-79 years and who each provided ≥4 valid days of accelerometry data (n=1122, including 599 women and 523 men).

RESULTS: In total, 24 articles describing 13 indicators were included in the scoping review. These indicators can be classified into three categories related to (1) the activity intensity distribution, (2) the activity accumulation, and (3) the temporal correlation and regularity of the acceleration signal. Most of these indicators were applied on a population of Luxembourg residents that spent 51% of daily time sedentary, 11% in light PA, 6% in MVPA and 32% asleep. Although, time spent in MVPA did not differ between women and men (76.9 and 79.8 min/day in men and women, respectively, p=0.22), the average 24h acceleration was higher (p<0.05), time spent in light PA was higher (p<0.001) and the intensity gradient was steeper (p<0.001) in women compared to men. These differences align with a lower average acceleration observed across the most active 30 and 15 minutes of the day in women (p<0.05). In total, more than a quarter (26.4%) of all sedentary time was spent in bouts lasting 60 minutes or longer. Women spent less time in sedentary behaviour (p<0.001), had shorter bout lengths (p<0.05) and fewer sedentary bouts of prolonged length (>30 min, p<0.001) compared to men.

CONCLUSION: Standard measures may not reflect differences between groups in PA and sedentary behaviour. The indicators identified in this study provide a more in-depth understanding of an individual's habitual movement behaviour profile. Surprisingly, few studies have investigated accumulation patterns of PA, time in light PA and especially sedentary time, even though there is evidence that extended periods of inactivity may have a harmful impact on health. The advantage of the identified indicators is that they cover the entire intensity range and provide additional information on their accumulation pattern.

COLLAGEN PEPTIDE SUPPLEMENTATION BEFORE BEDTIME REDUCES SLEEP FRAGMENTATION AND IMPROVES COGNITIVE FUNCTION IN MEN WITH SLEEP COMPLAINTS

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INTRODUCTION: Sleep quality is worse in athletes compared to the general population. As several nutrients interact with neurotransmitters that help regulate the sleep-wake cycle, there is a growing interest in dietary strategies that promote sleep. The non-essential amino acid, glycine, may improve sleep by activating N-methyl-D-aspartate (NMDA) receptors in the suprachiasmatic nucleus (SCN) (Kawai et al., 2015). Collagen peptides (CP) are rich in glycine and have also been shown to increase brain derived neurotrophic factor, which is diminished in poor sleepers (Flores et al., 2020) and after sleep restriction. Thus, the aim of this study was to examine if CP, which are increasingly used by athletic populations, can promote sleep quality in poor sleepers.

METHODS: In a randomized, crossover design, 13 athletic males (age: 24 ± 4 years; training volume; 7 ± 3 h·wk1) with sleep complaints (Athens Insomnia Scale, 9 ± 2) consumed CP (15 g·day1) or a placebo control (CON) 1 h before bed for 7 nights. Sleep quality was measured with subjective sleep diaries and actigraphy for 7 nights; polysomnographic sleep and core temperature were recorded on night 7. Cognition, inflammation, and endocrine function were measured on night 7 and the following morning. Subjective sleepiness and fatigue were measured on all 7 nights. The intervention trials were separated by ≥7 days and preceded by a 7-night familiarization trial.

RESULTS: Polysomnography showed less awakenings with CP than CON (21.3±9.7 vs. 29.3±13.8 counts, respectively; P=0.028). The 7-day average for subjective awakenings were less with CP vs. CON (1.3±1.5 vs. 1.9±0.6 counts, respectively; P=0.023). The proportion of correct responses on the baseline Stroop cognitive test were higher with CP than CON (1.00±0.00 vs. 0.97±0.05 AU, respectively; P=0.009) the morning after night 7. There were no trial differences in core temperature, endocrine function, inflammation, subjective sleepiness, fatigue and subjective sleep quality, or other measures of cognitive function or sleep (P>0.05).

CONCLUSION: Seven days of CP supplementation reduced awakenings and improved Stroop test cognitive performance and may therefore serve as a useful strategy to mitigate the potentially deleterious effects of poor sleep on exercise and cognitive performance in male athletes with sleep complaints.

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Oral presentations

OP-BM17 Coordination

RELIABILITY OF EVENT-RELATED SPECTRAL PERTURBATIONS IN TARGET-DIRECTED KICKING IN SOCCER

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INTRODUCTION: An accurate kick requires sensorimotor processing of visuospatial information and its translation into a motor output. Although distinctive cortical activity has been shown to be linked with superior accuracy in other target-directed sport actions (e.g. basketball throws), little is known about the cortical dynamics underlying precise kicking. This knowledge may help to optimize and specialize interventions to improve accuracy in applied scenarios such as penalty and pass-kicks. To explore relevant effects of e.g. expertise, fatigue or injury on kicking accuracy, it is important to extract reliable neurophysiological measures. Based on this background, the purpose of this study was to describe the reliability of event-related spectral perturbations (ERSP) underlying target-directed kicking in healthy novices.

METHODS: Eleven participants performed pass-kicks towards a target placed at three meters distance. Cortical activity was recorded using a 64-channel mobile EEG system. The experiment was repeated after one week. The EEG data was preprocessed and epoched based on kick-onset. Cortical sources of the EEG signal were identified through the application of independent component analysis (ICA). Functional sources were clustered according to k-means algorithm and the clusters including the majority of the sample at both time points were considered for further analysis. The ERSPs were extracted and intraclass correlation coefficients (ICC) were computed to quantify week-to-week reliability of kick-related ERSPs. To acknowledge comparable motor behavior, the anatomical motion range of the kicking leg was recorded through inertial-measurement-units and analyzed for week-to-week reliability.

RESULTS: The results revealed reliable activity of parieto-occipital and frontal regions upon kick onset. In the occipital brain regions, an alpha desynchronization was observed during the swing and follow-through phases with moderate to excellent reliability scores (ICCs between 0.57-0.9). In the frontal region, there was an evident theta synchronization prior to ball contact with moderate to good reliability scores (averaged ICC: 0.63) and an alpha desynchronization upon ball contact with moderate to excellent reliability scores (ICCs between 0.59-0.86). The anatomical motion ranges for hip flexion, knee flexion and foot external rotation showed moderate reliability (ICCs between 0.62-0.74).

CONCLUSION: This study aimed to assess the reliability of kick-related ERSPs for the first time. Under comparable motor behavior during kicking, the parieto-occipital and frontal brain regions demonstrated reliable activity. Particularly after kick-onset, the observed cortical phenomena demonstrated moderate to excellent reliability. These reliability findings provide the opportunity to explore deeper insights of cognitive and sensorimotor mechanisms which are involved in the planning, execution and different contexts of a target-directed kick.

INCREASE IN SULCAL DEPTH AFTER 12 WEEKS OF A PHYSICAL ACTIVITY BREAK WITH COORDINATIVE EXERCISES

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INTRODUCTION: Although there are some studies which investigated the effects of coordinative exercises on the brain structure, only a few studies investigated the effects on surface-based brain metrics [1, 2, 3] in adults. Furthermore, the current state of research on the effects of physical activity on brain outcomes is insufficient for young and middle-aged adults [4]. Therefore, a physical activity break (PAB) with coordinative exercises was offered to university office workers. The project aimed to evaluate the effects of the PAB on cortical thickness and folding.

METHODS: Nineteen women and six men participated in the randomized controlled study. They were allocated to an intervention (IG: n=16, 42.8±10.2 years) and a control (CG: n=9, 44.2±12.3 years) group. The IG performed a PAB for 15-20 minutes with coordinative exercises, mainly juggling tasks, two times per week for 12 weeks. Before (week 0), six (week 6), and twelve weeks (week 12) after the start of the intervention, we assessed changes of surface-based metrics of the brain with MRI (3T Magnetom Vida scanner, Siemens Healthineers Erlangen, Germany). Additionally, juggling performance was assessed by measuring the time of performing a three-ball-cascade. The surface-based brain metrics were evaluated using the fully automated pipeline in CAT12. For the estimation of the cortical thickness and central surface, the project-based thickness approach was used. All results were FWE-corrected. We used analysis of variance, t-tests, and non-parametric tests with a significance level of 0.05 to analyze the data.

RESULTS: Cortical depth increased in right inferior parietal regions at week 6 and 12 ($p < 0.001$) in the IG. No changes were found in cortical thickness. In addition, the juggling performance improved from week 0 (0.3±1.0 s) to week 6 (1.9±1.6 s; $p<.002$), from week 0 to week 12 (4.4±4.4, $p<.001$) and was different compared to the CG at week 6 (1.9±1.6 vs 0.0±0.0 s; $p<.001$), and week 12 (4.4±4.4 vs 0.0±0.0 s, $p<.001$). No significant changes for the brain and juggling parameters were found in the CG.

CONCLUSION: The regular engagement in the three-month PAB with coordinative exercises was associated with an increase in vertex-wise cortical depth in a cluster comprising the right inferior parietal lobe and improvements in juggling performance. There is evidence, that the identified sulcal cluster is implicated in tactile and visual object processing [5].

Furthermore, this cluster appears to display some overlap with areas of the intraparietal sulcus, which have been referred to as "interfaces between the perceptive and motor systems for controlling arm and eye movements in space" [5]. Therefore, this study shows evidence, that changes in surface-based metrics in this area can be related to regular engagement in exercise training with visuo-coordinative demands.

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BALANCE BIKE: AN EVIDENCED SOLUTION FOR LEARNING TO CYCLE INDEPENDENTLY IN HEALTHY ADULTS

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INTRODUCTION: Undoubtedly, adults find it difficult to ride with children if they have not learned to ride a bicycle themselves unless they would like to ride on a bicycle with training wheels. Unfortunately, previous studies showed that an average of 9.7% of the total population in 10 countries does not know how to cycle and is unable to self-launch and cycle on a conventional bike. Therefore, this multiphase project was conducted to determine whether healthy adults could be educated to learn to cycle independently: Phase 1) a case-control observational study and Phase 2) a one-arm 8-session intervention pre- and post-test study.

METHODS: In Phase 1, a total of 13 cyclists (6M and 7F; age: 22.62 ± 2.14 y; height: 167.12 ± 10.97 cm; weight: 62.49 ± 12.21 kg) and 8 non-cyclists (3M and 5F; age: 22.13 ± 1.36 y; height: 164.00 ± 5.45 cm; weight: 56.30 ± 3.49 kg) completed a battery of balance bike tests and a jump test. Based on these data, eight 20-minute balance bike training sessions specific to cycling postural stability and control were developed. In Phase 2, another 11 non-cyclists (2M and 9F; age: 36.73 ± 15.74 y; height: 160.68 ± 9.12 cm; weight: 57.50 ± 12.57 kg) completed the balance bike training that was formulated in Phase 1 to evaluate whether healthy adults without cycling experience could develop essential cycling stability on a balance bike and transfer the skills to a conventional bike. The study was approved by the Human Research Ethics Committee of The Education University of Hong Kong.

RESULTS: Bayes factor analyses revealed extreme evidence supporting the alternative hypothesis that the cyclists in Phase 1 were able to ride faster on a balance bike in a 15m sprint test (4.90 s vs 6.79 s, $BF01 = 0.228$, $p = 0.013$, $d = 1.89$) and a two-turn curved sprint test (6.35 s vs 9.66 s, $BF01 = 0.138$, $p = 0.037$, $d = 3.31$) than the non-cyclists. Besides, the Bayes factor for the time of completion in the two balance bike tests in the repeated measures in Phase 2 provided extreme evidence for the alternative hypothesis that the novel balance bike training improved non-cyclists riding performance on a balance bike (15m sprint: -1.68 s, $BF01 < 0.001$, $p < 0.001$, $d = 1.66$; two-turn curved sprint: -2.60 s, $BF01 < 0.001$, $p < 0.001$, $d = 2.29$). Jump height was also improved by 2.27 cm ($BF01 = 0.019$, $p < 0.001$, $d = 1.42$).

CONCLUSION: This study revealed that the balance bike manoeuvres could divide adults with and without the ability to cycle while jumping performance did not seem to be effective. Regardless of the participant's age (19–63 y), all non-cyclists learned to ride a conventional bike independently after completing eight 20-minute sessions of our novel balance bike programme. This study provided evidence of positive riding skill transfer from a balance bike to a two-wheel bike and building confidence for every adult to learn how to cycle with dignity.

A STUDY ON THE EFFECT OF COLOR VISION STIMULATION BY COLORED GLASSES LENSES ON MOTOR CONTROL ABILITY

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INTRODUCTION: The use of individually preferred colored glasses has gained popularity with the expectation that it may improve balance control and sports performance, however, the results of previous studies remain inconclusive. In the present study, we aimed to determine the association between participants' subjective preference and balance performance when wearing different colored glasses.

METHODS: The experiment was divided into two studies. In study 1, 13 participants stood on dominant-leg or two legs on a pair of synchronized force plates for 30 seconds with 60 seconds rest between the five-five randomized stance trials, while wearing red, blue, yellow, green, or transparent colored glasses. And subjects were asked to subjectively evaluate the balance performance under different colored glasses. In addition to 5 center of pressure related variables, we analyzed five features of electromyography data from three lower limb muscles (medial gastrocnemius, biceps femoris, tibialis anterior) on both legs. In study 2, the experiment was divided into experimental conditions and control conditions. In the experimental condition, 3 subjects were asked to wear the determined best and worst colored glasses based on each subjects balance performance during the single-leg stand task (Innochi test) among 26 colored glasses to complete the single-leg, side-hop, front-hop task and in control condition, wore without lenses-glasses to complete the same task. Center of pressure data was recorded during the keeping balance.

RESULTS: In study 1, no significant effect of colored glasses was found, however, rankwise analyses of the data consistently revealed that participants performed the stances with different balancing strategies when wearing different colored glasses, regardless of the color itself. However, changes in standing stability when wearing different colored glasses could not be determined by the participants' subjective preference. In study 2, we used one-way ANOVA analysis to compare the data from the center of pressure in the three conditions. And we found that in the front-hop task, differences in center of pressure were observed between wearing different colored glasses when doing front-hop task under non-dominant leg (Environmental area: P=0.007, Root-mean-square area: P=0.016). The balance performance of wearing the best colored glasses is more stable compared to the worst colored glasses (Environmental area: Best-worst: p=0.03, Root-mean-square area: Best-worst: p=0.016).

CONCLUSION: Overall, our experiment confirmed that subjects subjective evaluations cannot be used to judge their balance performance with their preferred colored glasses. Different subjects will have different motor strategies with different preferred colors. Then we demonstrated that wearing different colored glasses could affect our balance task performance when doing a front-hop task. Our experimental results provide support and benefit for the future development of colored glasses to improve athletic performance.

CONCURRENT ACTIVATION POTENTIATION IMPROVES LOWER-LIMB MAXIMAL STRENGTH BUT NOT DYNAMIC BALANCE IN RUGBY PLAYERS

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INTRODUCTION: Concurrent activation potentiation (CAP) is the phenomenon that increases athletic performance by activating muscles not directly involved in the performed activity (1). Among the CAP strategies, the effect of mouthguard jaw clenching on strength and power has been exhaustively studied (2, 3). Conversely, its influence in dynamic balance control has been poorly investigated. Rugby players need high levels of strength and balance to cope tackling events and are familiar with mouthguard to protect their teeth from injuries. Therefore, this study aimed to understand whether mouthguard jaw-clenching could acutely improve rugby players' dynamic balance and strength performance.

METHODS: Thirteen rugby players were involved in a cross-sectional design to test their dynamic balance and lower-limb maximal strength in maximal bite (MB) and no-bite (NB) conditions. Balance tests were performed over a force platform (AMTI BP6040, Watertown, MA, USA) placed on a servo-controlled electrically driven movable platform (EnginLAB srl, Padua, Italy). Subjects underwent five trials wearing a boil-and-bite mouthguard for MB and NB with an anterior-posterior perturbation of the base of support (displacement: 100mm; ramp rate: 400mm/s). In the first 2.5 seconds after the perturbation, we calculated the following center-of pressure (CoP) parameters: the Area95 (the area of the 95th percentile ellipse), the Unit Path (the mean velocity), the first displacement after the perturbation point (First Peak), and the displacement between the maximum and minimum peak of the CoP trajectory (Δ Max). The dominant-limb maximal strength was tested isometrically on a custom-built chair with a load cell. Maximal strength and rate of force development (RFD) in the 0 to 50, 50 to 100, and 100 to 150 ms time windows were calculated.

RESULTS: The t-test analysis did not show any statistically significant difference between the MB and NB conditions for the dynamic balance parameters calculated. Maximal strength was higher ($p<0.05$) in the MB (817.81 ± 186.94) than NB (770.66 ± 190.43) condition. For all the time windows considered, RFD values were higher in the MB condition (RFD0-50: 1324.19 ± 276.94; RFD50-100: 749.76 ± 158.31; RFD100-150: 502.15 ± 122.40) than NB condition (RFD0-50: 1228.06 ± 230.28; RFD50-100: 638.54 ± 144.84; RFD100-150: 467.33 ±114.14).

CONCLUSION: Our results provide the first evidence that jaw-clenching-induced CAP did not improve dynamic balance performance. Moreover, mouthguard jaw clenching alone acutely increased maximal isometric strength and RFD. This finding agrees with previous literature (4) that showed how the combined effect of CAP strategies (hand gripping, jaw clenching, and Valsalva maneuver) improved knee-extensor strength compared to no CAP condition.

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Oral presentations

OP-MH11 Resistance training in cancer patients

NO ADVERSE EFFECTS ON THE ARMS VOLUME DIFFERENCE AND SHOULDER-ARM DISABILITIES AFTER A 12-WEEKS RESISTANCE TRAINING PROGRAM IN FEMALE BREAST CANCER SURVIVORS: EFICAN STUDY.

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INTRODUCTION: Shoulder-arm disabilities and lymphedema are two of the most prevalent breast cancer-related side effects. These side effects induce a reduced ability to perform daily life activities, which is of major clinical and public health concern. Several factors such as surgery type, lymph node resection and treatment type might influence the appearance of shoulder-arm disabilities and lymphedema after breast cancer. However, it remains unknown if these factors may also influence the effects of a resistance training program. The aims of these secondary analyses of the EFICAN study were i) to assess the effects of a 12-weeks resistance training program on arms volume difference and shoulder-arm disabilities in breast cancer survivors, and ii) to evaluate whether the main risk factors for developing cancer-related lymphedema and shoulder-arm disabilities were associated with the effects of the training program.

METHODS: 60 female breast cancer survivors participated in this clinical trial and were randomized to an exercise group (12-weeks resistance training program) or a control group. Eligibility criteria were to be a breast cancer survivor, and to have completed surgery, chemotherapy, and/or radiotherapy up to 10 years before recruitment. Exclusion criteria were to have metastatic breast cancer, to have a breast reconstruction intervention planned within 6 months, to have any absolute contraindication for exercise, to perform more than 300 minutes/week of structured exercise. The participants underwent baseline and 12-weeks assessments where the arms volume difference, shoulder-arm disabilities and upper-limb muscular strength were evaluated. The treatment-related information was registered through the medical history.

RESULTS: No between-group differences were observed on arms volume difference (1.207; 95% CI -0.964 , 3.377; P=0.270) or shoulder-arm disabilities (2.070; 95% CI -4.362 , 8.501; P=0.521) after the training program. Likewise, there was no association of the surgery type, presence of lymph node resection, chemotherapy, radiotherapy, and hormone therapy with the changes in arms volume and perceived shoulder-arm disabilities after the intervention. However, a higher change in upper limb muscular strength was associated with a reduced shoulder-arm disabilities (-0.426; P=0.020).

CONCLUSION: The findings of this study indicate that resistance training does not affect arms volume difference and shoulder-arm disabilities in female breast cancer survivors. The main risk factors for developing lymphedema were not associated with the effects of the intervention, although higher increase in upper-limb muscular strength was associated with reduced shoulder-arm disabilities.

FEASIBILITY OF PROGRESSIVE RESISTANCE TRAINING IN BREAST CANCER SURVIVORS SUFFERING FROM PERSISTENT PAIN

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INTRODUCTION: The current knowledge on the feasibility of performing progressive resistance training in female breast cancer survivors (BCS) suffering from persistent pain is lacking. The aim of this study was therefore to conduct a summative process evaluation of the analgesic effect of a resistance training trial (ANTRAC), delivered to female breast cancer survivors (BCS) with persistent pain > 1.5 years after treatment to evaluate the feasibility of this type of training intervention.

METHODS: Twenty BCS with self-reported pain intensity ≥ 3 on a 0-10 numeric rating scale participated in the ANTRAC trial and were randomized to either an experimental group (EXP) or a control group (CON). The EXP completed a 12-week supervised resistance training program, resulting in a significant decrease in pain sensitivity, but not pain intensity. Following the intervention, EXP performed a summative process evaluation examining three domains: Fidelity, Participants & Response and Context. Fidelity referred to participant compliance and the extent to which the intervention was delivered as intended. Participants & response referred to the participants interaction and satisfaction with the intervention within four topics: Structure, Character, Effect and Concerns and side effects. Context referred to environmental and organizational factors. A 5-point Likert scale was used for the responses.

RESULTS: Mean participant compliance was 91% with 72-99% of the sessions delivered as intended, indicating that fidelity was high. Most participants (90 % on average) agreed or strongly agreed with all statements regarding structure, character, and effect, and disagreed or strongly disagreed with experiencing concerns and adverse effects. Finally, 90% of the participants were satisfied with the training facilities, equipment, and location, indicating that the context was appropriate.

CONCLUSION: The summative process evaluation indicated that participants were satisfied with the structure and content of the RT intervention. This study and the associated clinical findings underline that progressive resistance training could be offered to BCS reporting persistent pain.

METHODS: RESULTS: CONCLUSION: EFFECTS OF ECCENTRIC VERSUS CONCENTRIC CYCLING EXERCISE ON NEUROMUSCULAR FATIGUE AND MUSCLE DAMAGE IN PATIENTS WITH BREAST CANCER

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INTRODUCTION: Patients with breast cancer treated with chemotherapy experience substantial fatigue and skeletal muscle deconditioning (1). Eccentric cycling might be an interesting exercise modality to provide a strong neuromuscular stimulus (i.e., neuromuscular fatigue) in order to alleviate these symptoms, while minimizing the impaired and limiting contribution of the cardiopulmonary system. However, the neuromuscular consequences of eccentric cycling remain unclear. This study aimed to investigate the magnitude and etiology of neuromuscular fatigue induced by eccentric cycling, compared to conventional concentric cycling performed at either similar power output or VO2 , in patients with breast cancer.

METHODS: After familiarizations to eccentric cycling, nine patients with breast cancer performed 3 cycling sessions (3x6min) in eccentric or concentric mode. Eccentric cycling session (ECC) was compared to a concentric session matched for power output (CONpower, 80% of concentric peak power output, 95±23W) and another one matched for VO2 (CONVO2, ~10 mL/min/kg). Central and peripheral fatigue were quantified via changes in pre- to postexercise voluntary activation (VA) and quadriceps potentiated twitch force (Qtw) evoked by supramaximal femoral nerve stimulation, respectively. Rate of perceived exertion (RPE) was assessed using the Borg CR-10 scale after each cycling session. Muscle damage was quantified in the blood pre- and 24h postexercise using creatine kinase (CK) and lactate dehydrogenase (LDH) activities. Muscle soreness was quantified 24h and 48h postexercise using a visual analogue scale.

RESULTS: ECC resulted in a greater decrease in MVC (-25±12%) compared to CONpower (-11±9%) and CONvo2 (-5±5%) post-exercise (P<0.001). VA decreased only in ECC (-9±6% postexercise, P<0.001). The decrease in Qtw was similar between ECC and CONpower post-exercise (-39±21% and -40±16%, P>0.99) but was lower in CONVO2 (-17±9%, P<0.001). CONpower resulted in a twofold higher oxygen consumption compared to ECC and CONVO2 (P<0.001). No change in CK or LDH activities were reported from pre- to 24h post-exercise. RPE was higher in ECC compared to CONpower (P=0.042), but lower compared to CONVO2 (P<0.001). Thigh muscle soreness was greater in ECC compared to CONpower and CONVO2 24h and 48h post-exercise (P<0.01).

CONCLUSION: This study demonstrated that eccentric cycling induced greater neuromuscular fatigue than concentric cycling performed either at similar power output or VO2, without inducing harmful muscle damage. While matched for power output, the metabolic demand was 44% lower in eccentric than concentric cycling. Taken together, eccentric cycling might be an interesting exercise modality to provide a strong neuromuscular stimulus while minimizing the impaired and limiting contribution of the cardiopulmonary system.

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EFFECTS OF HIGH VS. MODERATE INTENSITY COMBINED STRENGTH AND ENDURANCE TRAINING DURING CHEMOTHERAPY ON CARDIORESPIRATORY FITNESS, MUSCLE STRENGTH AND ENDURANCE IN WOMEN WITH BREAST CANCER

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INTRODUCTION: (Neo-)adjuvant chemotherapy for breast cancer has the potential to reduce recurrence and mortality but are often accompanied by significant adverse effects. Both aerobic and resistance exercise has been shown to be beneficial for individuals with adjuvant therapy-related side effects, but few studies has investigated the optimal intensity, and timing of an exercise intervention (1). High intensity exercise has previously shown promising results on muscle strength and maintenance of cardiorespiratory fitness in patients with breast cancer (2, 3). The aim of the current study was to to compare the effect of high-intensity (HIT) vs. moderate-intensity (MIT) combined strength and endurance training on cardiorespiratory fitness (VO2max), muscular endurance and muscle strength measured as 1 repetition maximum (1RM) in patients with breast cancer during chemotherapy.

METHODS: Women diagnosed with stage I-III breast cancer was randomized to 12 weeks of HIT (n=29) or MIT (n=36). Both groups performed home-based endurance training and supervised strength training twice a week. The HIT group trained at an intensity of 80-90% of the heart rate reserve (HRR) and 1RM and the MIT group at 40-50% of the HRR and 1RM. The aerobic exercise consisted of 5x2 minutes intervals in the HIT group, and as continuous work in the MIT group. Testing of VO2max, muscle strength and muscular endurance was performed between the first and second cycle of chemotherapy (T0) and after chemotherapy (T1).

RESULTS: At baseline, VO2max was 33±7 ml/kg/min and was reduced in both groups by 7±12% (p<0.05) in HIT and by 9±9% (p<0.05) in MIT with no significant difference between groups (p=0.569). Chest press 1RM at baseline was 27±7 kg and increased in the HIT group by 8±14% (p=0.02) and tended to increase in the MIT group with 6±15% (p=0.06). There was no significant difference between groups (p=0.536). Leg press 1RM at baseline was 41±18 kg and increased in the HIT group by 11±18% (p<0.005). There was no change in the MIT group (2±19% (p<0.74)) and no significant difference between groups (p=0.08). There were no significant change in leg extension 1RM from baseline (37±9 kg) in either group, or in muscular endurance (baseline 33±15 repetitions There were no significant differences between groups for neither leg extension (p=0.48) nor muscular endurance (p=0.21).

CONCLUSION: Neither HIT nor MIT counteracted the decline in VO2max in breast cancer patients during the chemotherapy treatment. However, the decline was slightly lower in the HIT group and HIT also increased muscle strength in chest press and leg press, which correspond with previous findings (3).

References

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2. Mijwel et al., Breast Cancer Res. Treat. 2018; 169:93–103.

3. Demmelmaier I, Brooke HL, Henriksson A, et al. Scand J Med Sci Sport. 2021; 31:1144–1159

EFFECTS OF HEAVY-LOAD STRENGTH TRAINING DURING (NEO-)ADJUVANT CHEMOTHERAPY ON CARDIORESPIRATORY FITNESS, MITOCHONDRIAL ENZYMES AND CAPILLARIES IN WOMEN WITH BREAST CANCER

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INTRODUCTION: (Neo-)adjuvant chemotherapy for breast cancer has deleterious effects on maximal oxygen uptake (VO2max), mitochondrial function and capillary content in muscles (1,2). Physical exercise during treatment may counteract some of these negative effects. However, the effects of strength training (ST) alone are not well documented. The aim of this study was to investigate if heavy-load ST can counteract the deleterious effects of chemotherapy treatment on VO2max and muscle content of mitochondrial enzymes and capillaries in women diagnosed with breast cancer.

METHODS: Women diagnosed with stage I-III breast cancer were randomized either to a ST intervention group (INT, n=23) or a usual care control group (CON, n=17). The INT group performed supervised heavy-load ST twice a week over the course of chemotherapy (approximately 16 weeks) whereas the CON group was encouraged to continue with their usual activities. Measures of VO2max and collection of muscle biopsies from m. vastus lateralis was performed before the first cycle of chemotherapy (T0) and after chemotherapy (T1). Biopsies were analyzed for mitochondrial enzymes (Citrate Synthase [CS], COX4 and HADH) in western blots and capillaries per fiber area (CAFA) by immunohistochemistry. Unpaired and paired t-test were used to test for differences between groups and within-groups respectively.

RESULTS: VO2max decreased from 28.3±7.2 to 26.5±5.8 ml•kg-1•min-1 (-6±11%, $p<0.001$) in the INT group and from 29.1±7.7 to 26.8±7.4 ml•kg-1•min-1 (-11±9%, $p<0.001$) in the CON group from T0 to T1 with no differences between the groups ($p=0.13$).

CS levels were reduced in the control group (14.9±14.8%, $p=0.004$) and COX4 tended to be reduced (-11±23%, $p=0.073$) from T0 to T1. No changes were observed in the INT group and the change from T0 to T1 was different between the groups ($p=0.04$). No significant changes occurred in HADH. For all three enzymes combined, there was a decrease in the CON group with no change in the INT group and a difference ($p<0.001$) between the groups in change from T0 to T1.

CAFA was reduced in the CON group from T0 to T1 with 19±25% ($p=0.02$) in the type 2 fibers and non-significantly in the type 1 fibers (-9±23%, $p = 0.14$). There were no changes in the INT group and the percent change from T0 to T1 was different between the groups in type 2 fibers ($p=0.03$) and in type 1 fibers ($p=0.05$). There was a positive correlation between the percent change in VO2max and the percent change in CAFA in the type 2 fibers ($r=0.55$, $p=0.01$).

CONCLUSION: The ST program did not counteract the decline in VO2max in breast cancer patients during the chemotherapy treatment. However, ST prevented the decline in muscle mitochondrial enzymes and capillaries which was observed with usual care chemotherapy. Our data suggest that ST alone can preserve aerobic properties of the muscle cells in breast cancer patients during chemotherapy treatment.

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Oral presentations

OP-SH13 Sport Management and Law

RESIDENTS' PERCEIVED QUALITY OF LIFE TOWARDS SPORTS EVENTS: SYSTEMATIC LITERATURE REVIEW AND META-ANALYSIS

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Introduction

Sports events have numerous impacts on the host city such as economic and cultural impacts (Gursoy & Kendall, 2006; Kaplanidou et al., 2013). Among the potential benefits, a positive impact on host residents was one reason why cities bid to host sports events. When an event is held, residents' interactions with participants directly or indirectly affect their QoL (Quality of Life). Previous studies argued that the host residents who perceived higher QoL are more likely to support recurring sports events or recommend them to others. However, systematic reviews and comprehensive quantitative analysis

of the accumulated data are still lacking between residents' perceived impacts of sports events and QoL. The aim of this study is to identify the determinants of perceived QoL of the host population, to access the effect between different impact perceptions and QoL, and to examine whether host residents who perceive higher QoL have more support toward sports events.

Methods

The present study followed Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P), and the SPIDER framework was utilized to formulate the search strategy. EBSCO, Scopus, T&F, Emerald, and WOS databases were searched in January 2023. The search in 5 databases returned 1306 articles. Ultimately, 9 studies of QoL outcomes were included in the assessment and synthesis process.

Results

The meta-analysis results revealed a correlation between overall impact perceptions and QoL with r =0.23 (95%CI= 0.06-0.39). The r value for the correlation between economic impacts, sociocultural impacts, psychological impacts and QoL respectively: 0.28 (95%CI=0.03-0.49,k=3,n=3,189, Q=87.83,p<.001), 0.44(95%CI=0.26-0.59,k=3,n=3,189, Q=59.94,p<.001), 0.260 (95%CI=0.23-0.29, k=3, n=3,196, Q=0.07,p=0.97). The findings suggested a positive correlation between residents perceived overall QoL and their support for the sports event (r=0.27, 95%CI=0.17-0.36). Results showed that residents perceived higher overall QoL in their support for non-mega events than for mega-events. Besides, Residents in Asia are more sensitive to overall QoL when deciding on event support compared to North America. The present study also found no significant difference in perceived QoL during different phases of the sports event (95%CI=-0.01-0.31, k=4, n=7,984).

Discussion

The study found a significant positive impact of economic, sociocultural, and psychological factors on host residents QoL, with sociocultural impacts having the largest effect. The perceived overall QoL had a small effect on residents support for the event. Hence, we suggested that governments or event organizers could enhance host residents' support when bidding on sports events by emphasizing the potential sociocultural benefits, especially for mega sports events. Findings clearly suggest that a closer examination of different time points of sports events used to assess the QoL perceptions is needed.

CAN THE CREDIBILITY OF GLOBAL SPORT ORGANIZATIONS BE RESTORED? A CASE STUDY OF THE ATHLETICS INTEGRITY UNIT (AIU)

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This paper explores how the credibility of global sport organizations can be renegotiated in a post-scandal context. Many large-scale governance and integrity scandals have marked the recent history of sports organizations. In some cases, and under external pressure, this has led Global Sports Organizations (GSOs) to set up regulatory entities, such as the WADA.

Theoretical Frame

The paper draws on Goffman's frame analysis to understand how the AIU has managed to produce a framing that allows it to cope with and even overcome the discredit linked to the athletics doping scandals. We analysed three key factors □frame consistency, empirical credibility, and credibility of the frame articulators□, to understand "why some framings seem to be effective or 'resonate' while others do not" (Benford and Snow, 2000: 619).

Methods

1. A media analysis: in total, 14 outlets were included in the analysis, covering a total of 1111 articles from both news media and specialized analytical journalism on GSOs or athletics.

2. Social media analysis was conducted in a third step to identify and analyze messages expressed through Twitter.

3. Data on how IAAF/WA, AIU and representatives framed the AIU in their public communication.

4. Interviews with international antidoping specialists

Results

The frame consistency, empirical credibility and the credibility of the frame articulators contributed to the construction of credibility. Besides, transparency and accountability helped to align the athletics authorities' strategic self-framing with the frames used by external stakeholders. Through the social production of its own performance, the Unit could escape the reputation stigma that has discredited other federations and sport organizations.

The absence of structural criticism, the praise emanating from leading media or industry representatives around both the governance and the effectiveness frames and the trend for naming the AIU as a good –if not best– practice in the sport sector, provide indication of this success and show that AIU's frame consistency, empirical credibility, and credibility as articulators have so far been effective and 'resonate' within the audience (Benford and Snow, 2000). The AIU case study proves instructive as it represents renewed practice for the sector. Through the social production of its own performance, the AIU could appear to escape the reputation stigma that has condemned other federations and sport organizations. AIU's case shows that the traditional mode of sport governance, based on a front stage of celebration and self-

congratulation, a lack of transparency, sweeping the dust under the carpet, and decisions taken behind the scenes, is no longer accepted, at least in the democratic countries.

THE ROLE OF RURAL SPORTS PROGRAMS IN POVERTY ALLEVIATION AND THE PREVENTION OF POVERTY RETURNING IN CHINA

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Introduction

Through eight years of sustained work, China has lifted all rural poor population under the current standard out of poverty. Rural sports programs have played an important role in poverty alleviation and the prevention of poverty returning in China. Sports programs can reduce poverty by promoting health, education and diplomacy in developing countries. To provide references for the development of sport in the developing countries, it is important to make an intensive study of the role of rural sports programs in poverty alleviation and the prevention of poverty returning in China.

Methods

This study analyzes the history, the policies, the theories, and the governance system of poverty alleviation through rural sports programs in China, which will be examined by incorporating a literature review and comparative analysis into this paper.

Results

Based on the in-depth analysis of social functions of sport and rural poor people, Chinese sport administrators and sport management departments have formulated well-defined policies to guide the operation of poverty alleviation through rural sports programs, among which Opinions on the Implementation of Poverty alleviation through Sport Project released in 2018 by General Administration of Sport of China make a huge difference. In view of local conditions, different modes are used to shake off poverty and prevent poverty returning, including "sport plus tourism", "sport plus facilities", "sport plus health", "sport plus culture", "sport plus education", and "sport plus events".

Discussion

Through events and sport tourism, the underdeveloped areas have got investment from public institutions and private capitals. Through physical education and sport culture activities, rural poor people have got skills and willpower to eliminate poverty. Especially for those who fell into poverty due to illness, sport is an effective means of helping people to improve health and shake off poverty. Besides being a means of eliminating poverty, sports programs have also played an important role in preventing poverty returning.

Oral presentations

OP-MH10 Cardiovascular disease/Hypertension

BENEFICIAL EFFECTS OF A PERSONALIZED E-TRAINING PROGRAM IN MARFAN PATIENTS: THE FIRST RANDOMIZED CONTROLLED STUDY

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INTRODUCTION: Marfan syndrome (MFS) is a rare genetic disorder primarily affecting the vascular system. This randomized controlled trial aimed at characterizing the physical abilities and quality of life (QoL) of MFS patients and designing and proposing a 3-month personalized e-training program. To demonstrate that a personalized e-training program improves the QoL of patients with MFS. Secondary objectives: 1/ To determine the beneficial effects of the e-training program on the physical capacities of patients. 2/ To demonstrate the safe nature of the management of MFS patients through a personalized e-training.

METHODS: 82 Marfan patients and 35 healthy subjects (H-S) were included in this study. MFS patients were randomly divided into 2 groups (control and trained) and compared with 35 healthy subjects. Different parameters (e.g., V'O2peak, aortic diameter, 1RM, pulse wave velocity (PWV) and QoL (MOS SF-36) were assessed pre and post training.

RESULTS: The MFS significantly decreased the V'O2peak (-25%; $p<0.001$) and the QoL of patients compared to H-S. The e-training increased the V'O2peak (+3 mL/min/kg in average) and improved the scores of all MOS SF-36's dimensions. It also improved arterial pressure during exercise and had no adverse effect on aortic diameter (pre vs. post training: aortic root: 39±5 vs. 38±5 mm; $p= 0.71$) in our young MFS population.

CONCLUSION: Our e-training produced beneficial effects on MFS patients and maintained stable the aortic diameter. This work supports the feasibility and safety of personalized training for the management of MFS patients without severe symptoms.

THE EFFECT OF AEROBIC TRAINING ON EXERCISE-INDUCED HYPERTENSION IN ADULTS WITH PERSISTENT OR PERMANENT ATRIAL FIBRILLATION: A SECONDARY ANALYSIS OF THE OPPORTUNITY TRIAL.

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INTRODUCTION: Exercise-induced hypertension (EIH), defined as a systolic blood pressure (BP) of ≥175 mmHg and/or diastolic BP of ≥110mmHg at low-to-moderate exercise intensity, leads to a 36% increase in cardiovascular events independent of resting BP. Up to 80% of adults with atrial fibrillation (AF) suffer from hypertension which is an independent risk factor for ischemic or haemorrhagic strokes. EIH may be a useful prognostic tool for screening hypertension control in people with AF and an important treatment target. Aerobic training is an effective strategy for improving resting BP, however the effect of aerobic training on EIH in adults with AF has yet to be explored. The aim of this study was to determine if aerobic training is effective for reducing the burden of EIH in adults with persistent or permanent AF.

METHODS: Secondary analysis of a randomised controlled trial. Adults with persistent and permanent AF were randomised to 12-weeks of twice weekly aerobic training of: (i) high-intensity interval training (HIIT): 2 sets of 8 x 30-second high-intensity intervals at 80-150% peak power output interspersed with 30-second recoveries. A 4-minute recovery between sets was provided; or (ii) moderate-to-vigorous continuous training (MICT; standard-care control): 30 minutes at 67-95% heart rate peak or 12 to 16 on the Borg's Rating of Perceived Exertion Scale. EIH was assessed using peak systolic and diastolic BP recordings completed immediately following a six-minute walk test (6MWT); tests were completed at baseline- and 12-week follow-up. Two-proportion Z-test and chi-squared analyses were performed to determine differences in baseline vs. 12-week follow-up proportions in EIH (BP: ≥170/110mmHg) and differences between HIIT vs. MICT and EIH proportions, respectively.

RESULTS: Eighty-six adults with AF (age: 69±8 years, 32% females, resting systolic BP: 126±17mmHg, resting diastolic BP: 78±10 mmHg) were randomised into HIIT (n=43) or MICT (n=43). Most patients were taking anti-hypertensive medications (64% beta-blockers; 24% ACE-inhibitors; 20% angiotensin-receptor blockers). Overall, 11% of patients were categorized with EIH at baseline. Following 12-weeks of either HIIT or MICT, only 4% of patients had EIH; this reduction in EIH burden was not significant (p=0.07). A total of 35 out of the 69 (51%) patients who completed the intervention experienced a reduction in peak systolic BP across both the HIIT and MICE groups. No significant differences were observed between HIIT or MICT for changes in EIH or peak BP (mean: 144/84±16/11mmHg).

CONCLUSION: EIH was present in 1 in 10 patients with AF in our cohort, despite most patients taking anti-hypertensive medications. Monitoring EIH following a 6MWT or exercise stress test may be a cost-effective tool for screening BP control in this population. Our data also suggests 12-week, twice weekly HIIT or MICT may potentially be effective for mitigating EIH in adults with AF.

EVENING BUT NOT MORNING AEROBIC-TRAINING IMPROVES SYMPATHETIC ACTIVITY AND PERIPHERAL BAROREFLEX SENSITIVITY IN TREATED HYPERTENSIVE ELDERLY PATIENTS: A RANDOMIZED CLINICAL TRIAL

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INTRODUCTION: In a previous study with middle-aged treated hypertensive men, we observed that aerobic training conducted in the evening induces greater blood pressure (BP) decrease than when conducted in the morning (1). Additionally, this greater BP reduction was accompanied by a greater reduction in the low frequency component of BP variability, suggesting a greater effect of evening training on peripheral sympathetic autonomic system, which needs to be tested using direct measures. Therefore, this study was designed to compare the effects of aerobic training conducted in the morning (MT) and in the evening (ET) on muscle sympathetic nerve activity (MSNA) and peripheral baroreflex sensitivity (BRS) in treated hypertensive elderly patients.

METHODS: The study was conducted in a single-center with a parallel-group design. Twenty-three patients with treated hypertension were randomly allocated into two training groups: MT (n=12, 5 men, 69±7 yr) and ET (n=11, 7 men, 65±5 yr). Training protocols were identical in both groups (cycling, 3 times/week, for 45 min at moderate intensity), but MT was conducted between 7 and 10 a.m., while ET occurred between 5 and 8 p.m. Before and after 10 weeks of training, beat-to-beat BP (finger photoplethysmography), heart rate (electrocardiography), and muscle sympathetic nerve activity (MSNA, fibular nerve microneurography) were assessed. Additionally, peripheral BRS was evaluated by the modified-Oxford technique using bolus injection of nitroprusside followed by phenylephrine. Peripheral BRS was quantified by the slope of the weighted negative linear regression between diastolic BP and MSNA burst incidence. Two-way mixed ANOVAs were employed, and significance level was set as P≤0.05.

RESULTS: From pre- to post-training, systolic BP decreased in ET, but did not change in MT (149±9 vs. 136±16 and 146±10 vs. 145±15 mmHg, respectively, P interaction =0.04), while diastolic BP decreased similarly in both groups (ET = 80±7 vs. 76±13 and MT=78±13 vs. 76±11 mmHg, P phase =0.05). MSNA presented a greater decrease after ET than MT (42±3 vs. 33±4 and 40±5 vs. 37±4 bursts/100bpm, respectively, P interaction=0.04). Peripheral BRS improved in ET and did not change in MT (-1.44±0.63 vs. -2.20±0.58 and -1.63±0.68 vs. -1.62±0.86 bursts.100 heartbeats-1.mmHg-1, respectively, P interaction=0.05).

CONCLUSION: In hypertensive elderly patients receiving anti-hypertensive medication, 10 weeks of aerobic training conducted in the morning as well as in the evening decreases diastolic BP, while only aerobic training conducted in the evening improves systolic BP, MSNA, and peripheral BRS.

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EFFECTS OF DIFFERENT MODES OF ISOMETRIC RESISTANCE TRAINING ON AMBULATORY BLOOD PRESSURE VARIABILITY IN HEALTHY NORMOTENSIVES

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INTRODUCTION: One third of deaths globally each year are associated with hypertension, a modifiable risk factor for cardiovascular disease. Diurnal blood pressure (BP) variability including morning blood pressure surge (MBPS) and average real variability (ARV) of ambulatory BP, are associated with increased risk of stroke, heart failure and end-organ damage. Laboratory isometric resistance training (IRT) protocols have identified reductions in ambulatory BP MBPS and ARV following 8-10 weeks of training, however no research has investigated the effects of short-term IRT on ambulatory measures in normotensives. Therefore, the purpose of this study was to determine the effects of a novel home-based IRT device on ambulatory BP, MBPS and ARV in normotensives following 4 weeks of IRT.

METHODS: Thirty-eight normotensives (20 men, age = 33 ± 14 yr; 18 women, age = 28 ± 13 yr) were randomly assigned to an isometric handgrip training (IHG, n = 13), isometric training band (ITB, n = 12) or control (CON, n = 13) group. Before and after the 4-week laboratory-based training programme, resting and ambulatory BP, MBPS (mean systolic BP 2 hours after waking, minus the lowest sleeping 1-hour mean systolic BP) and ARV (calculated as previously reported [1]) were measured. IRT consisted of 4 x 2-minute contractions at 30% MVC (IHG) or at a perceived rate of exercise exertion equivalent to 30% MVC (IBT), with 2-minute rest periods, 3 days per week. A two-way repeated measures ANOVA was used to assess the within and between groups changes in resting, ambulatory BP MBPS and ARV.

RESULTS: Significant ($P < 0.05$) reductions were detected in resting systolic BP for both training modes (IHG = -5 ± 4mmHg; ITB = -5 ± 3mmHg) with no further reductions in resting BP measures. Additionally, no significant reductions were seen in 24-h (IHG = -1 ± 6mmHg; ITB = 2 ± 7mmHg), daytime (IHG = 0 ± 6mmHg; ITB = 1 ± 7mmHg) or night-time systolic ambulatory BP (IHG = -4 ± 7mmHg; ITB = -4 ± 8mmHg). Furthermore, no significant changes were observed in the MBPS (IHG = -1 ± 15mmHg; ITB = 1 ± 10mmHg), 24-h (IHG = 1 ± 3mmHg; ITB = 1 ± 2mmHg) or daytime (IHG = -1 ± 2mmHg; ITB = 0 ± 2mmHg) ambulatory ARV systolic BP.

CONCLUSION: These results support the unpublished data establishing the novel training device as a valid tool for lowering resting systolic BP and provides further evidence that IRT is effective for lowering resting BP in normotensives. However, the lack of significant reductions in ambulatory BP, MBPS and ARV following a four-week IRT programme may indicate that for diurnal BP reductions to occur a longer training stimulus may be needed. Further, the absence of any ambulatory reductions may be associated with the proposed biphasic pattern to vascular adaptations.

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THE EFFECTS OF COCOA FLAVANOLS ON UPPER AND LOWER LIMBS DURING UNINTERRUPTED SITTING: INSIGHTS INTO MACRO- AND MICROVASCULAR FUNCTION

DANIELE, A., LUCAS, S.J., RENDEIRO, C.

UNIVERSITY OF BIRMINGHAM

INTRODUCTION: Prolonged sitting affects endothelial function in peripheral conduit arteries. Nutritional strategies might play an important role in counteracting these negative effects. Consumption of cocoa flavanols enhances peripheral vascular function, as measured in the brachial artery via flow-mediated dilation (FMD); however, whether this positive outcome is also present in the superficial femoral artery is not known. The objective of this study is to investigate whether acute ingestion of cocoa flavanols can prevent sitting-induced impairments in macrovascular and microvascular function in both the upper and lower body vasculature in young healthy adults.

METHODS: In a randomized, double-blind (the two cocoa beverages remain blinded as 523, and 947), cross-over trial, 13 young healthy men (age: 23 ± 3 years) completed two, 2-hour sitting conditions with consumption of either a high or low flavanol cocoa beverage. FMD and shear rate of the femoral and brachial artery, microvascular function (i.e., reperfusion slope) of the calf (assessed via near-infrared spectroscopy), and blood pressure, were collected before and after the 2-hour sitting intervention.

RESULTS: In these initial 13 participants (recruitment target n=36; complete set of data will be available at the time of the presentation), sitting significantly reduced femoral FMD (pooled data: 4% vs. 2.7%, p=0.011). However, this detrimental decline in vascular function was prevented in response to only one of the two cocoa beverages (i.e., 523). Reperfusion slope was not affected by sitting; however, our preliminary data suggests that cocoa beverage 523 may have a positive impact on reperfusion slope (although not statistically significant). In regard to brachial FMD, no significant changes were observed neither in response to sitting nor cocoa ingestion. Furthermore, these preliminary data suggest that sitting may have a negative impact on brachial FMD (pooled data: 5.5% vs. 4.8%, p=0.28; interaction: p=0.09), but this is only observed following cocoa beverage 947. In addition, positive shear rate declined in both the femoral (p<0.01) and brachial

artery (p<0.01) following sitting, although this was not differentially affected by flavanol content (interaction: p>0.1). No significant changes in blood pressure were observed neither in response to sitting nor cocoa ingestion. Finally, the impact of individual's cardiorespiratory fitness on vascular function in response to cocoa ingestion and sitting will be available at the time of the presentation.

CONCLUSION: Preliminary observations highlight the potential impact of cocoa consumption in ameliorating macrovascular and microvascular function following uninterrupted prolonged sitting, specifically in the lower limbs. Hence, cocoa consumption may be effective in attenuating sitting-induced vascular dysfunction in lower limb conduit arteries.

Oral presentations

OP-SH07 Physical activity promotion

STRENGTHENING COMPETENCES OF FUTURE HEALTH PROFESSIONALS IN PHYSICAL ACTIVITY PROMOTION: THE DEVELOPMENT OF AN INTERPROFESSIONAL PEDAGOGICAL TOOL ON THE EXAMPLE OF THE COMMUNITY-BASED PROGRAM: "MOVE Y

WEGRZYK, J.1, LOTFY, H.1,2, SCHLÄPPY, F.1, SANTOS-ROCHA, R.3, DE LABRUSSE, C.1, HYVÄRINEN, M.1

SCHOOL OF HEALTH SCIENCES, UNIVERSITY OF APPLIED SCIENCES WESTERN SWITZERLAND

Introduction: Health professionals play a crucial role in promoting active lifestyles thereby increasing well-being and lowering the rate of noncommunicable diseases. Yet, university students (including future health professionals) do not meet guidelines on physical activity (PA) and sedentary behaviour [1, 2]. Meaningful and innovative learning environments could sensibilize and empower them to increase control over their own health and to promote PA in the community [3]. On the basis of the perinatal program "Move your Baby (MYB)" [4], as part of the BSc curriculum at HESAV, we developed a theory-based pedagogical tool to support evidence-based practice in PA promotion.

Methods: An online survey on PA and sedentary behavior was developed for the students including the study courses: physiotherapy, nursing, midwifery, radiologic medical imaging technology. Subsequently, a transversal pedagogical device for PA promotion for interprofessional and community-based settings was developed based on previously identified barriers to promote PA according to the Behavioral Change Wheel [5] and experience from the MYB program in which more than 200 BSc students participated since 2018. A self-administered questionnaire based on Gérard's method [6] is used to rate the tool's pedagogical effectiveness.

Results: 73% of the students (HESAV, n=193) reported sitting activities of >6h, and dissatisfaction (> 50%) with regards to access opportunities to be more active in and around the campus. The evidence-based, transversal pedagogical device has been implemented in the BSc curriculum of physiotherapy (n=70/year) and midwifery (n=60/year). Evaluation grids allowed to standardize interventions and evaluation processes. Students are currently rating improvement in their knowledge, skills and confidence to promote PA in order to rate the tool's effectiveness.

Discussion: Offers to increase the students' level of PA as well as meaningful learning environments through community-oriented educational programs can support identifying with the role as future health promoters, understanding social determinants of health, and providing personalized counseling in PA. We present a generic framework that guide behavioral change intervention and can be adapted and implemented for (future) exercise professionals while addressing different target groups (e.g., children, seniors).

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NEGOTIATING A PHYSICALLY ACTIVE LIFE DURING THE SCHOOL DAY –– AN ETHNOGRAPHIC MULTIPLE CASE STUDY IN SWEDISH SECONDARY SCHOOLS

HOY, S., THEDIN JAKOBSSON, B., LUNDE, C., LARSSON, H.

THE SWEDISH SCHOOL OF SPORT AND HEALTH SCIENCES

Introduction

A national policy for physical activity in Swedish compulsory school can be found in the general curriculum, where it states that "the school should also strive to provide all students with daily physical activity within the framework of the entire school day" (SNAE, 2019). Yet, many schools seem to struggle to meet this task. The aspiration to provide all students with daily physical activity in school settings are far more paradoxical than at a first glance. Educational settings are often

defined as 'the solution', because it gathers all adolescents during a third of the day. And, whilst the health benefits of physical activity are well documented, the reasons for choosing these behaviors or not are complex, related to social, cultural, and gender structures of the school and its individuals.

The objectives of this study are to explore secondary schools (i) understandings and practices connected to the physical activity policy embedded in the general curriculum, and (ii) what the perceived barriers and facilitators towards implementation of the policy are.

Methods

This ethnographic multiple-case study was performed by a team of four researchers over the course of a year in four Swedish secondary schools. The fieldwork involved participant observations, informal conversations, and semi-structured interviews (72 interviews with 86 respondents) with school management, staff responsible for secondary students and for student health or/and are engaged in physical activity, physical education teachers, as well as secondary school students (13-14 years old). All phases of data analysis were performed using reflexive thematic analysis.

Results and Discussion

Preliminary results show that the structure of the school and its environments clearly influence the opportunities and conditions for physical activity during a school day. At the same time, the age of adolescence is a period in life when we go from being children to becoming adults, where independence increases and thence the free choice of being active or inactive. Students own influence and participation in how they want to be active or not should reasonably increase with their development in autonomy. With this autonomy, physical activity behaviors also work as a social marker that is informed by gendered and socio-cultural structures. It appears to create tension between the ideas of agency and structure, both at the individual level but also at the school organisational level. Conflicting ideas between the public good and private rights often seem to arise in this endeavour.

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CORPORATE WELLNESS: INTERVENTION TO PROMOTE PHYSICAL ACTIVITY, ERGONOMICS, HEALTH AND ACTIVE LIFESTYLE WITH ONE YEAR FOLLOW-UP

FRACCA, I.

STUDIO PREVENZIONE E SALUTE DI FRACCA DOTT.SSA ILENIA

Introduction. The promotion of health in the workplace plays a role of increasing importance at European level, worthy of note is the "European Network Workplace Health Promotion" (ENWHP) program. Industry leading company in the production of machines for tanneries and equipped with a gym, hosted us to conduct our study.

Aims. This study evaluated the effectiveness of an informative workplace wellness program in increasing physical activity levels, reducing sedentary behaviour and musculoskeletal disorders in staff.

Methods. In the beginning, 89 Employees (E) (average age=45.2 years, 8.9% female (F) divided in 50 Operational Staff (OS) and 39 Offices Employees (OE), completed three questionnaires: International Physical Activity Questionnaire (IPAQ short form),Occupational Sitting and Physical Activity Questionnaire (OSPAQ), Nordic Musculoskeletal Questionnaire (NMQ). At the same time, postures during work were observed, photographed and analysed. These observations were followed by 3 information bimonthly phases: company training meeting for E, distribution of an information brochure on the physical activity benefits and distribution of different protocols of adapted physical exercise for OS and OE.

At the 1-year FOLLOW-UP, 73 E, (average age=45 years, 7.3% F, OS = 38, OE = 35), compiled the questionnaires IPAQ, OSPAQ, NMQ and Client Satisfaction Questionnaire-8 (CSQ-8) which contained a space for suggestions. Data were examined with chi-Quadro and ANOVA for repeated tests.

Results. In initial data it was observed that only 15% of E used the company gym, and 69.66% could be considered very active (IPAQ). Many of the E suffer or have suffered in the last 12 months from musculoskeletal disorders (NMQ): lumbar area E=51,69%, OS=60%, OE=41,03%; cervical area E=49,44%, OS=44%, OE=56,41%.

In the follow-up (dropout 17.98%), there were significant changes in OSPAQ: in the OS a reduction in time spent standing ($P = 0.004$) and an increase in time spent walking ($P = 0.008$) in one day, in E the time spent standing is reduced ($P < 0.05$) which goes from 40.57% to 30.41% of the total time.

No significant differences were observed in physical activity levels (MET-min/wk), working day sitting time and musculoskeletal disorders by anatomical district (NMQ) although a tendency to decrease in general is noted.

Conclusions. This workplace wellness was much appreciated, the ergonomic recommendations were followed, however it did not affect the use of the company gym and in the reduction of musculoskeletal pain by anatomical district (NMQ) although there is a tendency towards lack in general, did not improve the already high levels of physical activity. Considering the average age and that many E suffer or have suffered from musculoskeletal disorders further and different proposals are needed.

11:00 - 12:15

Plenary sessions

PS-PL02 The development of sports champions: applied perspectives on the nature vs nurture conundrum

HOW SPORTS CHAMPIONS DEVELOP MAY NOT BE HOW YOU THINK

MACNAMARA, B.
CASE WESTERN RESERVE UNIVERSITY

What makes a champion? Two popular theories, one from psychology and one from sports science, have emerged offering countering claims. According to the deliberate practice view, athletes who specialize early and engage in maximal amounts of coach-led practice will prevail. In contrast, according to the deliberate play view, athletes who play multiple sports for fun at young ages will prevail.

Which is correct? To an extent, the answer depends on the age of the athletes: When examining youth athletes, meta-analyses reveal results aligned with the deliberate practice view: Compared with their national-class counterparts, international-class athletes specialized earlier and had accumulated more coach-led practice in their main sport. However, when examining adult athletes, the pattern is the opposite: Compared with their national-class counterparts, world-class athletes specialized later and had accumulated more coach-led practice in other sports, but less overall practice in their main sport.

These results tell us that the oft-regaled tales of Tiger Woods and Serena Williams starting at a young age and focusing on their sport to become great champions are the exception, not the rule. In fact, these tales are often false: Both Tiger Woods and Serena Williams played multiple sports before specializing in their main sport.

Nonetheless, several questions often emerge after hearing these findings. Did the results differ by type of sport played? They did not. Were world-class athletes simply more talented athletes, better at multiple sports? World-class athletes reached sports-specific milestones later than their national-class counterparts, indicating they were not outperforming the competition when they were younger. Does the deliberate play view explain these differences? Amount of peer-led play had little on performance at any age or level of competition.

These results align with other, more recent meta-analyses indicating that the top junior athletes do not become the top adult athletes (and that the top adult athletes were not top junior athletes). Junior performance explains less than 2% of the variance in performance as an adult. At the oldest junior age category, only 1 out of 4 international-level performers reach the international stage as adults. At one age category younger, the number drops to 1 out of 11. One age category younger, 1 out of 17. This suggests that talent identification based on a young athlete's current performance is misguided.

Why is youth performance such a poor predictor of later performance? Along with dropout due to burnout, injury, or other reasons, various predictors may develop at different times and speeds across individuals, such as biological maturation. My plenary partner, Craig Harrison, will continue this discussion, addressing various physiological issues in the context of developing sports champions.

BIOLOGY TO BEHAVIOUR: ADVANCES IN TALENT DEVELOPMENT

HARRISON, C.
AUCKLAND UNIVERSITY OF TECHNOLOGY

How do we keep potential champions in sport long enough to prevail? Since youth sports began in the early 20th century, kids have competed based on chronological age. Twelve-year-olds against other 12-year-olds. Fifteen-year-olds against other 15-year-olds. Yet while chronological age increases at the same rate for everyone, biological age does not. Kids develop at different rates. Some earlier. Some later. Thus, athletes with the same birth date can differ considerably in their biology. How does this affect talent identification? While skill plays an obvious role in top junior performance, an increasing body of research shows the significant impact of biological maturation.

Studies examining selection in youth sports indicate a distinct bias towards early developing athletes. Simply put, bigger, faster, stronger kids are more likely to make the team. Why is this true? In junior cricket, biologically older players bowl faster, throw further, hit harder, and perform better in tests of body strength, increasing cricket performance. In football and basketball, advantages in strength, power and speed give the early-maturing player the edge in competition. Crucially, such physical advantages show up in the evaluations of coaches during selection. A bias that, in some cases, is not lost until the transition from junior to senior sport.

The fact that potentially skilled but later-maturing athletes are less likely to make the team, and/or more likely to be deselected, is a failure of our talent system. Because short-term outcomes trump long-term development, kids with promise but who can't yet compete physically, are overlooked. However, new approaches that assess individual growth rates are starting to appear, with exciting implications for athlete development. New research in swimming shows, for instance, how maturation-based corrective adjustments may start levelling the playing field for young athletes.

Changes in biology not only influence who makes the team but a young athlete's development trajectory once they get there. Most noteworthy is how they cope with training volume and intensity. Rapid increases in height and weight common during the adolescent growth spurt change the way an individual experiences sport. Coordination can be lost. Skill can digress. Bones and tendons become more sensitive to stress. And all at a time when for a talented young athlete, demand typically goes up!

The adolescent growth spurt is a crucial stage of development. Major physical and physiological changes lead to fluctuations in performance and a heightened risk of injury. Importantly, new research investigating methods to control load exposure and stabilise the stress response amongst developing athletes is encouraging for healthy athlete development.

What is youth sport for? How we identify potential sport champions, as well how we develop them once they appear, starts with answering this question.

13:15 - 14:30

Invited symposia

IS-AP05 Repeated Sprint in Hypoxia – What now? what next?

HAPPY BIRTHDAY RSH - 10 YEARS OF INNOVATION - AN UPDATE

MILLET, G.

UNIVERSITY OF LAUSANNE

The first publication on RSH is dated 2013. After 10 years, more than 50 publications have been published in a large range of sports from badminton to rugby or cross-country skiing. RSH effectiveness seems due to large recruitment of fast-twitch (FT) fibers combined to a compensatory vasodilation (with an increase in blood flow) mechanism; overall benefiting more FT fibers due to their great fractional O2 extraction (when highly perfused). The oxidative-glycolytic balance during RSH sessions and the minimal hypoxic dose are also important points to be considered. Many areas remain non investigated; e.g. induced fatigue? optimal conditions? potential adaptation and translation to clinical patients (PAD, elderly, ...)? Is it limited to team or racket-sports players?

In this session, we will also discuss the limitations of RSH and why it may not work for you.

RSH AND DIETARY NITRATE SUPPLEMENTATION: IS IT THE WHOLE GREATER THAN THE SUM OF ITS PARTS?

SOUSA, A.

UNIVERSITY OF TRÁS-OS-MONTES E ALTO DOURO

High-intensity interval training (HIIT) and repeated sprint training in hypoxia are gaining attractiveness and are based on different mechanisms. Combining nutritional strategies while performing RSH may result in more favourable outcomes on performance. One nutrient is of particular interest: inorganic nitrate (NO3-), a precursor of nitric oxide (NO), which is normally ingested by athletes in the form of beetroot juice. NO production, via NO3- supplementation, is accelerated in both acidic and hypoxic environments, seeming to be one of the primary vasodilatory candidates for the enhanced RSHs hyperemia. Collectively, dietary NO3- has the potential to improve training adaptation under hypoxic conditions as could be particularly effective to ameliorate the adverse impact of hypoxia. Studies performed within lighter exercise intensities and/ or during short period of supplementation, suggest that dietary NO3- reduces muscle metabolic perturbation and that muscle oxygenation status and exercise tolerance are improved. However, recent acute and chronic interventions have shown that dietary NO3- supplementation could be interpreted as unnecessary to improve performance or training adaptation when RSH is conducted. This session will assist athletes and coaches, to consider the recommended supplementation protocols to improve performance or training adaptation in hypoxic conditions, particularly when RSH is performed.

COMBINING ENVIRONMENTAL STRESSORS WITH REPEATED-SPRINT TRAINING IN HYPOXIA: WHAT TO EXPECT, WHERE TO GO?

BROCHERIE, F.

FRENCH INSTITUTE OF SPORT

Repeated-sprint training in hypoxia (RSH) has been demonstrated to provide putative physiological and performance benefits. Recently, repeated-sprint training in the heat was also shown to enhance fitness level, thereby conferring a substantial interest in the combination of both environmental stressors to maximize the physiological adaptations and performance gains. Contrasting findings question whether the addition of heat during RSH confers a greater physiological and/or mechanical strain and induced larger performance alteration, which may depend on the environmental dosage and training characteristics. This presentation will summarize the last evidences on RSH-based training combined with other environmental stressors and discuss future perspectives.

Oral presentations

OP-PN16 Muscle Metabolism II

UNDERLYING SKELETAL MUSCLE DETERMINANTS OF THE FORCE-VELOCITY-ENDURANCE PROFILE OF ELITE ENDURANCE ATHLETES

BLERVAQUE, L.1, DELHAYE, C.1, MERLET, A.2, MOREL, B.1, BOWEN, M.1, DIRY, A.3, FÉASSON, L.2, SAMOZINO, P.1, MESSONNIER, L.A.1

1.LABORATOIRE INTERUNIVERSITAIRE DE BIOLOGIE DE LA MOTRICITÉ (LIBM), UNIVERSITÉ SAVOIE MONT BLANC, CHAMBÉRY, FRANCE.

INTRODUCTION: Athlete's force-velocity-endurance (FVE) profile is an important factor of rowing performance (1, 2), but its underlying skeletal muscle determinants remains unknown in this population. In endurance-trained athletes, the critical power (CP), a major component of the FVE profile, is strongly related to muscle O2 supply (i.e. capillarization) (3) but could also in theory be influenced by changes in O2 consumption capacities (4). Interestingly, elite rowers display high maximal oxygen uptake and elevated CP (2). Therefore, it can be hypothesized that elite rowers display exceptional both O2 supply and consumption which are determinant of their elevated CP. CP can result from different combinations of critical force (F0c) and velocity (V0c). Although different physiological and muscle characteristics determinants can intervene on the dimensions of force and velocity of CP, they have never been investigated. Therefore, the aim of the present study was to investigate the relationship between skeletal muscle features and parameters of the FVE profile in elite rowers.

METHODS: Eleven elite rowers performed i) a 3-min all-out test (3AO), ii) a 2000 m trial, both on a rowing ergometer, and iii) a muscle biopsy (vastus lateralis). Before the 3AO, six strokes in different velocity conditions were performed and these force/velocity data were analysed to assess maximal power (Pmax), maximal force at null velocity (F0i) and maximal velocity at null force (V0i). The same procedure was replicated at the end of the 3AO to obtain F0c, V0c and CP. Biopsy cryosections were used for immunofluorescent staining to obtain fibre-type specific capillary-to-fibre ratio (C/Fi), fibre cross-sectional area (CSA) as well as fibre typology. Histo-enzymatic staining of the sections was used to quantify relative activity of cytochrome C oxidase into the fibres (COx).

RESULTS: Pmax and CP were positively related to the 2000m trial performance ($r=0.86$; $p<0.001$ and $r=0.74$; $p<0.01$). CSA was positively correlated to Pmax and F0i ($r=0.70$; $p<0.02$ and $r=0.71$; $p<0.01$) but not V0i ($r=0.44$; $p=0.15$). C/Fi and CSA ($r=0.72$; $p<0.02$ and $r=0.73$; $p<0.02$) but not COx ($r=0.30$; $p<0.37$) were related to CP. The correlation with C/Fi was also significant with F0c ($r=0.63$; $p<0.05$). V0c did not correlate with any of the muscle characteristics.

CONCLUSION: The present study demonstrated the importance of skeletal muscle capillarisation in CP in elite endurance athletes. Surprisingly, even in these highly endurance-trained and oxidative athletes, fibre oxidative capacity did not seem to determine CP. As expected, Pmax was mainly determined by CSA. Interestingly, the muscle characteristics determined only the force component of the initial and critical power, i.e. F0i and F0c.

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A PHYSIOLOGICAL REDUCTION IN PH PROVIDES A POTENTIAL MECHANISM FOR THE PREFERENTIAL INHIBITION OF LIPID METABOLISM WITH INCREASING EXERCISE INTENSITY

FRANGOS, S.M., DESORMEAUX, G.J., HOLLOWAY, G.P.

UNIVERSITY OF GUELPH

INTRODUCTION: A transient reduction in intramuscular pH (acidosis) occurs with increasing exercise intensity alongside a shift in fuel preference from lipids to carbohydrates. In vitro, even mild acidosis (pH 7.2 to 6.8) can reduce the maximal activity of the rate-limiting enzyme for lipid oxidation, carnitine palmitoyltransferase-I (CPT-I), indicating CPT-I may be a key control point for the acidotic attenuation of lipid metabolism. However, the mechanisms underlying this effect are not well-characterized and it remains unknown whether the aerobic metabolism of carbohydrates and/or mitochondrial metabolism common to both substrates is also affected by pH. Therefore, we utilized mitochondrial respiration to assess the influence of pH on single and mixed substrate responses in murine skeletal muscle at rest and following a single bout of intense exercise.

METHODS: Mitochondria were isolated from resting hindlimb skeletal muscles of wild type C57BL/6N female mice and permeabilized skeletal muscle fibers were prepared from the red gastrocnemius at rest or following a single bout of intense exercise (20 m/min, 15% grade, to exhaustion). Mitochondrial respiration was performed in buffers at pH 7.2 or 6.8. Substrates were titrated individually (CPT-I-dependent and independent substrates, pyruvate, lactate, glutamate, succinate, and ADP), or combined titrations were performed. Data was analyzed using a paired Students t-test and expressed as mean + SD.

RESULTS: Despite no difference in mitochondrial coupling, oxygen affinity or ADP respiratory responses between pH values, oxidative phosphorylation (OXPHOS) was generally attenuated by acidosis, as respiration with CPT-I-dependent

substrates, pyruvate, lactate, glutamate, and succinate were attenuated at pH 6.8 compared to pH 7.2. However, providing more pyruvate and ADP at pH 6.8 to model increases in glycolytic/glycogenolytic flux and ATP turnover with intense exercise, overcame the acidotic attenuation of carbohydrate-linked OXPHOS, supporting literature indicating that glycolytic/glycogenolytic flux increases with exercise intensity despite reductions in intramuscular pH [1]. Alternatively, we suggest lipid metabolism may be particularly sensitive to acidosis, considering CPT-I-dependent respiration was attenuated and malonyl-CoA (M-CoA) inhibition of CPT-I was enhanced, which together would limit the contribution of lipids to ATP provision. This potent effect of acidosis to enhance M-CoA inhibition of CPT-I in sedentary muscle persisted following a single bout of intense exercise, providing a possible mechanism whereby lipid metabolism may be preferentially inhibited at higher exercise intensities.

CONCLUSION: Combined, these data support transient acidosis as a mechanism preferentially attenuating lipid metabolism, and therefore a possible regulator of intensity-dependent shifts in skeletal muscle fuel use.

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RESISTANCE-ONLY AND CONCURRENT EXERCISE INDUCE SIMILAR MYOFIBRILLAR PROTEIN SYNTHESIS AND ASSOCIATED MOLECULAR RESPONSES IN MODERATELY ACTIVE MEN

LEE, M.J., CARUANA, N.J., SANER, N.J., KUANG, J., STOKES, T., MCLEOD, J.C., OIKAWA, S., BISHOP, D.J., BARTLETT, J.D., PHILLIPS, S.M.

VICTORIA UNIVERSITY

INTRODUCTION: The molecular responses to aerobic and resistance exercise are divergent and may be antagonistic if performed concurrently. Concurrent exercise is hypothesised to compromise the anabolic response to resistance-only exercise. The potential for molecular incompatibility may depend on concurrent exercise order and participant training status; however, the influence of these variables is understudied. Therefore, we examined myofibrillar protein synthesis (MyoPS) rates, and associated molecular responses, to resistance-only and concurrent exercise (with different exercise orders), before and after 10 weeks of training.

METHODS: Healthy, moderately active males were allocated to one of three groups, which were matched for age, baseline strength, body composition, and aerobic capacity: (1) resistance-only exercise (RE, n = 8), (2) RE followed by high-intensity interval exercise (RE+HIIE, n = 8), or (3) HIIE followed by RE (HIIE+RE, n = 9). Participants trained 3 days/week for 10 weeks. Concurrent sessions were performed on the same day, separated by 3 h. On the first day of weeks 1 and 10, muscle biopsies were sampled immediately before, after, and 3 hours after each exercise mode and analysed for changes in molecular markers of MyoPS (via western blot and PCR), and muscle glycogen. Additional muscle was sampled at the end of both weeks to determine MyoPS using orally administered deuterium oxide.

RESULTS: In both weeks, absolute MyoPS rates and relative changes from pre-training were similar between all groups ($P > 0.05$). MyoPS increased from pre-training levels in Week 1 (FSR%/day [fold-change] RE: 2.02 ± 0.27% [~1.4-fold]; RE+HIIE: 1.86 ± 0.22% [~1.4-fold]; HIIE+RE: 1.81 ± 0.36% [~1.4-fold]), but not Week 10 (RE: 1.43 ± 0.24% [~1.0-fold]; RE+HIIE: 1.59 ± 0.26% [~1.1-fold]; HIIE+RE: 1.49 ± 0.25% [~1.1-fold]). Post-exercise changes in many proteins reflective of MyoPS (e.g., mTORC1, eEF2, rpS6) were also similar between groups. MuRF1 and MAFbx mRNA exhibited order-dependent responses; MAFbx mRNA decreased during recovery from prior RE, while MuRF1 mRNA increased after HIIE (irrespective of exercise order) and decreased after subsequent RE. Exercise-induced changes in MyoPS and some genes were also dampened from Week 1 to Week 10 (e.g., PGC-1α mRNA, ~6 to 7-fold vs ~2 to 3-fold).

CONCLUSION: Concurrent exercise did not compromise the anabolic response to resistance-only exercise, irrespective of exercise order or training status. Our findings challenge the idea that concurrent aerobic and resistance exercises are incompatible at a molecular level. Our data also suggest that molecular responses are dampened after training when exercise is performed at the same relative intensity. These findings provide unique data that could inform programming of exercise variables for athletes and individuals who engage in concurrent training.

HIGH-VOLUME STRENGTH TRAINING DECREASES MITOCHONDRIAL RESPIRATORY CAPACITY IN SKELETAL MUSCLE OF YOUNG WELL-TRAINED ROWERS

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INTRODUCTION: Strength training of moderate volume has performance-enhancing benefits for elite rowers with effects primarily attributed to an increased muscle mass and maximal- and explosive muscle strength. Mitochondria are organelles within cells and are vital for the energy metabolism. The function of the mitochondria is related to endurance performance and can be improved by aerobic training and moderate volume strength training. In periods, the Danish National Rowing Team practice strength training of a high volume; however, the impact of this type of strength training on the mitochondrial function has yet to be clarified. In this study, we investigated the effects of high-volume strength training on mitochondrial respiratory capacity (MRC) in well-trained rowers.

METHODS: Twenty Danish male (n = 12) and female (n = 8) rowers with a mean (± SEM) age of 22.2 ± 0.76 years and a maximal oxygen consumption (VO_2max) of 54.1 ± 1.7 ml/kg/min were enrolled in the study. Based on body weight, sex, training history, and performance level the participants were matched and randomized to either a group performing high-volume strength training (HV-ST) (n = 10), or a control group assigned to strength training of moderate volume (MV-ST) (n = 10). The intervention period was eight weeks with a recovery week after week three and seven. The strength train-

ing program involved three exercises (leg press, trap-bar deadlift, and bench pull) and was performed three times per week. In HV-ST the volume was gradually increased from three to 10 sets of 10 repetitions during the initial three weeks and maintained at 10 sets in week four to seven. Load adjustments were made throughout the training period to ensure that no repetitions were in reserve during the last three sets of each exercise. MV-ST completed three sets of 10 RM/exercise throughout the training period. Before and after the eight-week intervention period, the participants performed a VO2max test and had a muscle biopsy obtained from m. vastus lateralis. MRC was measured in permeabilized muscle fibers using high resolution respirometry after the addition of substrates, ADP and an uncoupler to stimulate complex I (CIp) and II (CI+IIp) respiration and to test maximum capacity of the electron transfer system (ETS).

RESULTS: The results showed a decrease in MRC (p = 0.002) after HV-ST when assessing CI+IIp linked respiration, whereas a decline was detected in both groups for CIp stimulated respiration and ETS. No changes were observed in body weight or VO2max after the intervention period in neither of the two groups.

CONCLUSION: These findings indicate that HV-ST and, at varying degree, MV-ST cause a decrease in mitochondrial function. It could be speculated whether the observed mitochondrial respiratory impairment is an artefact of overtraining rather than a chronic physiological adaptation to HV-ST, as the measurements were performed five to seven days after the last training session.

THE IMPACT OF MUSCLE MITOCHONDRIAL UNCOUPLING AND CARDIAC OUTPUT ON VO2PEAK IN SINGLE-LEG KNEE EXTENSION EXERCISE

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INTRODUCTION: The dynamic single-leg knee extensor ergometer (SLKE) is a model used to isolate the quadriceps exercising muscle. The O2 peak uptake (VO2peak) during exercise is represented by the Fick principle, which accounts for both the convective and diffusive transport of O2. However, it is widely believed that the muscle mitochondrial oxidative capacity exceeds the delivery of O2 at VO2max (1, 2), resulting in the peripheral oxygen diffusion being ignored. In the SLKE, due to the difficulty in reaching maximum cardiac responses, the peripheral components, specifically muscle mitochondrial oxygen extraction, play a crucial role in determining VO2peak. This study aims to comprehend the relative influence of cardiac output (CO) and muscle mitochondrial respiration on VO2peak during maximal SLKE exercise. It is hypothesized that the peripheral components will have a predominant impact on VO2peak during SLKE exercise.

METHODS: During a maximal incremental test (+10W/min) at a SLKE, VO2peak of 20 young healthy subjects (10 M + 10 F) was assessed using a metabolic cart. Moreover, a muscle biopsy sample from the vastus lateralis was taken from each participant, and mitochondrial respiration was analyzed by high-resolution respirometry. CO, and mitochondrial Electron Transport Coupling Efficiency (ETCE), Net Oxphos Capacity (NOC), Electron Transport Excess Capacity (EC) were calculated.

RESULTS: A multiple linear regression was calculated to predict VO2peak based on CO, ETCE, NOC, and EC. A significant regression equation was found ($F(4,13)=64.26$, $p<0.001$), with an R2 of 0.9519. Participants' predicted VO2peak is equal to 3.308 + 0.1034(CO) - 4.02(ETCE) + 0.01226(NOC) - 0.0001476(EC), where CO is expressed in L/min. CO ($p<0.001$), ETCE ($p=0.001$), and NOC ($p=0.027$) were significant predictors of VO2peak.

CONCLUSION: During SLKE, the VO2peak is highly influenced by CO and muscle mitochondria O2 extraction capacity. Indeed, the increase in VO2 is linearly associated with increases in CO and mitochondrial respiration in the OXPHOS/ET state. Most importantly, we assessed that VO2peak is inversely associated with the mitochondrial coupling efficiency, usually influenced by ROS accumulation, protein secretion, leak/slip partial coupling. The last point confirms in vivo studies and suggests that mitochondrial uncoupling, as well as CO, play a key role in VO2 consumption during maximal SLKE exercise.

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Oral presentations

OP-AP16 Force Velocity Profiling and Training

WEIGHTLIFTING PERFORMANCE IS CORRELATED WITH SQUAT JUMP MAXIMAL POWER, BUT NOT WITH VERTICAL FORCE VELOCITY IMBALANCE

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INTRODUCTION: Weightlifting performance is defined by the ability to vertically lift the heaviest load using two movements – the Snatch (Sn) and the Clean & Jerk (C&J). Power output is the one of the key performance factors (1). Previous studies show some kinematic movement similarity, i.e., triple extension, and kinetic variables similarity, i.e., power output or force

production during weightlifting and vertical jump movements (2). In addition, jumping performances are related to vertical force-velocity profile parameters, especially to maximal power output (PMAX) and force-velocity imbalance (F-vIMB) i.e., magnitude of the difference between actual and optimal force-velocity profile. Then, it could be hypothesized that vertical force-velocity profile parameters may also be related to weightlifting performance. The aim of the present study was to test correlations between weightlifting performances in Sn and C&J, and vertical force-velocity profile parameters.

METHODS: Forty-one trained weightlifters (20 males and 21 females; age: 20 ± 5.5 years; height: 1.72 ± 0.35 m; body mass: 68.64 ± 12.72 kg) performed vertical jumps with four different additional loads (0%, 25%, 50% and 75% of their body mass). Parameters of their vertical force-velocity profile were calculated using system mass, push-off distance, and jump height. The analysis of the force-velocity profile was focused on several parameters, including theorical maximal force (F0), velocity (V0), PMAX, slope of force-velocity profile (Sf-v) and F-vIMB. The participants were required to provide their personal record in Sn and C&J, which had to be achieved within two weeks of the test session. All data were analysed with multiple correlations to determine the magnitude of association between weightlifting performance and force-velocity profile parameters.

RESULTS: Subjects' performances were 80.9 ± 27.4 kg (40-163kg) for Sn and 100.8 ± 33.7 kg (50-200kg) for C&J. Very high correlations were observed between weightlifting performances and PMAX (Sn: $r = 0.85$, $p < 0.001$; C&J: $r = 0.86$, $p < 0.001$) as well as F0 (Sn: $r = 0.79$, $p < 0.001$; C&J: $r = 0.76$, $p < 0.001$). In addition, moderate correlations between weightlifting performances and V0 (Sn: $r = 0.40$, $p < 0.001$; C&J: $r = 0.42$, $p < 0.001$) were found. However, no significant correlation was observed between weightlifting performances and SF-v (Sn: $r = -0.09$; C&J: $r = -0.06$) or F-vIMB (Sn: $r = 0.19$; C&J: $r = 0.15$).

CONCLUSION: Participants with higher F0, V0 and PMAX also had better weightlifting performances. Therefore, these parameters of the vertical force-velocity profile can be considered as factors associated with performance in weightlifting. However, unlike jumping performance, the slope and imbalance of the force-velocity profile were not related to weightlifting performance. Thus, it seems that the concept of an optimal vertical force-velocity profile may not be relevant for weightlifting.

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CAN SET CONFIGURATION MODULATE FORCE-VELOCITY PROFILES IN UNTRAINED LIMB? THE CROSS EDUCATION PHENOMENON.

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INTRODUCTION: Cross education phenomenon (CE) consists in strength transfer from trained to untrained limb after an unilateral strength training program (1). Neuromuscular strength training adaptations may be evaluated analysing the force-velocity relationship (FV) changes (2). It is known that traditional training programs (TT) close to muscular failure result in CE regarding the one repetition maximum load (1RM), in contrast with Cluster training programs (CT) (3). The objective of this study was to evaluate the FV changes after two strength training protocols for lower limb with different set configuration.

METHODS: After 1RM (pre and post intervention) and 10RM evaluation for knee extension exercise, 35 subjects were randomly assigned to control (CON) TT and CT groups. 10 sessions were performed with dominant limb using the 10RM load. TT performed 4 sets of 8 repetitions with 3min rest between sets. CT performed 32 sets of 1 repetition wit 17.5s rest between each set. Parameters derived from FV linear equation were: force and velocity axis intercept (F0, V0), slope (SFV) and estimated power (Pmax= F0 ·V0 /4). Additionally, we obtained the percentage of F0 and V0 represented by optimal force and velocity respectively r (%Fpower; %Vpower) in both trained and untrained limbs.

RESULTS: For dominant limb, main effect of time was observed regarding F0 and V0 (postest > pretest), and for the SFV (steeper slopes in postest). Time × group interaction was observed only for Pmax ($p=0.002$), showing increments in CT and TT. No main effects or interaction was observed neither for %Fpower nor %Vpower. Regarding nondominant limb, main effect was observed for time with higher F0, and Pmax, and steeper SFV. Time × group interaction ($p=0.048$) was observed in V0, with significant decreases in CON. No main effect nor interaction was observed for %Fpower nor %Vpower.

CONCLUSION: These results suggest changes to strength-oriented force profiles in both segments. Although set configuration can modulate CE regarding 1RM (3,4), it seems that this factor does not influence on non-trained limb changes of FV nor of %Fpower and %Vpower.

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EFFECT OF VELOCITY ON POWER-DURATION RELATIONSHIP IN JUMPING: TOWARDS AN INDIVIDUAL FORCE-VELOCITY-ENDURANCE PROFILE

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INTRODUCTION: The ability of lower limbs to produce and maintain high levels of power output depends on both the Power-Velocity (PV) relationship and ii) the power-duration (PD) relationship. While these two relationships have been mostly studied separately [1,2], the interaction between both remains less explored, notably the effect of velocity (independently from the movement frequency) on the PD relationship parameters: the critical power (CP, asymptote of the PD relationship) and the total amount of work that can be performed above CP (W'). Moreover, PD relationship has been widely studied through locomotion movements (e.g. pedalling, 2) but less during movements used in strength training (e.g. jumping). This study aimed at i) testing the feasibility of determination of PD relationship in jumping, ii) testing the effect of velocity on CP and W', and iii) exploring the likely associated interindividual variability.

METHODS: The PD relationship (CP and W') of 14 subjects were determined (via linear work-time model) in two velocity conditions (V1: 0.70±0.02 m/s and V2: 0.95±0.09 m/s) during repeated jump (a jump every 2s) tests to exhaustion performed at four power outputs (set via different loads) for each velocity (set via jump height) [3]. The goodness of fit of the PD relationship, the effect of velocity on CP and W' and the correlation in CP and W' between the two velocities were tested. From CP at the two velocities, the individual velocity maximising CP (critical optimal velocity, CVopt) was estimated.

RESULTS: The median R2 (linear work-time model) was 0.99. CP values (247± 44 W for V1 and 225± 43 W for V2) were moderately (d=0.509, P=0.006) lower at V2 than V1. W' was not different between V1 (1597±1254 J) and V2 (1629±891 J). CP (r=0.830) and W (r=0.532) were correlated between the two velocities. The difference in CP between V1 and V2 was positively correlated with the difference between CVopt and the average of V1 and V2 (r=0.905, p<0.001). The difference in W' between V1 and V2 was negatively correlated with the difference between CVopt and the average of V1 and V2 (r=-0.815, p<0.001).

CONCLUSION: The PD relationships, as well as CP and W', i) can be accurately determined during jumping and ii) are affected by velocity, but with iii) high interindividual variability and iv) moderate to high correlations between velocities. The interindividual variabilities in the differences in CP and W' between the two velocities can be partly explained by the positioning of V1 and V2 with respect to the individual estimated CVopt. This would suggest different individual Force-Velocity-Endurance profiles: some athletes present higher endurance capacities in high force-low velocity conditions than in low force-high velocity conditions, and vice versa for other athletes.

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FORCE-VELOCITY-ENDURANCE PROFILING APPLIED TO ROWING PERFORMANCE

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INTRODUCTION: The power output achieved in rowing, is contingent upon the ability to product and sustain elevated levels of power [1]. The two mains' power capacities determining performance are the maximal (Pmax) and the critical (Pc) power, the latter is defined as the asymptote of the power-duration relationship and represents the intensity threshold above which fatigue develops drastically, i.e. severe domain.

It is widely accepted that Pmax and Pc are both determinants of performance in 2000m rowing [2], although the precise extent of their contributions has yet to be fully established. Force-Velocity-Power (FVP) relationships define Pmax and Pc as the combination of maximal force (F0max and F0c) and velocity (V0max and V0c) qualities. During the 2000m rowing, the same level of power can be achieved with different FV combinations. Although the role of F0max and V0max in explosive performance has been thoroughly studied, their contributions, to performance in power endurance sports as well as the role of F0c and V0c remain unexplored.

The purpose of this study was to establish the interaction between rowing performance and Force-Velocity-Endurance (FVE) profile by determining the contribution of i) initial (Pmax) and critical (Pc) power, and ii) their respective force and velocity components, on rowing 2000-m ergometer performance.

METHODS: 11 high level-to-elite rowers performed a 3min All-out ergometer test, preceded and followed by 6 maximal strokes to establish initial and critical FVP profiles. Pmax and Pc are the apex of the PV relationship. FVE parameters (F0max, V0max, F0c and V0c) are the associated extremum parameters of FVP before and after the all-out exercise. Stepwise regression analyses were performed to quantify the contribution of theses variables on the mean power during the 2000-m ergometer test (P2000). Relative Weight Analyses is performed to gain a better understanding of the respective role played by each predictor in the linear regression [3].

RESULTS: The first model showed that 75% of the P2000 variance was explained by both Pmax and Pc (relative weight respectively 44.2% and 55.8%). The second model including FVE parameters showed that 72% of P2000 variance was explained by F0max and F0c (relative weight respectively 48.3% and 51.7%), without any significant contribution of V0max and V0c.

CONCLUSION: The results of this study showed as expected the important and balance contribution of Pmax and Pc in rowing performance during a 2000m test. Within the power, it appears that force qualities seem more predictive of the variance in P2000 than velocity ones. The best rowers presented here force oriented FVE profiles, meaning that it can be of great of interest to orient training to preferentially improve force and force endurance to maximise power production capacities.

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Oral presentations

OP-AP38 Fatigue

THE INTERACTIONS OF EXERCISE INTENSITY, MODALITY, AND DURATION ON CONCURRENT EXECUTIVE FUNCTION PERFORMANCE AMONG HIGHLY TRAINED ATHLETES

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INTRODUCTION: High-intensity exercise is often associated with decreases in concurrent executive functioning (EF) performance, but it's less clear if this also applies to athletes whose sport requires EF under intense physical loads. Furthermore, little is known about EF during high-intensity interval exercise or about how exercise duration may interact with intensity. This study aimed to assess the effects of exercise intensity and modality on EF, and to explore temporal patterns of EF during exercise. We predicted that athletes would maintain performance across conditions, and that within conditions, performance would decrease over time.

METHODS: Six female (22.91±4.68 y) and 12 male (20.10±1.55 y) water polo players performed a 4-colour Stroop task during three cycling exercise conditions: constant-load moderate intensity (60% of maximal aerobic power [MAP]; CL60), constant-load high intensity (80% of MAP; CL80), and high-intensity interval (alternating 110% and 50% of MAP; HIIE). Conditions were work-matched, with exercise durations of 8 min 16 s (CL60) or 6 min 12 s (CL80 and HIIE). The Stroop task consisted of colour-naming trials; incongruent trials, which required participants to press the button of the same colour as the font; and switch trials, where participants instead had to identify the colour spelled by the word. Friedman tests for each trial type compared accuracy between conditions, and a linear mixed model was used to compare reaction time (RT) based on Condition and Trial type. To explore the effects of exercise duration on EF, in each condition, Stroop performance was divided into early, middle, and late thirds, and a second linear mixed model including Condition, Trial type, and Thirds as fixed effects was conducted for RT.

RESULTS: While there was no difference in accuracy between the conditions, RT was faster in CL60 compared to HIIE (diff=38.27 ms, $p<0.01$). There was no difference between the CL80 and HIIE conditions. RT for switch trials was slower than for both incongruent (diff=67.7 ms, $p<0.0001$) and naming (diff=249.5 ms, $p<0.0001$) trials, and incongruent trials were slower than naming trials (diff=181.8 ms, $p<0.0001$). The model considering exercise duration revealed interactions of Third with Condition ($p<0.001$) and Trial type ($p=0.02$). Stroop performance decreased in CL80 and HIIE – but not CL60 – after the first third. Consequently, though RT was similar across conditions in the first third, it was worse during CL80 and HIIE compared to CL60 during the middle and/or late thirds. Moreover, in all conditions, switch trial RT was slower during the late compared to the early third (diff=50.23 ms, $p=0.005$).

CONCLUSION: Our study suggests that high-level athletes also experience impairments to EF during high-intensity exercise, be it constant load or in intervals. Critically, it seemed that performance was initially similar across conditions, degrading at high intensity as a function of exercise duration, as well as depending on the complexity of the task.

CHANGES IN ELECTRICAL IMPEDANCE MYOGRAPHY (EIM) INDUCED BY FATIGUING CONTRACTIONS AND THE TIME-COURSE OF RECOVERY

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INTRODUCTION: Electrical impedance myography (EIM) is a technique deriving from the classical bioelectrical impedance analysis. In EIM, the electrodes are applied locally over a body segment to describe its bioelectrical tissue properties by resistance, reactance, and phase angle analysis. EIM, which is painless and quick to perform, has been demonstrated to change in response to different level of muscle contractions and fatiguing tasks. However, there is still little evidence about

its potential use to assess muscle fatigue and monitor fatigue recovery. Therefore, the aim of this study was to measure changes in EIM components induced by fatiguing contractions and the time-course of recovery.

METHODS: Fifteen healthy men (mean±SD; age=21.6±1.2 years; body mass=73.4±10.3 kg; height=176.0±7.4 cm) were recruited. Participants underwent a fatiguing and a control session (CTRL) in random order, separated by one week. During the fatiguing session, knee extensors maximum voluntary isometric contraction (MVC) and EIM components (i.e., resistance, reactance, and phase angle) over the anterior thigh were assessed PRE, POST, POST 5 min (POST5), POST 10 min (POST10), and every 10 min until the 90th min of recovery after a fatiguing exercise. The latter consisted in cycles of 5-s MVC/5-s rest until MVC reached 50% of PRE-value. The same procedures and time-course of evaluations were performed in CTRL with 10-min rest instead of the fatiguing task. Data were analysed by repeated-measure ANOVA with $p<0.05$.

RESULTS: After fatiguing contractions, MVC recovered within POST40 compared to PRE ($p>0.05$). Resistance decreased peaking at POST20 (-6.5%, $p<0.01$) and recovered within POST50 compared to PRE ($p>0.05$). Reactance decreased peaking at POST20 (-20.6%, $p<0.01$) and recovered within POST50 compared to PRE ($p>0.05$). Phase angle decreased peaking at POST20 (-15.5%, $p<0.01$) and recovered within POST50 compared to PRE ($p>0.05$). Some inter-individual differences in recovery time were present, particularly for MVC. No significant changes occurred during CTRL at any time points in any variable ($p>0.05$).

CONCLUSION: These preliminary results show that fatiguing contractions induced alterations in the EIM components. MVC and EIM alterations returned to PRE-values within 60 min from the cessation of the fatiguing task. These results indicate that EIM may have the potential to monitor recovery after a fatiguing exercise. However, further experiments are needed to confirm these preliminary results and investigate inter-individual variability.

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EFFECT OF THE PRE-TAPER LEVEL OF FATIGUE ON THE TAPER-INDUCED CHANGE IN PERFORMANCE IN ELITE SWIMMERS

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INTRODUCTION: In swimming, a taper period is usually planned before major competitions to reach a peak performance. The pre-taper level of fatigue is a key factor to consider in the individualization of taper strategy. If parameters that condition the pre-taper level of fatigue are little known, sleep appears to play a key role due to the recovery processes activated during this phase. Thus, the aims of this study were 1) to assess the effect of taper on performance according to the pre-taper level of fatigue in elite swimmers and 2) to evaluate the role of sleep on the pre-taper level of fatigue.

METHODS: Physiological, psychological, biomechanical and sleep profiles were evaluated in 26 elite swimmers on 2 occasions: T0 and T1, scheduled respectively 10 and 3 weeks before their major competition. External training load was assessed on a daily basis. Race time was assessed during three official competitions (at T0 and T1 during intermediate competitions, and at the end of the protocol during the major competition).

RESULTS: Considering changes in physiological, psychological and biomechanical profiles between T0 and T1, 14 swimmers (17±2y; 1.8±0.1m; 63±11kg; best performance in % world record: 88±3%) were allocated to acute fatigue group (AF) and 12 swimmers (18±2y; 1.7±0.1m; 67±10kg; best performance: 89.5±2.6%) to functional overreaching group (F-OR). External training load before and during the taper was not different between groups, as well as the change in race time from T0 to T1. In contrast, the race time was lower in competition than at T1 in AF (-1.80±1.36%), while it was higher in F-OR (+0.49±1.58%, $p<0.05$ vs AF). Before taper, total sleep time was lower in F-OR, as compared to AF. Conversely, the fragmentation index was higher in F-OR ($p=.06$). From wakefulness to sleep, the internal temperature decreased in AF but not in F-OR. The minimum temperature during sleep was significantly lower in AF than in F-OR.

CONCLUSION: As compared to swimmers with acute fatigue, pre-taper sleep was poorer in overreached swimmers, which could contribute to their different response to the same training load. This poorer sleep could be linked to a lower regulation of the internal temperature before and during sleep. Moreover, the decrease in training load during the taper was not high enough to observe a gain in performance in overreached swimmers, probably due to excessive cumulated fatigue.

Thus, it could be interesting to evaluate and improve, if necessary, the sleep of swimmers before the overload period, in order to prevent overreaching. In this way, techniques that aim to improve sleep by acting on body temperature, such as cryostimulation, cold water immersion or specific mattresses, could be relevant. Also, it could be interesting for overreached swimmers to extend the use of these techniques during the taper period to further reduce their level of fatigue and, a fortiori, to observe a gain in performance during the competition.

PREDICTION OF SOCCER PLAYERS' FATIGUE: A MACHINE LEARNING APPROACH

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INTRODUCTION: Predicting the state of fatigue in soccer players is useful to design training and optimize performance on match day. Therefore, the aim of this study was to explore, using a framework of big data analytics, the most important predictors of fatigue in a group of sub-elite soccer players using inexpensive and practical data monitoring tools.

METHODS: Four sub-elite professional soccer teams took part in this study. Team 1 and 3 competed in the Italian professional third division (Serie C), while Team 2 and 4 competed in the fourth semi-professional Italian division (Serie D). Within an hour after the end of each training session or match, the players provided their session ratings of perceived exertion (sRPE) to quantify, together with training or match duration, the internal training load of the previous day, week (acute) and month (chronic). Moreover, every morning, the players filled the Wellness Questionnaire which includes subjective measures of fatigue, sleep quality, muscle soreness, stress and mood. Finally, some contextual factors, i.e. next match difficulty, score difference of the previous match, distance to previous match, and distance to next game, were also recorded. Machine learning models were trained and tested in order to assess their ability to predict the players' fatigue status of the next day.

RESULTS: Machine learning models can accurately predict the players' fatigue (accuracy 79-84%) using practical and inexpensive training monitoring tools. Specifically, muscle soreness, sleep quality, mood, and stress predict ~48% of the fatigue state with training load variables accounting for ~10%. Contextual factors related to matches add a further ~15% to the prediction of the fatigue state.

CONCLUSION: Sport scientists and coaches can use this framework of big data analytics to simulate the effects of different training programs in order to maximize players' readiness and reduce the potential drops in performance associated with fatigue.

Invited symposia

IS-SH04 Winning at all costs? Current approaches to preventing doping in sport and exercise

KNOWLEDGE IS NOT ENOUGH! WHY VALUES-BASED DOPING PREVENTION COULD COMPLEMENT TRADITIONAL INFORMATION-BASED APPROACHES

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As doping has tremendous negative consequences for athletes and the integrity of sports, the need for effective prevention programs is obvious. Primary prevention through education at an early age is key; however, educating young athletes about doping-related knowledge is deemed to be not sufficiently effective to minimize doping (Backhouse, 2015). Therefore, a focus on a values-based educational approach is emphasized by WADA (2021) and has become increasingly present in anti-doping efforts. Values-based education means "delivering activities that emphasize the development of an individual's personal values and principles. It builds the learner's capacity to make decisions to behave ethically". (WADA, 2021, p.10). As such, values-based anti-doping education can address emotions, motives, attitudes and values and often incorporates the fostering of moral competencies. This seems plausible since a person's morality, defined as his or her beliefs and practices about what is right or wrong, is presumed to be shapeable/trainable (e.g., Blatt and Kohlberg, 1975; Lind, 2009). Moreover, research indicates that especially moral variables, both personal and environmental, play an essential role in predicting doping proxies (i.e., likelihood, intention, attitudes). For example, variables like anticipated guilt, empathy, moral disengagement, moral identity, self-regulatory efficacy, and collective moral norms/moral atmosphere have been strongly and consistently linked to doping proxies in numerous studies (e.g., Boardley et al., 2018; Kavussanu et al., 2020; Ntoumanis et al., 2014) and, recently, also have been addressed in anti-doping efforts. Bandura's (1991) social cognitive theory of moral thought and action has served as foundation for most of this research. For instance, Kavussanu et al.'s (2021, 2022) research showed that intervening on athletes' moral identity and disengagement, their anticipated guilt and self-regulatory efficacy as well as on the team's moral atmosphere can reduce doping likelihood in athletes. Based on this evidence and on the method of ethical decision making training (Elbe & Brand, 2016) we present the evaluation of a recent values-based doping intervention for young athletes that aimed at affecting their anticipated guilt, empathy, moral disengagement and collective moral norms through six 45-min sessions. Within a cluster randomized controlled trial 30 teams (321 athletes) were assigned to one of the three conditions: values-based (VB), information-based, and no-intervention control and data were collected at pre, post, and follow up. Results showed that, for the VB condition moral disengagement sustainably (i.e., at follow up) decreased, whereas anticipated guilt at posttest and empathy at follow up increased. As a conclusion, specific elements from this intervention could potentially be a useful addition to traditional anti-doping education (i.e., information provision).

ANTI-DOPING EDUCATION: EXISTING EVIDENCE AND FUTURE TRENDS

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Doping use constitutes one of the most important threats of sport integrity. Education has been proliferated as the most important prevention approach (Barkoukis, 2015). In this respect, several interventions have been developed (Barkoukis et al, 2016; Codella et al., 2019; Duncan & Hallward, 2019; Kavussanu et al., 2022; Nicholls et al., 2020; Ntoumanis et al., 2021). Still recent evidence suggested that the majority of athletes reported low willingness to receive anti-doping education; especially males and young players (Skoufa et al., 2022). A possible explanation may lie on that anti-doping education is currently at an early stage and traditional learning pedagogies are used, e.g., traditional, lecture-like, one-way

communication approaches, are largely used. To address this issue learning pedagogies, such as problem-based learning (PBL), enable the learners to actively engage with the learning content (e.g., anti-doping education), set their own learning objectives, and accordingly engage in self-directed and independent learning are suggested (Wood, 2003). The use of new technologies, such as serious games and virtual reality, can address shortcomings in existing anti-doping education as evidence suggests that they can produce behavior change (Botella et al., 2017; Maples-Keller et al., 2017). The present study describes the evaluation of the application of a serious game and a virtual reality program against doping. The evaluation of the serious game has been conducted with 36 adolescents (Mage =16.36 years SD = 0.59, 21 males - 15 females). Participants completed a questionnaire based on Lund's (2001) questionnaire to measure the serious game's usability. It measures Usefulness, Ease of use, Ease of Learning, and Satisfaction. In addition, the EGameFlow questionnaire (Fu et al., 2009) was used to measure participants' enjoyment. This questionnaire measures Concentration, Clear Goal, Feedback, Challenge, Autonomy, Immersion, Social Interaction, and Knowledge Improvement. Responses are provided on a 7-point Likert ranging from 1 (strongly disagree), to 7 (strongly agree). The results of the analyses indicated that participants scored high on all dimensions of enjoyment except immersion and social interaction. With respect to usability the analyses indicated that participants found the game simple, easy and useful. Still, these data do not provide evidence on the effectiveness of new technologies on changing doping related mindsets. To address this question, we present an ongoing study on the implementation of a virtual reality game on important risk and protective factors of doping use. Up to fifty exercisers who will view a virtual reality game will respond to measures of doping willingness, attitudes, and anticipated regret prior and after their exposure to the virtual reality game. A sub sample of up to eight participants will participate in semi-structured interviews on the impact of the virtual reality game on their doping mindset.

A POSITIVE APPROACH TO TACKLING DOPING IN RECREATIONAL SPORT: EVIDENCE FROM THE MINDFUL MUSCLES PROJECT

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Once thought to be an issue confined to elite competitive sport, doping is becoming more prevalent in recreational sport and exercise settings across Europe. According to UK Anti-Doping (2021) there are approximately one million users of anabolic steroids in the UK, and approximately 1 out of 5 exercises across different European countries self-reported the use of steroids and other doping substances, at least once in their lifetime (Lazuras et al., 2017). A growing body of research has shown that doping use in recreational sport is associated by body image concerns, such as drive for muscularity and muscle dysmorphia (Greenway & Price 2018; Goldman et al., 2019). Third-wave psychological interventions focus on positive psychological traits, such as self-compassion, self-acceptance, and mindfulness. Such interventions have been found effective in alleviating body image-related concerns and anxiety, and in the treatment of substance misuse (Linardon et al., 2018; Spijkerman et al., 2016). Project Mindful Muscles utilised principles and constructs of third wave psychological interventions (i.e., self-compassion, self-acceptance, and mindfulness) to address body image concerns and the use of image and performance enhancement drugs (e.g., anabolic steroids) among exercisers in seven European countries. Mindful Muscles developed a series of evidence-informed, self-administered modules targeting exercisers, as well as a guide for practitioners, in order to further promote the integration of self-compassion, self-acceptance, and mindfulness as key components of doping prevention in recreational sport.

The present paper will discuss the key findings of the Mindful Muscles project. This includes a rapid literature review that helped in developing the Mindful Muscles resources for exercisers and practitioners (Study 1); one-to-one interviews with practitioners in anti-doping, sport, and other professions with a doping prevention remit in 7 countries (Study 2); and the findings for a survey-based feasibility study that assessed exercisers' satisfaction and perceptions towards using the Mindful Muscles resources in 7 countries (Study 3). The paper will also discuss the theoretical implications of project Mindful Muscles, as well as the recommendations for policy and practice for doping prevention in recreational sport.

Oral presentations

OP-BM18 Muscle function

CHARACTERIZING THE LIGAND-BINDING BEHAVIOR BEHIND MUSCLE SYNERGISM BY ELASTOGRAPHY

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INTRODUCTION: Ultrasound elastography is a widely accepted methodology to assess the mechanical properties of soft tissues. In biomechanics, this methodology allows to measure the shear elastic modulus (C44) of skeletal muscle in vivo and non-invasively. Most of the previous works have studied the relationship between C44 and different muscular variables related to muscle contraction. However, the link between muscle elasticity, force generation, and the binding dynamics among the contractile filaments during load sharing is currently poorly understood. Thus, the present work aims to apply elastography and the ligand-binding framework to explain the possible molecular basis behind muscle synergism.

METHODS: Thirteen healthy volunteers were asked to perform linear torque (T) ramps of isometric elbow flexion from 0-30% of MVC over 15 s (elbow flexed at 90°, wrist supinated) by using a research isokinetic dynamometer. The C44 map of the biceps brachial (BB), brachioradial (BR), and brachial (BB) muscles were measured during tasks through an Aixplorer ultrasonic scanner with a linear transducer array (4-15 MHz) in SSI mode. For each i-muscle, we calculated the Ci coefficient as Ci=1-(C44(0)/C44(T)), and applied conventional methods typically used in molecular receptors to characterize the kinetic behavior of each muscle. Specifically, if the Ci vs. T plot described a rectangular hyperbolic-like behavior, and the fits of 1/Ci vs. 1/T (Lineaweaber-Burk (LB) plot), T/Ci vs. T (Langmuir-Hines (LH) plot), and Ci vs. Ci/T (Scatchard plot) were linear with a determination coefficient (R2) ≥ 0.9, the binding dynamics was hyperbolic (H). On the other hand, if Ci vs. T showed a sigmoid curve and the fit of Ln(Ci/(1-Ci)) vs. Ln(T) (Hill plot) was linear with R2 ≥ 0.9, the binding dynamics was cooperative (positive (C+) if slope >1, negative (C-) if slope <1) or non-cooperative (slope=1).

RESULTS: The Ci coefficients of BB, BR, and BA muscles displayed different dynamics regarding the joint torque level. Beyond some individual variation, a general trend was observed. Thus, on average, the BR and BB muscles showed a C+ dynamic in the range of 4+-2% to 22+-5% MVC and 11+-4% to 30+-0% MVC, respectively. On the other hand, the Ci of the BA behaved differently between subjects, showing either C+, C-, or H dynamics between 1+-1% to 14+-4% MVC.

CONCLUSION: In this work, we studied a synergistic muscle system by applying the molecular ligand-binding framework in a biomechanical study elastography-driven. The Ci coefficients, calculated directly from C44, are suggested to be a good indicator of the amount of the attached actin-myosin cross-bridges. In this way, the results showed that the kinetics of cross-bridge formation could be accelerated (C+), decelerated (C-), or maintained at a constant speed (H), depending on muscle and the level of joint torque. This could be the underlying mechanism (at the molecular level) of the torque-dependent changes in load sharing between the elbow synergist flexors muscles.

CONTROLLING THE STRENGTH OF MAMMALIAN SKELETAL MUSCLE CONTRACTION BY THE THICK AND THIN FILAMENTS

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INTRODUCTION: Strategies for improving skeletal muscle contractile function via pharma- and nutraceuticals in athletic populations have been limited by our current understanding of regulatory mechanisms of contraction in mammalian muscle. Recent evidence from frog muscle (1) has shown that the thick filament plays a key regulatory role in contraction, where thick filament stress is a key determinant for the release of myosin motors from the helical folded OFF state to the actin attached ON state by modulating load in accordance with the force-velocity relationship. Here, we test this mechanosensing paradigm in mammalian skeletal muscle by coupling X-ray diffraction with unloaded shortening at maximal force generation.

METHODS: Small-angle X-ray diffraction patterns were collected in 2ms frames on an Eiger 2X-4M detector at the ID02 beamline at the ESRF, Grenoble, France, at a range of camera lengths to view both the low-angle X-ray reflections or the sarcomere reflections. Intact mouse extensor digitorum longus at 27°C were set to a sarcomere length (SL) of 2.85μm in resting muscle and electrically stimulated for 120ms. 60ms after the first stimulus under fixed-end conditions (SL 2.7μm), unloaded shortening was allowed for 15ms (SL 2.3μm), after which force redeveloped at the new fixed muscle length (SL 2.2μm). ~30 sets of 220ms X-ray records were collected per muscle (n=7).

RESULTS: Imposition of rapid shortening at the tetanus plateau caused a rapid abolition of force associated with concomitant changes in actin- and myosin-based X-ray reflections. The spacing of the M3 reflection, associated with the ~14.34nm axial repeat of myosin motors at rest, rapidly decreased to 14.28nm at the end of shortening. The first order myosin layer line reflection, associated with the ~43nm helical repeat of myosin motors, recovered to ~30% of its resting value, indicating partial recovery of the helical order of the myosin motors into the folded OFF state. However, the thick filament backbone, signalled by the M6 reflection with an axial spacing of ~7.17nm at rest, remained partially elongated (~7.20nm) at the end of shortening, indicating that the filament backbone – a key determinant of thick filament regulation – remained extended, despite the abolition of force. The second actin-based layer line, signalling the azimuthal position of tropomyosin, also decreased during unloaded shortening, indicating cooperativity between thin filament activation and myosin motor attachment.

CONCLUSION: These results indicate that activation of both the thick and thin filaments decreases during unloaded shortening at the tetanus plateau, though the thick filament is still strained at zero load. These results are consistent with the mechanosensing paradigm in the thick filaments (2,3), activation of the thin filaments by myosin motors, and positive coupling between the regulatory states of the thick and thin filaments.

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2 Hill et al., eLife (2021)

3 Hill et al., J Physiol (2022)

DISTINCT MUSCLE FIBER TYPE DISTRIBUTIONS AFFECT WHOLE-BODY ENERGY RATE OF ISOLATED PLANTAR FLEXOR CONTRACTIONS AND THE ENERGY COST OF LOCOMOTION NEAR THE WALK-TO-RUN TRANSITION SPEED

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INTRODUCTION: Single muscle fiber studies demonstrated that fast twitch fibers consume substantially more energy during isometric contractions than slow fibers, yet, the relative increase in energy rate with faster contractions appears smaller in fast compared to slow fibers [1]. Such observations introduced the idea that inter-individual muscle fiber type distributions may explain observed variability in whole-body (WB) energy rate during exercise. However, existing literature on the relationship between muscle fiber typology and WB energy rate is inconclusive, potentially due to the clear gap between a single muscle fiber and full-body exercise. Here, we first assessed the effect of isolated triceps surae muscle contraction velocities on WB energy rate in subjects with distinct muscle fiber type distributions and then related these results to the WB energy rate of walking and running at 2 m/s, exercises with comparable energy costs but distinct triceps surae muscle contraction velocities [2].

METHODS: We used H-MRS to non-invasively measure the muscle fiber type distributions of 29 subjects from which we selected the subjects exhibiting a rather slow (SLOW, n=10) or fast (FAST, n=8) muscle fiber typology. Next, these subjects performed cyclic plantarflexion contractions at three different ankle angular velocity conditions (isometric, 30°/s and 60°/s) while target torque (25% MVC), cycle frequency (1 Hz) and duty factor (1/3s activation, 2/3s relaxation) were kept constant. All angular velocity conditions as well as the treadmill walking and running trials at 2.0 m/s were sustained for 6 minutes during which we collected WB energy rate and triceps surae muscle activations.

RESULTS: With increasing ankle angular velocity, triceps surae muscle activations and WB energy rate increased in both groups ($p < 0.02$). However, during the isometric condition, net WB energy rate was lower in the SLOW compared to the FAST group ($p = 0.04$) whereas at faster ankle angular velocities, this between-group difference disappeared ($p > 0.39$). When walking at 2 m/s, an exercise associated with higher triceps surae contraction velocities but lower muscle force demands compared to running [2], WB energy rate was similar between groups with a trend towards the FAST group being characterized as more economical walkers than the SLOW group ($p = 0.10$). In contrast, when running at 2 m/s the SLOW group's WB energy rate was significantly lower compared to the FAST group ($p = 0.04$; interaction effect < 0.01).

CONCLUSION: For the first time, we demonstrated that distinct muscle fiber type distributions translate to different WB energy rate responses during isolated muscle contractions at different velocities. Additionally, we showed that muscle fiber type distributions may relate to observed difference in WB energy cost while walking or running near the preferred walk-to-run transition speed.

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THREE-DIMENSIONAL SHAPE OF SKELETAL MUSCLE CONTRIBUTES TO MUSCLE STRENGTH EXERTION

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INTRODUCTION: A skeletal muscle presents a variety of sizes and shapes across human individuals. A large body of literature has shown that the muscle size (i.e., volume or cross-sectional areas) determines the capacity of its force exertion. However, whether the variation of muscle shape impacts its function is one of the outstanding questions in the muscle biomechanics area. Herein, to address this issue, we generated the statistical shape model of skeletal muscle to represent the individual variation of three-dimensional shape and analyzed the association of the muscle shape with its strength exertion.

METHODS: The T1-weighted images of the right lower limb were acquired from 33 healthy young adults using a 3.0-T magnetic resonance imaging system. The heads of the quadriceps femoris muscle were labeled based on the automatic segmentation. Their volumes and maximum cross-sectional areas were calculated from the images. After given the shape correspondence among all images using a non-rigid registration, we constructed the statistical shape models of the quadriceps femoris and its heads, which consist of the mean shape and the shape vectors encoding most of the shape variations that was computed by principal component analysis. The muscle shape of each subject was defined as the representation in the shape vector space (i.e., principal component score). For muscle strength, isometric knee extensor torque was measured using a dynamometer. To probe the association of the muscle shape with its strength, stepwise regression was used specifying the muscle strength as a dependent variable and the principal component scores and the muscle volume or the cross-sectional area as independent variables in each muscle.

RESULTS: The shape variation could be represented by a small number of shape vectors in each muscle. Specifically, each of first three shape vectors possessed more than 10% explanation rate of shape variation and those three vectors explained approximately 70% of the total variance for each muscle. The stepwise regression showed that the muscle volume was the independent variable of muscle strength for the quadriceps, the rectus femoris, and the vastus lateralis and intermedius muscles. However, for the vastus medialis, both the principal component score in the second shape vector space and the muscle volume were identified as the independent variables of muscle strength. The second shape vector

explained 23% of shape variation and contributed to the deformation of the distal part of muscle, the so-called vastus medialis oblique. Comparable results were also obtained when the maximum cross-sectional area was used as the independent variable instead of the muscle volume.

CONCLUSION: Our findings demonstrated that the three-dimensional shape of vastus medialis could be one of the determinants of knee extensor strength, as the muscle size of the quadriceps femoris is. In addition, this study provided a new framework for understanding skeletal muscle geometry and its function.

Oral presentations

OP-AP14 Coaching: Talent Development

CONTEMPORARY CROSS-CULTURAL VARIATIONS OF TALENT CONSTRUCTIONS IN A WESTERN-EUROPEAN CONTEXT

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Introduction

Talent has extensively been researched throughout a widespread of fields and by various scholars (e.g. Aggerholm, 2015), but especially within football (Christensen, 2011). Despite the abundance of scholarship, critics point to the persisting absence of a common definition for the notion of talent (e.g. Gray & Plucker, 2010). This raises the question of why it is so challenging to grasp the concept of talent, especially since many individuals, including coaches and talent scouts, engage with it regularly on a professional level. However, and although talent being a global and frequently used concept, it struggles to establish meaning. Culture is one of the main influences of human behavior and sensemaking (Sreen et al., 2018). However, and thus far, there is a lack of research investigating how cultural differences may impact sensemaking processes surrounding talent.

Theory/Method

The first part of the analysis been conducted using a discourse-theoretical approach based on Laclau and Mouffe (1985) which can be considered a method and theory at the same time. In the second part, Hofstedes cultural framework has been applied to get a better understanding of cross-cultural differences of the variations of constructions of talent (e.g. Hofstede, 2001)

Results

This research reveals significant disparities regarding how talent in football is constructed within Swedish and German media. The discourse-theoretical analysis reveals that talent is a floating signifier. Additionally, the results show that articulations of 'talent' are more non-linear and heterogenous in German media discourses compared to Swedish media. When articulating 'talent', Swedes and Germans both utilize comparable themes, yet, when contrasting the two countries, we observe a variation in which themes are emphasized. Applying Hofstedes model to these results, the analysis confirms a connection between cultural factors - such as the level of tolerance for uncertainty within a culture or whether a country is more masculine or feminine - and understandings of talent in football.

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DETECTING INTERESTS AND THUS TALENTS: ELEMENTARY SCHOOL CHILDREN AND THEIR PROFILES OUT OF SPORTING ABILITIES AND PREFERENCES

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JOHANNES GUTENBERG-UNIVERSITY MAINZ

Introduction

Current efforts to design an effective, goal-oriented method of detecting talent are now focused on the differing interests of children (their preferences) and not just their sports-related motor skills (their ability) (e.g., Pion, 2015). When a person-oriented approach is used, it is of central importance to create profiles of different types in order to design movement

offers that effectively target the relevant groups and prevent dropouts. The aim of this study was to investigate in the elementary school context what types it is possible to identify in terms of both interests and ability.

Methods

A total of 159 children (8-11.5 years of age) were assessed to determine their interests and their ability using a sequential design approach. Affective interests were equated with the children's "preferences" for forms of exercise; these were scored on a seven-point Likert scale with smiley symbols during a video-assisted interview. "Ability" was assessed using seven sports-related motor skills tests. The mixed methods approach consisted of a quantitative step 1, a cluster analysis using SPSS27 (Ward's method; squared Euclidean distance). Based on the clusters, in-depth qualitative interviews were conducted in step 2; the results were subsequently evaluated using a content analysis process.

Results

Analysis revealed five clusters of children that exhibited significant differences in terms of ability and interests. In addition to the emotional-affective component (fun), the qualitative interviews also served to classify the interest aspects in terms of their cognitive and value-based components. They are indicative of the personality characteristics of the five types. For example, Cluster 4 showed situational interest in almost all sports on offer (fun score > 4 each). Their interest is associated with positive emotions, although their sport-related motor skills were rather below average.

Discussion

The data indicates that children at the age of 8 to 11.5 years are for the most part not yet committed to one type of sport. Their interests are determined by positive experiences and prior knowledge. Since athletic careers do not follow a straight line, and especially since multidisciplinarity in childhood is considered a favorable foundation for a successful career in sport (DiSanti & Erickson, 2019), schools, sports practice and sports science are faced with the task of responding suitably to children with different combinations of ability and preferences in the early phase of talent detection. The mixed method approach makes it possible to obtain differentiated insights.

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TALENT DEVELOPMENT ENVIRONMENTS IN NORWEGIAN AGE-SPECIFIC NATIONAL TEAMS IN HANDBALL AND ICE HOCKEY

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NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

INTRODUCTION: The Talent Development Environment Questionnaire (TDEQ-5) (1), has been used in the Norwegian context to investigate the TDE of male players in soccer academies (2). However, the Norwegian version of the TDEQ-5 has not been tested for factorial validity. Furthermore, to the best of our knowledge, no previous studies have compared how female and male athletes experience their TDE across national teams in separate team sports. This study aims to test the Norwegian version of the TDEQ-5 through confirmatory factor analysis (CFA) for a five-factor structure, (a) long-term development focus (LTD), (b) communication (COM), (c) alignment of expectations (AOE), (d) holistic quality preparation (HQP), and (e) support network (SN). We also aim to compare how female and male athletes experience the TDE across different team sports.

METHODS: Athletes of age-specific national teams (N=216, 42.59% female), between ages of 15-18 (M=16.28, SD=.88), from handball (44.91%) and ice hockey (55.09%) were included in this study. Questionnaires were administered by hand on location of national team gatherings.

RESULTS: The initial model of the CFA met most of the thresholds of the fit indices; X2(265)=479.99 (p<.001), X2/df(1.8) , RMSEA=.06 .05-.07, SRMR=.06. However, the CFI (.87) and the TLI (.86) were slightly below the acceptable reference value. Checking the modification indices suggested to add two covariate links between SN1 and SN4, and between AOE1 and LTD4. This improved the model fit; X2(263)=437.38 (p<.001), X2/df(1.7) , RMSEA=.06 .05-.07, SRMR=.06, and CFI=.90. Leaving only TLI (.88) slightly off the reference value. Cronbach´s alpha was calculated to test scale reliability; LTD (a=.76), AOE (a=.64), COM (a=.84), HQP (a=.80), SN (a=.66). To test for sport- and gender differences a series of two-way ANOVAs were performed. For LTD handball scored higher (p<.05). For AOE there were no significant differences between sports or gender. For COM men scored higher (p<.01). For HQP handball scored higher (p<.01). For SN there were gender- and sport differences, in addition to an interaction effect. Men scored higher compared to women (p<.01), handball scored higher compared to ice hockey (p<.05), and the interaction effect implied a larger difference between male and female athletes in ice hockey compared to handball (p<.05).

CONCLUSION: The Norwegian version of the TDEQ-5 appears to be an applicable tool for research and can be used to compare the TDE across gender and different team sports on a high level of competition.

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Invited symposia

IS-MH06 New targets for exercise in cardiac rehabilitation

EXERCISE IN PEOPLE BORN WITH A CONGENITAL HEART CONDITION

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Congenital heart disease is one of the most frequently diagnosed congenital disorders, afflicting approximately 1% of live births worldwide. Congenital heart conditions range from minor septal defects to complex cardiac anatomy that requires urgent surgical intervention to sustain life, and many patients live with a cardiac anatomy that compromises cardiorespiratory function for the rest of their lives. Congenital heart disease (CHD) is a unique cardiovascular condition because it impacts people of all ages, from young babies to older adults, highlighting the importance of diverse approaches for prescribing exercise and physical activity across the lifespan.

The population of people living with CHD has grown rapidly in recent decades due to major advances in surgical and medical care. Although the benefits of physical activity and exercise are well recognised in the management of chronic diseases, the therapeutic role of exercise for the CHD population has been under-studied and under-recognised. In fact, people living with complex CHD have traditionally been advised against participation in sport and moderate or vigorous physical activity due to safety concerns. However, a evolving body of literature has demonstrated that physical activity and exercise are safe and beneficial for the vast majority of people with CHD following appropriate screening and that exercise training exercise training is a potent therapy to improve well-being and cardiorespiratory fitness in patients with CHD, which likely has important implications for prognosis. This has led to exercise training becoming an increasingly important adjunct to medical therapy in the management of patients with CHD. This presentation will describe the impact of different forms of congenital heart condition on the exercise response, summarise exercise training studies from the scientific literature and provide evidence-based guidance regarding appropriate exercise prescription in children and adults with diverse CHD.

EXERCISE IN THE PREVENTION AND MANAGEMENT OF ATRIAL FIBRILLATION

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Atrial fibrillation (AF) is the most common cardiac arrhythmia, characterized by irregular atrial activity. AF is related to increased risk of thromboembolic events, heart failure, and premature mortality. This highlights the need to treat AF and to prevent its potentially life-threatening complications. Regular physical activity and exercise training are integral for the secondary prevention of cardiovascular disease. Despite recent advances in more holistic care pathways for people with atrial fibrillation (AF), exercise rehabilitation is not provided as part of routine care.

The most recent European Society of Cardiology report for AF management states that patients should be encouraged to undertake moderate-intensity exercise and remain physically active to prevent AF incidence or recurrence. Indeed, emerging research has demonstrated beneficial effects of exercise on AF prevalence and AF-specific outcomes, including AF recurrence post-ablation. For example, meeting the international guidelines for physical activity, corresponding to ~150 min of exercise per week at moderate-to-vigorous intensity, seems an evidence-based recommendation for patients with AF to improve AF-specific outcomes and quality of life. Finally, studies reported a counterintuitively higher prevalence of AF in veteran endurance athletes compared with the general population. During this lecture, a state-of-the-art overview will be provided pertaining to the evidence and underlying mechanisms underpinning the role of exercise as medicine in the development and management of AF, but also the counterintuitive detrimental role of excessive endurance exercise.

EXERCISE IN CARDIO-ONCOLOGY

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Worldwide there are an estimated 400,000 children and adolescents every year that develop cancer. In high income countries, ~85% of children diagnosed with cancer are expected to survive. Unfortunately, survivorship comes at the cost of ongoing health concerns, as a direct result of the initial cancer and/or its treatment. Of particular concern, is the heavy burden of cardiovascular disease; childhood cancer survivors are eight times more likely than the general population to die as a result of cardiovascular disease. Data from the St Judes' study indicates that over 50% of survivors develop injury to the heart. Cardiac abnormalities occurring in survivors of childhood cancer are difficult to detect as there is often an extended latency period where there may not be any apparent symptoms for several years after the completion of therapy. As a result, abnormalities are often not detected until the process is advanced, and aggressive therapy is required. Once cardiac disease and eventual heart failure manifests, the 2-year mortality can be as high as 60%, emphasizing the importance of early recognition of cardiac injury and cardiovascular disease (CVD) in an effort to prevent progression of cardiovascular injury in cancer survivors. This presentation will share data from our lab which shows exercise stress testing can be used to detect early, pre-clinical stages of cardiovascular disease in young adult survivors of childhood cancer.

Efficient intervention is crucial for optimal management of potentially modifiable risk factors to reduce lifelong disease and early mortality. Numerous studies have determined that childhood cancer survivors are not reaching recommended physical activity guidelines and are less likely to be physically active than their healthy peers. Exercise is therefore widely promoted as a cornerstone strategy to maintain health and prevent the development of late effects following childhood cancer, and current guidelines encourage survivors to participate in regular aerobic exercise, while caution that intense isometric or strenuous loads should be avoided. This presentation will explore the latest Cardio-Oncology Rehabilitation (CORE) guidelines and current evidence covering safety, screening and individualised prescription of exercise and the implementation of CORE into clinical practice.

Oral presentations

OP-MH14 Sarcopenia

HOME BASED, APP-MONITORED PHYSICAL EXERCISE INTERVENTION FOR OLDER PEOPLE WITH SARCOPENIA. PRELIMINARY RESULTS OF THE GROW YOUR MUSCLE (GYM) STUDY.

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INTRODUCTION: Sarcopenia is a pathophysiological process of aging, caused by reduction of muscle strength, mass and function and it is associated with an increased risk of falls, fractures and physical disability. To date no longitudinal intervention studies have assessed physical activity as a primary outcome for treatment of sarcopenia. The aim of this study was to investigate the effects of a home-based, app-monitored body-weight resistance training program in improving muscle health in elderly and people living with HIV (PLWH) with sarcopenia. We here present measures of muscle mass, strength, and function of enrolled participants at baseline (BL) and after 12 weeks (W12).

METHODS: This is a monocentric, 48-week, randomized, parallel-group, superiority trial. Inclusion criteria are being sedentary; >60-year-old in the elderly or >50-year-old in the PLWH group and sarcopenia, as defined by low appendicular skeletal muscle mass index (ASMMI) by bioimpedentiometry (BIA) and/or low muscle strength by handgrip. Participants are randomized 1:1, separately in each group (elderly and PLWH), to: 1) Exercise group (EG), where participants perform a home-based, app-monitored resistance-training program; 2) Control group (CG), without exercise prescription. At BL, W12 and end of study (W48) participants are tested for muscle strength (handgrip, chair-stand-test, right thigh extensors), balance (Mini-BESTest), physical function (6MWT), and blood lipids. Correlation between variables were assessed by the Spearman correlation test, changes between BL and W12 by Wilcoxon matched pairs signed rank test and percent change differences between groups by Mann-Whitney test.

RESULTS: Fifty-six participants [41 elderly, age: 71 (63-75) and 15 PLWH, age: 59 (57-66), median (IQR)] have been screened so far and 44 (78%) have been enrolled in the study: 22 in EG and 22 in CG. At BL, there was a significant relationship between ASMMI and BMI (P=0.003; R=0.4), right thigh extensors (P<0.0001; R=0.6), handgrip (P<0.0001; R=0.8). The association between ASMMI and BMI was also maintained in men (N=21, P=0.018; R=0.5) and women (N=23, P=0.018; R=0.5). Seventeen participants (7 EG and 10 CG) completed the first 12 weeks of study and 7 dropped-out (5 EG and 2 CG). At W12 we did not observe significant percentage differences between EG and CG. However, a trend difference between EG and CG at W12 were observed in BMI [-0.3% (-2.8-1.7%) vs 1.2% (-0.1-3.1%)], ASMMI [1.8% (-2.7-4.1%) vs -0.8% (-2.2-3.0%)], handgrip [6.3% (-6.7-9.7%) vs -2.7% (-3.7-7.6%)], chair-stand-test [24% (0-40%) vs -6% (-12-8%)], Mini-BESTest [12% (0-16%) vs 9% (-5-24%)] and right leg extension [1.9% (-5.7-32.3%) vs -3.8% (-11.7-3.7%)] were observed.

CONCLUSION: Preliminary data show that BMI can be used as a potential tool for screening of sarcopenic participants. We expect that continuation of the study with enrolment of more participants will show an increase of strength, muscle mass and functional measures.

ASSOCIATIONS BETWEEN PHYSICAL ACTIVITY VOLUME AND INTENSITY AND KEY COMPONENTS OF SARCOPENIA: FINDINGS FROM THE MASS_LIFECOURSE STUDY

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INTRODUCTION: The Muscle Ageing and Sarcopenia Studies Lifecourse (MASS_Lifecourse) study aims to investigate age-related changes in skeletal muscle across mid-life and old age. The study involves detailed phenotyping of skeletal muscle with a comprehensive assessment of lifestyle factors including physical activity (PA). While PA confers a range of health benefits into old age, the relationship between PA and skeletal muscle structure and function remains unclear. This may be related to the methods used for quantifying PA via accelerometry, which typically reports time spent in specific intensity categories. This approach relies on population specific cut-points and ignores a substantial proportion of the data from the 24-h profile. An alternative approach to describe PA involves two population-independent metrics: the average acceleration (indicative of the volume of activity; ACC) and the intensity gradient (indicative of the intensity distribution of activity; IG). We aimed to examine associations between ACC and IG with key components of sarcopenia in the MASS_Lifecourse study.

METHODS: Participants aged 45-85 years were recruited via primary care in Newcastle, UK. Grip strength, time taken to complete 5 chair stands (converted to speed (stands/sec) so that higher values indicate better performance), and appendicular lean mass index (ALMI; kg/m2) were measured. Participants were asked to wear a wrist-worn triaxial accelerometer (GENEActiv) for 7 days with PA quantified via ACC (volume of activity) and IG (intensity distribution). Data were processed and analysed using the R-package GGIR. We used linear regression to examine sex-specific associations of ACC and IG with grip strength, chair stand speed and ALMI. Data are mean [SD].

RESULTS: A total of 63 men (67 [10] years) and 81 women (63 [10] years) were included in analyses (grip strength: men 41.0 [11.0] kg, women 25.0 [6.1] kg; chair stand speed: men 0.46 [0.15] stands/sec, women 0.48 [0.17] stands/sec; ALMI: men 8.24 [0.91] kg/m2, women 6.35 [0.76] kg/m2). Participants achieved reasonably high volumes of activity (mean ACC: men 28.4 [7.3] mg; women 29.2 [7.9] mg) but were generally accumulating more time in low-to-mid range intensities (IG: men -2.52 [0.19]; women -2.58 [0.19]). There was no evidence of associations between either ACC or IG and grip strength or ALMI in either sex. There was weak evidence of a modest association between IG and chair stand speed in women (difference in mean chair stand speed per 1SD increase in IG = 0.04 stands/s; 95% CI 0.00-0.08, p = 0.04).

CONCLUSION: In MASS_Lifecourse, evidence for associations between PA volume and intensity with key components of sarcopenia was limited. Even though these participants were generally achieving high levels of PA, they may not be engaging in PA behaviours which benefit skeletal muscle structure and function. Further work should explore associations between specific PA behaviours and components of sarcopenia across mid-life and old age.

EFFECT OF RESISTANCE TRAINING AT MODERATE ALTITUDE ON SERUM MUSCLE DAMAGE BIOMARKERS

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INTRODUCTION: Hypoxia exposure is becoming increasingly useful as a complementary method in recovery processes after exercise-induced muscle damage due to its potential link with protein and satellite cell turnover activity when combined with resistance exercise (1). However, beyond the fact that most research studies have been conducted under simulated hypoxia conditions, the literature is very scarce regarding underlying molecular mechanisms during resistance training (RT) programs performed in terrestrial hypobaric hypoxia (HH). The present study aims to analyze the influence of HH exposure on exercise-induced muscle damage biomarkers after an 8-week RT program.

METHODS: Twenty men (22.75±3.73 years; 176.4±5.93 cm; 73.01±10.97 kg) participated in an 8-week program (3 sessions/week) of a traditional hypertrophy training under intermittent terrestrial HH (2320 m; CAR Sierra Nevada) or normoxia (690 m). Seventy-two hours before and after weeks 6 and 8 of the program, blood samples were taken to analyze inflammatory cytokines, such as tumor necrosis factor-alpha (TNF-α) by immunology multiplex assay (Sigma-Aldrich; Darmstadt, Germany) and creatine kinase (CK) activity by a COBAS kit from Roche (Indianapolis, USA).

RESULTS: Maximal strength increased in both groups after the training period ($p<0.05$), displaying large differences in favor of HH (13.95 % vs 27.49 % in N and HH; p= 0.018 [($\eta 2p= 0.27$]). Compared with PRE values, only the HH group displayed a moderate to large decrease in circulating TNF-α along the period (-5.29% vs -25.08% in N and HH; $p<0.05$ [($\eta 2p= 0.25$]). CK values did not reveal changes of interest between both conditions at any time ($p>0.05$).

CONCLUSION: The results of this research reveal that a RT period conducted under HH conditions improved strength and reduced the inflammatory muscle response concerning the same training in N. This could be attributed to physiological adaptations induced by the stress of the hypoxia exposure towards an M2 macrophage anti-inflammatory profile, partially inhibiting the TNF-α release into the bloodstream (2). Interestingly, CK values were maintained within the accepted range in the HH condition. This circumstance joined to a more decreased inflammatory response than in N, could suggest that the stressors factors linked to RT in HH may play a key role in the muscle adaptation process without compromising performance.

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SARCOPENIA EXACERBATES MUSCLE FATIGABILITY DURING KNEE-EXTENSOR DYNAMIC CONTRACTIONS IN OLD ADULTS

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INTRODUCTION: Aging is associated with structural and functional changes at skeletal muscle level (1). Along with alterations of the neuromuscular junction and muscle atrophy, old and very-old adults show lower knee extensors (KE) isometric

torque and greater muscle fatigability, compared to young subjects [2, 3]. Sarcopenia, a condition leading to reduced mobility, increased risk of falls and loss of independence [4], worsens age-related loss of strength and power in non-fatiguing conditions [5]. The aim of this study was to compare the loss of exercise-induced KE isometric torque and power, during KE dynamic contractions in healthy and sarcopenic old adults and investigate the potential mechanisms involved at voluntary activation and muscle level.

METHODS: Old (n=71, 37 women; age=76±5yr) and young adults (Y; n=21, 11 women; age=24±4yr) were recruited. Hand grip strength, chair-to-stand, and appendicular lean mass from DEXA were used to divide old adults into healthy (HO; n=54) or sarcopenic (SO; n=17) [6]. Each participant performed 80 maximal-velocity concentric KE contractions (1 every 3s) with a load equivalent to 20% of the maximal voluntary isometric contraction (MVIC) torque. Mechanical power output (Pw) of each contraction was calculated as the product of the measured torque and angular velocity. Before (PRE) and immediately after (POST) the dynamic fatiguing exercise, voluntary activation (VA) was evaluated by interpolated twitch technique during 5-s MVIC. High-frequency doublets (Db100) and single (St) transcutaneous electrical stimulations were also delivered through the femoral nerve on relaxed muscle.

RESULTS: Baseline MVIC torque showed a main effect of group ($p<.001$), and it was lower in SO (106±41Nm, compared to HO (148±50Nm, $P=.02$), being in both groups lower than Y (196±64Nm, all $p<.003$). At POST, relative MVIC torque reduction was not different among groups (about 20%). Baseline Pw showed a main effect of group ($p<.001$) and it was lower in SO (66±24W) than in both HO (88±31W, $p=.04$) and Y (145±36W, $p<.001$). The Pw reduction during exercise showed a main effect of group ($p<.01$), with a power loss of about 18% in Y, 22% in HO and 31% in SO. VA was not different among groups at any time point. In POST, St decrease was lower in Y (-12±88%) compared to SO (-27±17%; $p<.05$).

CONCLUSION: In old adults, sarcopenia was associated with a reduction in KE isometric torque and power. Exercise-induced loss of isometric torque was not different between healthy and sarcopenic adults whereas reduction in power after dynamic contractions resulted higher in the latter, suggesting that the age-related changes in fatigability are contraction-specific. Since no differences were observed for voluntary activation, the greater power reduction during exercise in sarcopenic adults may be due to intrinsic muscle impairment of contractile and/or metabolic nature.

1. Faulkner et al 2007; 2. Hunter et al 2016; 3. Sundberg et al 2018; 4. Larsson et al 2020; 5. Bahat et al 2021; 6. Cruz-Jentoft et al 2019

IMPACT OF ONLINE PHYSICAL ACTIVITY COMBINED WITH FUNCTIONAL BARS ON UREMIC SARCOPENIA IN NON-DIALYSIS CHRONIC KIDNEY DISEASE PATIENTS

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INTRODUCTION: Chronic kidney disease (CKD) is a pathological condition characterized by several comorbidities, including uremic sarcopenia (US), which affects the quality of life and increases the risk of cardiovascular mortality [1]. Literature data suggest that regular and adapted physical activity (APA), combined with dietetic-nutritional treatments are effective to counteract the CKD progression and its comorbidities [2]. This pilot study evaluates the potential effects of 12-week online APA protocol combined with functional bars on the prevention of US and other related-CKD comorbidities.

METHODS: 21 CKD patients, aged 62.7±5 years, were randomized into 4 groups: A) online APA protocol (3 sessions per week, lasting 1 hour each) combined with a daily intake of 2 antioxidant and anti-inflammatory bars, based on natural bioactive compounds; B) only online APA protocol; C) only consumption of the functional bars; D) usual care. Physical capacity (6-minute walking test), muscle strength (handgrip strength test), body composition (bioelectric impedance analysis - BIA), quadriceps femoris muscle thickness (ultrasonography) and laboratory parameters were evaluated at baseline (T0) and after 12 weeks (T1).

RESULTS: At T1, 6-minute walking test reported an increase of walking distance, in groups A (9.4%) and C (11.5 %), while handgrip strength test decrease in group D for the right (-6.3%) and left limb (-6.0%). After the intervention, BIA showed an improvement in fat free mass and fat mass in groups A (7.2%) and B (-12.5%), where APA was included. The thickness of quadriceps femoris increased in groups A (12.6%), B (13.4%) and C (9.7%). We also observed an improving trend in total cholesterol in groups A (-7.6 %) and B (-15.4 %), however, all study groups showed a reduction of creatinine levels.

CONCLUSION: These preliminary data seem to confirm the effectiveness of APA and the additive role of the natural bioactive compounds in countering the US and other CKD comorbidities. Further studies are needed to confirm these preliminary data.

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Oral presentations

OP-MH27 Physical activity/Inactivity II

HOME-BASED EXERCISE AND AMINO ACIDS SUPPLEMENTATION INCREASE MUSCLE STRENGTH IN OLDER PEOPLE: A RANDOMIZED CONTROL TRIALS

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INTRODUCTION: Aging causes structural and functional changes in skeletal muscle and it is associated with decreased individual quality of life. The aim of this study is to evaluate the effect of a 24-weeks home-based resistance training program and amino acids supplementation on physical performance and muscle health in older subjects.

METHODS: This is a three-arms randomized-controlled study conducted at the IRCCS Ospedale Galeazzi-Sant'Ambrogio (Milan, Italy) enrolling 35 healthy and sedentary older participants (age: between 60 and 80 years) that have been randomly allocated into an experimental group performing a 24-weeks resistance exercise intervention (EXE; n=11), or an experimental group performing a 24-weeks resistance exercise intervention plus an intake of amino acids for the first 12-weeks (SUPPL; n=12), or a control group (CON; n=12). At the beginning (PRE), and after 24-weeks (POST), participants were assessed for muscle strength (Chair Stand Test, Handgrip Test, Maximum Isometric Strength of knee extensors and flexors, and One Repetition Maximum (1RM) by Leg-Press), balance and gait capacity (Mini-BESTest), body composition by Gold Standard assessments (dual energy X-ray absorptiometry: to obtain Appendicular Skeletal Muscle Mass Index (ASMMI); magnetic resonance imaging of thigh: to evaluate Intra Muscular Adipose Tissue (IMAT) and muscle Cross Sectional Area (CSA)).

RESULTS: Two-way ANOVA was used to test the effect of time, the effect of group and the effect of interaction. Intra- and inter-group differences for all variables were tested by Bonferroni post-hoc test. Results showed that EXE and SUPPL significantly improved the Chair Stand Test (EXE: PRE=12.36±3.11; POST=16.00±3.13; p=0.0003. SUPPL: PRE=12.08±2.84; POST=15.25±4.29; p=0.0009. Effect of Time: p<0.0001, Group: n.s., Interaction: n.s.) whereas no significant differences were observed in CON. In addition, SUPPL improved 1RM (PRE=145.46±35.60kg; POST=167.27±52.17kg; p=0.041. Effect of Time: p=0.016, Group: n.s., Interaction: n.s.) and Handgrip Test (PRE=21.73±9.48kg; POST=27.25±9.92kg; p=0.005. Effect of Time: p=0.002, Group: n.s., Interaction: n.s.). No significant differences were found on IMAT and CSA, but a difference was detected in CON group for ASMMI (PRE=7.31±1.61kg/m2; POST=6.91±1.44kg/m2; p=0.037. Effect of Time: n.s., Group: n.s., Interaction: 0.041).

CONCLUSION: It is well known that exercise and amino acids supplementation play a crucial role in maintaining good physical health and muscle mass. Data of this study demonstrated that home-based exercise could be an alternative method from traditional training practices, as it increases the maximal and submaximal strength of the lower and upper limbs. Furthermore, the two intervention groups maintained the baseline muscle mass while the CON group decrease the ASMMI.

LONG-TERM PARTICIPATION AFTER SEVERE BURN INJURY: IS PHYSICAL FITNESS, FATIGUE, AND PHYSICAL ACTIVITY LEVEL ASSOCIATED WITH SOCIAL PARTICIPATION? PRELIMINARY RESULTS OF A CROSS-SECTIONAL STUDY

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ASSOCIATION OF DUTCH BURN CENTRES; UNIVERSITY MEDICAL CENTRE GRONINGEN, DEPT. OF HUMAN MOVEMENT SCIENCES; HANZE UNIVERSITY OF APPLIED SCIENCES GRONINGEN; UMC ROTTERDAM, DEPT. OF PUBLIC HEALTH

INTRODUCTION: Advances in treatment of acute burn injuries have resulted in improved survival rates, leading to an increased number of burn survivors that have to live with physical and/or psychological sequelae. Returning to daily activities and social participation is an important aspect of burn care rehabilitation. Exercise-based interventions have been shown to be effective in improving the social participation in other patient groups. However, in burn survivors it is unclear whether exercise-based interventions may improve their participation. In this study, we examined whether factors modifiable by exercise, i.e. fatigue, physical activity level, muscle strength, and aerobic capacity are associated with long-term social participation in burn survivors with severe burns. If so, these factors could be target of intervention to enhance social participation in burn survivors.

METHODS: A cross-sectional study was conducted in the three dedicated Dutch burn centers. Eligible were patients 18 years and older with severe burns (total body surface area (TBSA) burned >20% if 50 years or older, or TBSA burned >10% if >50 years, or TBSA full thickness >5% [1]). Five to seven years post burn, their social participation was assessed with the Work Productivity and Activity Impairment General Health questionnaire (question 6). Fatigue was assessed with the Brief Fatigue Inventory, and physical activity levels with the Baecke Physical Activity Questionnaire. Furthermore, grip strength was used as a measure of overall muscle strength and aerobic capacity was assessed with the Steep Ramp Test. Logistic regression was used to examine whether social participation (no limitations (score 0) vs limitations (score 1-10)) was associated with an individual's level of fatigue, physical activity level, muscle strength or aerobic capacity.

RESULTS: Forty-seven burn survivors participated (response rate: 33.6%), of which 68.1% was male. Their mean age was 52.7 years old (SD 15.8) and their median %TBSA burned was 18.0% (IQR: 12.0-34.0). Fifty-one percent reported to be limited in social participation. Their limited social participation was not associated with their level of fatigue (OR: 1.23; 95%CI: 0.92-1.65; p=0.16), physical activity level (OR: 0.66; 95%CI: 0.32-1.37; p=0.26), muscle strength (OR: 0.21; 95%CI: 0.02-2.80; p=0.24), or aerobic capacity (OR: 0.90; 95%CI: 0.57-1.41, p=0.64).

CONCLUSION: Many burn survivors experienced limitations in social participation. Their social participation could, however, not be explained by factors that can be modified by exercise. More research is necessary to identify modifiable factors for long-term social participation after severe burns. Such factors may support the design of tailor-made rehabilitation programs for burn survivors restricted in social participation.

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PHYSICAL ACTIVITY BEHAVIOR OF AN IN-PATIENT POPULATION WITH ANOREXIA NERVOSA: A COMPARISON WITH HEALTHY CONTROLS

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UNIVERSITÄT INNSBRUCK

INTRODUCTION: Physical activity (PA) behavior of patients with anorexia nervosa (AN) is commonly associated with abnormally high PA levels, often caused by a drive for fitness in order to initiate weight loss [1]. In an in-patient rehabilitation setting, the PA behavior of AN patients is usually limited due to PA restrictions within the daily routine. Yet, AN in-patients reported higher frequencies of PA if measured subjectively when compared with healthy controls [2]. The aim of this study was to objectively measure the PA behavior of an in-patient AN population and compare it with healthy controls. We hypothesized that PA characteristics, such as walking time and step count, would be enhanced in AN in-patients, despite PA restrictions.

METHODS: PA behavior of 30 female AN in-patients and 30 sex and age-matched healthy controls (18-39 years) was measured using accelerometers (Move4, MoviSense) on 2 weekdays and 2 days at the weekend. AN in-patients were assessed within the clinical routine of their rehabilitation stay at the Schön Clinic Roseneck, Germany. Compulsive Exercise Test (CET) and Commitment to Exercise Scale (CES) were used in order to determine obsessive-compulsive PA behavior risk in both groups.

RESULTS: Active PA parameters (walking, step count, running, cycling) differed significantly between groups, whereas passive PA parameters (sitting/standing, lying) did not. In average, AN in-patients showed longer daily walking times (185 ±44.6 min, vs. 121 ±43.1 min; p< .001), a higher step count (20498 ±2224 vs. 13106 ±4043; p< .001) and longer running times (22 ±31.2 min vs. 7 ±8.9 min; p= .078), whereas healthy controls spent more time during cycling (15 ±11.8 min vs. 1.8 ±2.3 min, p< .001). Daily time spent during sitting/standing (p= .511) or laying (p=.081) did not differ significantly between groups. High CET and CES scores correlated with low BMI rates (r (59) = .442, p< .001) and high step counts per day (r(59) = .362, p=.013). PA behavior did not differ significantly on weekdays compared with weekends in the two groups (p >.05).

CONCLUSION: Even in a rehabilitation setting when AN in-patients underlie PA restrictions, walking time and step count seem to be enhanced in AN in-patients compared to healthy controls. These results could be used by exercise therapy staff in rehabilitation to further monitor these specific PA parameters and adapt or form specific PA recommendations.

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ASSOCIATION OF MUSCULAR ENDURANCE/STRENGTH WITH MOVEMENT-EVOKED PAIN IN PATIENTS WITH NON-SPECIFIC CHRONIC LOW BACK PAIN: THE BACKFIT PROJECT.

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INTRODUCTION: Individuals with chronic pain might evade certain movements to prevent their experience of pain(1). A recent call for the transformation from studying pain and movement, to studying pain with movement has raised(2). Knowledge about potential MEP and factors associated with it in patients with non-specific chronic low back pain (NSCLBP) might lead to improve the knowledge on the disease and help in the development of future recommendations for this population. The aims of the current study were: (i) To examine the presence of movement-evoked pain (MEP) after muscular fitness tests completion; (ii) To test the association of muscular endurance/strength with MEP in patients with non-specific chronic low back pain (NSCLBP).

METHODS: A total of 104 (69 women) patients with NSCLBP aged 51.0±10.3 years old participated. To measure back extensor, back flexor, upper-body, and lower-body muscular endurance, the Biering-Sørensen, prone bridging, handgrip and the 30-sec chair stand tests were used, respectively. A visual analogue scale (VAS) was used to measure subjective changes in back pain intensity and unpleasantness. Testing was performed at arrival while participant was at rest sitting (VAS-pain at baseline) and immediately after performing each muscular fitness test during assessment (MEP). Global

muscular endurance was calculated with a weighted average of normalized index (z-score = (value – mean) / standard deviation) of each muscular strength/endurance test. To test the differences between VAS-pain after performing each muscular fitness test and VAS-pain at baseline, a paired t-test was performed. To assess the magnitude of the difference (effect size) Cohen's d coefficient was used. To test the association of muscular fitness with MEP, multivariate linear regression analysis was used controlling for VAS-pain at baseline, age, sex, time since diagnosis, marital status, education, fat percentage using the 'stepwise' method. Since no clear differences between sex were observed, all analyses were performed across the whole sample.

RESULTS: Patients showed greater pain after the Biering-Sørensen (mean difference=0.56; 95% confidence interval (CI)=0.02, 1.11; P=0.044) and the prone bridging tests (0.68; 0.15, 1.21; P=0.013) and lower pain after the handgrip (-0.99; -1.46, -0.52, P<0.001) tests completion. Greater global muscular fitness was associated with lower MEP after the Biering-Sørensen (b=-1.41; -2.29, -0.53, P=0.002), the 30-sec chair stand (-1.32; -2.10, -0.53, P=0.001), and the prone bridging (-0.81; -1.53, -0.09, P=0.028) tests completion.

CONCLUSION: Patients with NSCLPB presented MEP after the completion of back extensors and flexors muscular strength tests, whereas pain diminished after the completion of upper-body muscular strength. Greater muscular strength was overall associated with lower MEP. Motivating patients with NSCLBP to improve their muscular fitness seems advisable but needs confirmation with intervention studies.

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Oral presentations

OP-BM22 Jumping and landing I

NO CONTRIBUTION OF PRESYNAPTIC INHIBITION PATHWAYS TO IA AFFERENT DEPRESSION IN THE SOLEUS MUSCLE DURING DROP LANDINGS

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INTRODUCTION: Type Ia sensory fibers have been found to be phase dependently modulated during drop landings (DL) [1]. This modulation results in depressed soleus (SOL) H-reflex amplitudes shortly after ground contact (GC) during DL, which is thought to adjust the muscle-tendon stiffness in order to avoid injury [1, 2]. Since descending pathways from supraspinal centers can affect presynaptic inhibition (PSI), this study aimed to examine PSI during the flight and landing phases of DLs.

METHODS: Fifteen participants (3 females; 25.8y ± 7.0) received peripheral nerve stimulations during quiet stance (QS), 40cm DLs pre (PRE) and post (POST) GC. SOL H-reflexes elicited by tibial nerve stimulations were timed to occur 30 to 0ms PRE, 30 to 60ms POST landings and during QS. Ia presynaptic inhibition was assessed by conditioning the SOL H-reflex with femoral nerve stimulations, eliciting H-reflex heteronymous facilitation (HHF) and common fibular nerve stimulations, eliciting H-reflex D1 presynaptic inhibition (HD1) [3]. The conditioned SOL H-reflex amplitudes were then compared to the unconditioned test reflexes (HTEST) during QS, PRE and POST. Furthermore, EMG of SOL, medial gastrocnemius (MG), tibialis anterior (TA) and vastus medialis (VM) as well as hip, knee and ankle joint angles in unstimulated and stimulated trials were measured throughout DL tasks and QS. Two-way repeated measures ANOVAs for the factors time (QS, PRE, POST) and conditioning (HTEST, HHF, HD1) were performed.

RESULTS: HTEST amplitudes POST were significantly lower than PRE (-8.5% of Mmax, 95% CI[-1.9, -15.2], p = .011). Even though facilitation and inhibition could be observed in QS (HHF-HTEST: +6.7% of Mmax, 95% CI[-11.4, -2.0], p < .001 & HD1-HTEST: -6.9% of Mmax, 95% CI[-0.7, -13.1], p = .020), HHF and HD1 amplitudes exhibited no difference to HTEST (p = 1.000) PRE and POST. EMG recordings revealed significant differences in muscle activity just prior to stimulation between DL conditions (p < .045). Additionally, background EMG in unstimulated trials demonstrated increased EMG activity in DL conditions compared to QS and increases in MG activity during PRE and VM activity during POST (p < .007). No statistical differences were found for HTEST/HMAX responses (QS, PRE & POST), ankle angle and dorsiflexion angular velocity at GC (PRE & POST), M-wave amplitudes in TA and VM during HHF and HD1 conditions (QS, PRE & POST) and fatigue prior to post experiment (p > .074).

CONCLUSION: Differences in muscle activity during landing conditions might indicate altered behavior between the conditions. The differences in behavior might originate from the different nerve stimulations and lead to changed H-reflexes. Nevertheless, these results provide first evidence to suggest no influence of presynaptic inhibition on the modulation of H-reflex depression in drop landings.

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LANDING FROM A COUNTER-MOVEMENT JUMP IN ALTERED GRAVITY CONDITIONS. CURRENT KNOWLEDGE AND FUTURE DIRECTIONS

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INTRODUCTION: Landing from a jump is a complex pre-planned motor action requiring the central nervous system (CNS) to predict the instant of contact with the ground (touchdown, TD). In this study, the human motor control of landing from a counter-movement jump was assessed in different conditions of simulated gravity (i.e., microgravity and hypergravity) and of sensory input environment (i.e., 1g, 0g or hypergravity). The objective is to provide a summary of our findings and shed light into the understanding of the biomechanics and human motor control of landing.

METHODS: Eight participants were asked to perform counter-movement jumps. Microgravity conditions (0.2g0, 0.4g0, 0.6g0 and 1g0) were simulated in a weightlessness environment (0g), during parabolic flight manoeuvres, by means of a Subject Loading System (SLS), providing a pull-down force. Hypergravity conditions (1.2g, 1.4g and 1.6g) were simulated on Earth with the SLS or by turn manoeuvres, generating centrifugal forces. Kinematics, kinetics and lower limb muscle activity (EMG) were recorded. A mixed-model ANOVA, with gravity level (0.2g-1.6g) and sensory input environment (1g, 0g, hypergravity) as fixed factors, and participant as a random factor, was performed.

RESULTS: In every condition, there is a pre-landing EMG of about 100 ms prior to TD. With increased gravity level in both hypergravity sensory input environments, angles at TD of the hip, knee and ankle joints are significantly decreased [1]. In hypergravity conditions simulated by centrifugal forces, angles at TD of the hip, knee and ankle joints are significantly decreased compared to hypergravity simulated by the SLS [1]. With increased gravity level in microgravity conditions, angles at TD of the hip, knee and ankle joints are significantly decreased [2]. In 1g0, angles at TD of the knee and ankle joints are significantly decreased compared to 1g on Earth [2].

CONCLUSION: The presence of pre-landing EMG about 100 ms prior to TD and the adaptation of body configuration at TD according to the gravity level suggest that participants were able to predict TD in altered gravity conditions. The increased "crouched" body configuration at TD with increased gravity levels or in unusual sensory input environments with the same gravity level (i.e., 1g0 and hypergravity simulated by centrifugal forces) may be a natural protective mechanism: increased ankle dorsiflexion at TD may increase stability [3] and increased knee flexion at TD may reduce the risk of anterior cruciate ligament injury [4, 5]. This natural protective mechanism deserves further investigations in injury prevention. Future research aims at assessing the landing coordination using intersegmental covariation of elevation angles [6].

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BIOMECHANICAL PARAMETERS OF THE LOWER LIMBS WHEN LANDING FROM A JUMP DURING CHILDHOOD

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INTRODUCTION: In sports, such as volleyball, basketball, gymnastics, parkour, jumping is a common task, and the control of landing is essential to perform as well as to avoid injury. Although this skill seems simple, it requests the integration of sensory information to predict the instant of touchdown (TD) and the characteristics of the forthcoming impact force, to finely adjust the biomechanical properties of the lower limbs to land softly.

In the present study, we aim to investigate the control of landing from a jump throughout childhood.

METHODS: 59 children from 3 to 12yo performed double-leg landings from a box of 30cm (n=275). No instruction was provided about the manner, speed, or arm movement. The vertical component of the ground reaction force (Fv) was measured using instrumented force plates and then the vertical acceleration (av), velocity (Vv) and displacement (Sv) of the center of mass of the body were calculated. A model was used to characterise the control of landing and was divided into two phases: 1) from TD to the peak of Fv, the lower limb behavior was modeled by a spring whose stiffness–k1 was determined as the slope of the linear relationship of the av-Sv curve; 2) from the peak of Fv to the end of landing, where the behavior was modeled as a spring associated with a damper and a stiffness–k2 and the damping coefficient–c2 were determined by iteration of av-Vv-Sv [1].

Statistics: A Principal Component Analysis (PCA) with Varimax rotation was used to identify the relationship between the age and the biomechanical parameters (k1, k2, c2).

RESULTS: The biomechanical model fits with the experimental data during both phases; R-squared equals 0.91±0.08 during the 1st phase and 0.85±0.09 during the 2nd. The PCA indicates that two components explain 85% of the total variance. The 1st component explains 49% and the loadings for the age, k1, k2 and c2 are respectively 0.92, -0.90, 0.11 and 0.29, while the loadings for the 2nd component are respectively 0.03, 0.10, 0.93 and 0.88. So, the PCA indicates that the stiffness–k1 decreases with the increase of age (from 1135±410 s-2 at 3-4yo to 328±138 s-2 at 11-12yo, mean±S.D.), while k2 and c2 do not change.

CONCLUSION: Our results show a decrease of the stiffness–k1 throughout childhood but no modification of the parameters k2-c2. As the motor development of children follows a cephalo-caudal direction involving an increased number of degrees of freedom [2], one explanation of the stiffer behavior observed in young children compared to older children could be a poor control of the ankle joint. This assumption is consistent with observations on the role of the ankle in the control of landing [3]. In the future, sports instructors should consider the stiff strategy in young children and develop adapted training programs to reduce the risk of injury.

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HOW BIOMECHANICAL STABILITY DEFICITS DURING UNPLANNED SINGLE-LEG LANDINGS RELATE TO SELECTED MARKERS OF PURE COGNITIVE AND COGNITIVE-MOTOR FUNCTION?

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INTRODUCTION: Cognitive skills such as visuomotor processing speed and executive function (e.g., cognitive flexibility or inhibitory control) are suggested to have an impact on injury risk during time-constrained athletic movements. It can be speculated that cognitive-motor performances are even more strongly related to injury risk than performances in classical pure cognitive assessments due to its higher ecologigal validity. Thus, the aim of this study was to gain further insights into the cognitive-motor processes associated with biomechanical stability during unplanned jump-landings.

METHODS: Twenty healthy amateur football players (27±5years, all males) performed 24 countermovement jumps with single-leg landings on a pressure plate. Equally balanced and randomly ordered, these needed to be performed either preplanned (landing leg indicated before take-off on screen) or unplanned (visual cue automatically shown approx. 400 ms before landing). Both conditions involved a visual distraction component that was briefly shown during the jump (moving players). Participats were asked to recall the movement directions of the players after landig. Biomechanical stability was meassured by means of peak ground reaction force (pGRF; [N]) and center of pressure path length (COP [mm]). In addition, decision-making was assessed as the amount of landing errors (wrong/both feet) in the unplanned condition. Selected cognitive-motor performances (responses to visual stimulus with lower limb) were assessed in standing position using the SKILLCOURT® System. The same cognitive tests (i.e., visuomotor reaction time; RT, cognitive flexibility, inhibitory control) were meassured via conventional computerized testing in sitting position requiring a minimal motor involvement (i.e., pressing button on the keyboard).

RESULTS: According to dependent t-Tests, unplanned landings produced higher COP values upon landing than the preplanned condition (+13%, p=0.034, d=0.6), but not sigificantly higher pGRF (p>.05). The increases of the COP (i.e., unplanned landing costs) were positively related to specific markers of cognitive-motor function (slower simple RT: r=0.55, p=0.015, and choice RT: r=0.47, p=0.04), but not to the pure cognitive test results (p>.05). No significant relationships could be found in terms of cognitive flexibiliy (switching test) and inhibitory control (Go no go test).

CONCLUSION: Cognitive-motor testing may be a promising, but still little researched moderator of unplanned jump-landing safety. Further research should elucidate the potential additional value of such novel test approaches to identify team sport athletes who are at risk of sustaining an injury during challenging athletic movement tasks that involve divided attention and time-constrained decision-making components.

MUSCLE ACTIVITY PRE AND POST DROP JUMP LANDING IN CHRONIC ANKLE INSTABILITY DURING REHABILITATION

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INTRODUCTION: In chronic ankle instability (CAI), among others, decreased peroneus longus and increased tibialis anterior muscle activity has been reported 200 ms prior to drop jump landing compared to healthy controls [1,2,3]. This study aims to analyse the recovery of lower extremity muscle activity during drop jump landings of chronic patients during their rehabilitation process and compare them to healthy controls.

METHODS: Eight CAI patients (26 ± 6 years) were evaluated over 3 months. The patients received individual physiotherapy focusing on e.g., muscle strengthening, coordination, and or joint mobility. The patients and 10 age-matched healthy controls performed a 2-limb stance trial and 5 drop jumps, which were recorded using Qualisys 3D motion analysis system. Muscle activity was recorded using surface EMG sensors (Noraxon). The tasks were repeated in weeks 0, 3, 6 and 12. The EMG data of the drop jumps were normalised using the 2-limb stance. The area under the curve was assessed for the phases 200 ms pre and 200 ms post landing. A pre- vs post-landing ratio was calculated. A repeated measures

statistical analysis was performed in SPSS for non-normally distributed data. The FAAM and CAIT were used to monitor daily life performance subjectively.

RESULTS: The CAI group had a significant higher pre-post ratio for all measurement times for the Peroneus longus, the Gastrocnemius medialis and lateralis, and Biceps femoris activity compared to the controls. The post-landing activity of the Abductor hallucis was lower for the CAI (not significantly). The patients reported a significant improvement in daily activities (FAAM-ADL), sports (FAAM-S), and instability score (CAIT) over time.

CONCLUSION: The observed abnormal muscle activity in CAI during drop jump landings did not recover during the rehabilitation process, while the patients reported improved daily and sport functions.

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Oral presentations

OP-BM28 Gait

THE EFFECT OF TRUNK INCLINATION ON CENTER OF MASS DYNAMICS AND STEP-TO-STEP TRANSITION

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INTRODUCTION: The anterior inclination of the trunk elicits a change in the position and projection of the center of mass (CoM) relative to the ground (1). Alterations in the sagittal alignment of the CoM and ankle joint positions are associated with a modification of the velocity and acceleration of the CoM relative to normal walking (2). In turn, it could result in a delayed timing of CoM redirection from downward to upward, modifying the step-to-step transition (3). In older adults, a delayed redirection of the CoM velocity has been observed and associated with a lack of propulsion at the end of the stance (4). Older adults also display greater trunk flexion (3), but its effect on step-to-step transition is unknown. To investigate the modification induced by trunk inclination, we compared the step-to-step transition in healthy young adults walking normally and walking with 4 different imposed trunk inclinations.

METHODS: Ten healthy young men walked at 1.1 m s-1 on an instrumental treadmill. They walked with a natural trunk position and with an imposed 10°, 20°, 30° and 40° of trunk flexion. The angles were controlled on the sagittal plane by OnForm app. For each condition, participants walked 3 minutes and the last 10 seconds of each session were recorded. The vertical ground reaction force (Fv) under each foot was recorded. The ratio between the maximal force of the front and the back leg (Ff/Fb) during the step-to-step transition was measured. From Fv, we computed the vertical velocity of the CoM, to determine the beginning (Vv,min) of the transition. A one-way ANOVA and Bonferroni post hoc were used to compare our variables.

RESULTS: No differences in step length were observed between conditions (ANOVA, $p=0.532$). The timing of Vv,min relative to the foot contact and Ff/Fb were different between conditions (ANOVA, $p<0.001$): the greater the increase in trunk flexion, the later Vv,min occurred relative to FC ($p<0.05$). Also, as compared to natural walking, Ff/Fb was higher in the 20°, 30°, and 40° trunk flexion conditions ($p<0.05$). No differences were founded in Ff/Fb between 10° and normal ($p = 1.00$).

CONCLUSION: Our results suggest that the trunk inclination modifies the transfer from one leg to the other. Therefore, the gait modification in older adults may partly be due to trunk flexion. Indeed, older adults have been reported with 9° of trunk inclination. However, in older adults, this inclination has been related to a significant change in Ff/Fb and a much greater modification of Vv,min than what we observed with a similar trunk angle (4). This suggests that trunk inclination alone cannot explain the alterations observed with age, but should be considered as a confounding factor since the step-to-step transition is a major determinant of the overall cost of walking (5).

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DIFFERENCES IN EEG DELTA FREQUENCY BAND BETWEEN TREADMILL AND OVERGROUND WALKING

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INTRODUCTION: For several decades, low-frequency cortical activity and electroencephalogram (EEG) delta bands (0.5-4 Hz) have been associated with sleep (1). Recently, various studies have suggested the use of low-frequency cortical activity in analyzing sensorimotor-related information. Human EEG delta activities were decoded to investigate kinematic parameters (2-4) and muscle activities (5) among different tasks and experimental. In treadmill and overground walking, the similarity of gait parameters and kinematic patterns were exhibited, while the disparity muscle activation patterns, joint moments and joint powers were frequently observed (6). We hypothesized that a significant difference in EEG delta frequency band would be presented between treadmill and overground walking during walking gait cycle. Therefore, the goal of this study was to compare EEG delta activities between gait cycles of human passive treadmill and overground walking.

METHODS: The electroencephalogram (32-channel EEG: eegoTMmylab ANT Neuro) and inertial measurement unit data (IMU: NORAXON Ultium Motion) were recorded from 10 healthy (5 men and 5 women) participants. The participants performed 3 minutes of passive treadmill and overground walking. Raw EEG and IMU data were analyzed using MATLAB software. The stride cycle of human walking was identified based on thigh angle (Noraxon MyoMotion-Segments Thigh RT-orientation-y), in which the maximum angle was demonstrated at initial contact. Then, the EEG delta frequency band was selected from peak locations (location vector at the peak indices) of thigh angle. The processed EEG data yielded a matrix of 30 rows (regarding 30 observing EEG active electrode placements) and 100 columns (regarding 100 time points/percentage of gait cycle). Statistical parametric mapping (SPM) analyses were performed to investigate the difference in continuous EEG delta frequency band of human walking gait cycle between passive treadmill and overground walking.

RESULTS: The average participant's stride cycle was 98. EEG delta frequency band of the walking gait cycle demonstrated a significant difference at Cz position within the 16.8% to 18.1% ($p=0.031$), and within the 65.8% to 66.3% of gait cycle ($p=0.031$). The duration of sub-phase of human gait cycle at Cz revealed mid-stance and initial swing phases respectively. At 17.5% to 19.8% of gait cycle, P3 position was significantly different ($p=0.002$). The duration of sub-phase of human gait cycle at P3 exhibited the mid-stance phase.

CONCLUSION: The results demonstrated brain activities responded at the Cz and P3 positions across the mid-stance and initial swing sub-phases of gait cycle supporting the role of sensorimotor integration (lower extremity) and sensations. Brain activities at Cz position relevant with motor task, and P3 associate with sensory input. Thus, this neural activation pattern observed during walking gait cycle potentially light up the knowledge for developing effective neuroprostheses for walking rehabilitation.

DIFFERENCES IN SQUAT AND STAIR DESCENT LOWER LIMB KINEMATICS BETWEEN HEALTHY CONTROLS AND PATIENTS WITH PATELLOFEMORAL PAIN

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INTRODUCTION: Patellofemoral pain (PFP) is one of the most common knee conditions that physiotherapists and physicians have to confront and has various aetiologies. To assess PFP, functional tests such as the squat and stair decent are routinely performed by clinicians (3). Little information exists, however, on the quantitative differences between healthy and PFP patients' movement patterns when executing these tasks, especially as neuromuscular activation may differ due to PFP (4).

METHODS: Ten healthy controls (age: 29.0 ± 6.6 years, height: 1.71 ± 0.11 m, body mass: 78.7 ± 16.32 kg, females: n = 5) and 10 PFP patients (age: 34.0 ± 9.1 years, height: 1.72 ± 0.09 m, body mass: 77.4 ± 18.9 kg, females: n= 5, referred by a consultant or general practitioner to NWW NHS physiotherapy department were recruited in this study. They performed a one leg hopping-landing-self-selected squatting task and a three-step descent task starting with the unaffected leg. 3D motion analysis was used to examine quadriceps angle (QAngle), knee flexion (KF), foot supination (FS), anterior and posterior pelvic rotation (PR_ASIS and PR_PSIS, respectively), and forward and backward pelvic tilt (PT_FWD and PT_XY, respectively) during execution of the squat or stair decent. Statistical Parametric Mapping (SPM) was used to compare the normalised kinematics time-series between controls and ACL patients for all the above variables and both tasks. Additionally, a 2 (group) x 2 (task) compared the maximum angle for QAngle KF and FS, followed with Bonferroni-corrected pairwise comparisons, where differences were revealed.

RESULTS: SPM revealed no changes in squat normalised kinematics time-series for QAngle, FS, and PT_FWD. KF differed significantly ($p < 0.05$) between 18-20% of the movement range, PR_ASIS between 0-32% and 35-100%, PR_PSIS between 0-20% and 78-100% and PT_XY between 4-12%. For stair decent, no significant differences were revealed for any variables. Finally, no differences were revealed for maximum angle for QAngle and FS. KF revealed a significant difference for task only, with a 48.2° higher knee flexion for squat ($p = 0.001$).

CONCLUSION: Our results suggest that discrete values from the functional tests used to assess PFP are unlikely to show differences between healthy and PFP patients. Similarly, the movement pattern of the stair decent is not affected by PFP, with only the squat showing such differences between groups. These findings contribute to understanding of PFP assess-

ment, while support calls for identification of more robust tests (1, 2) as well as for examinations of the full movement range rather than discrete values from it (5).

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REDUCED SHOE DROP IN CHILDREN INDUCES A MORE MID-FOREFOOT FOOTSTRIKE WHILE SPRINTING BUT NOT WHILE WALKING

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INTRODUCTION: Physical activity and sport bring many health benefits for children. However, it can also cause musculoskeletal injuries. The immaturity of the musculoskeletal system of children, when subjected to repeated microtraumas, favors the appearance of growth pathologies, such as the Sever's disease. Among the factors predisposing to the risk of injury at the lower limbs, one of the most important is the use of unsuitable footwear. Although research on adult footwear is extensive, the impact of the footwear on children's locomotion remains largely unknown. In adults, the reduction of the heel-to-toe drop seems to induce a footstrike pattern modification more on the forefoot1,2,4,5. It would thus make it possible to reduce the constraints applied under the calcaneus, which is closely related with the Sever's disease1,5. This reduction would also lower the maximal knee flexion and therefore limit the elongation of the patellar tendon3,4, which is a key factor in Osgood's disease. Thus, the main objective of this study was to analyze the acute effects of drop reduction on the kinematics and dynamics of child's locomotion during walking and sprinting.

METHODS: Eleven children (8 boys and 3 girls, age 7.8 ± 1.6 yrs, height 1.29 ± 0.11 m, body mass 26.3 ± 6.3 kg), who regularly practiced physical activities in addition to physical education, tested 3 sport shoes, only differing by their heel-to-toe drop: 0 mm, 4 mm and 8 mm. The experimental walking and sprinting conditions were carried out across a motion capture system (Vicon MX, Oxford, UK) with 4 forceplates (Kistler 9286BA, Switzerland). Repeated measures ANOVA's were performed on spatiotemporal, kinematic and dynamic parameters. When a significant effect was detected ($p<0.05$), Bonferroni's post-hoc test was applied.

RESULTS: For the sprinting condition, the drop reduction induced a modification of the footstrike pattern, transitioning from a rearfoot strike to a mid-forefoot strike. There was indeed a significant difference ($p=0.004$) between a 0 mm drop and a 8 mm drop (1.6 ± 6.4° and 5.9 ± 8.4°, respectively). A significant reduction ($p=0.04$) was also observed in the occurrence rate of the vertical ground reaction force impact peak in the 0 mm drop (62 ± 25%) compared to the 8 mm drop (76 ± 19%) . For the walking condition, the drop reduction did not significantly impact the investigated parameters.

CONCLUSION: The main finding of this study was that sprinting gait in children was influenced by wearing reduced heel-to-toe drop shoes. Such drop reduction, by implying a more mid-forefoot footstrike, would induce a forward shift of the plantar constraints distribution. These biomechanical adaptations would reduce the compression forces under the calcaneus and could contribute to reduce the risk of Severs disease.

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Oral presentations

OP-SH08 Cognition I

COGNITIVE FUNCTION IN RESPONSE TO AN ACUTE, HIGH INTENSITY EXERCISE – DOES GENDER PLAYS A ROLE?

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Introduction: The growing evidence favoring the positive effect of exercise on cognition is mostly based on men participants (75 %). We therefore exposed females and males to acute intensive exercise session and evaluated gender cognitive response to this intervention.

Method: Thirty- two adults (M=17; F=15) ages 18-34 participated in the study. Exercise consisted of ten repetitions: 10 seconds sprints at maximal speed, following by 50 seconds active recovery. Stroop test (ST) 1-3; Trail-making test (TMT) 1-2; Word fluency were evaluated at three time points: prior to, immediately post exercise, and at 45 recovery. Two-way ANOVA with repeated measures (three test points X 2 gender groups) was used to test the effect of exercise on cognitive performance.

Results: Both males and females reached close to maximal heat rates at the end of the 10th running round. This finding and the Rate of Perceived Exertion- RPE at the end of the effort (range 16-20 males, 13-20 females) indicates that the exercise stimulation was at a high level of effort for both sexes. Stroop 1- 2 results improved for both males and females from pre to post exercise ($p<0.01$). After 45 males returned to pre-exercise while females still retained high values. For Stroop 3 both genders improved from pre to post ($p<0.01$), and retained high values after 45. For TMT-1 males showed no response while females results improved immediately and at 45 post intervention ($p<0.01$). For TMT-2 both genders improved immediately after exercise ($p<0.01$); however, only females continued improving at 45 recovery. Word fluency was positively affected by exercise in males only.

Conclusions: Acute intensive bout of exercise has a positive immediate effect on cognitive performance both in males and females; however only females retained the positive effect of exercise for longer time periods, at least 45 minutes after intervention and possibly longer.

Since our data point to gender variability in cognitive response to the exercise stimulation, thus future research should include female participants to broaden database on both genders.

A PROSPECTIVE STUDY OF CARDIORESPIRATORY FITNESS AND NEUROCOGNITION IN MIDDLE-OLD ADULTS WITH AND WITHOUT APOLIPOPROTEIN E4 ALLELE

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Introduction

Although cardiorespiratory fitness has been identified as a potential protective factor for age-related decline in prefrontal-dependent inhibitory control, it remains unknown whether longitudinal changes in cardiorespiratory fitness have effects on inhibitory control and whether such effects are affected by the apolipoprotein E4 allele (ApoE4) carriage during aging. Accordingly, the purpose of this study was to determine the effects of longitudinal changes in cardiorespiratory fitness on behavioral and neuroelectric measures of inhibitory control performance in ApoE4 carrier versus non-carrier older adults.

Methods

A prospective study including a baseline assessment and a 18-month follow-up assessment was conducted from 7/1/2018 to 5/1/2021. One hundred and fifty-nine 50–70 years old adults without psychiatric, neurological, and cardiovascular conditions were initially recruited to participate in the study. Due to the COVID-19 pandemic and lockdown, 76 participants withdrew after completed the baseline stage, resulting in a final sample of 83 participants who completed the follow-up assessment for the registered (NCT05652140 at ClinicalTrials.gov) longitudinal analysis. Inhibitory control outcomes included the 18-month changes of response time, accuracy, and N1 and P3 amplitudes of event-related potential during a computerized Stroop test. Change score of the estimated maximum oxygen consumption (VO2max) from the baseline to 18-month follow-up assessments was quantified to form the four groups based on the directionality of fitness change (Gaining-Fit vs. Losing-Fit) and carriage of ApoE4 (carrier vs. non-carrier).

Results

The final sample of 83 participants included in the analysis had a mean age at 62.6±4.5 years, 65 females (78.3%), 33 in the Gaining-Fit group (39.8%), and 20 ApoE4 carriers (24.1%). Compared to the Losing-Fit Group, the Gaining-Fit group showed more positive changes over the 18-month period in behavioral (e.g., increased incongruent accuracy [6.4±2.3%, 95% CI: 1.9% to 10.9%, $p < .01$], decreased overall response time [-38.18±12.87ms, 95% CI: -63.79ms to -12.56ms, $p < .01$]) and neuroelectric outcomes (e.g., increased overall P3 amplitude [3.06±1.15uV, 95% CI: 0.77uV to 5.35uV, $p < .01$]) of inhibitory control. ApoE4 carriage did not influence these effects.

Discussion

In this study, older adults with and without carrying ApoE4 who gained cardiorespiratory fitness showed positive changes in inhibitory control performance and neuroelectric marker of attention allocation processes. These findings suggest that increasing cardiorespiratory fitness may have beneficial effects on inhibitory control and associated brain functioning during aging regardless of the presence of the genetic risk factor for cognitive impairment.

THE FIT BRAIN: UNDERSTANDING THE RELATIONSHIPS BETWEEN CHILDREN'S AEROBIC FITNESS AND COGNITIVE FUNCTION THROUGH NEURAL EFFECTIVE CONNECTIVITY

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INTRODUCTION: The growing trend of sedentary behavior among children has sparked interest in the relationship between cardiorespiratory fitness and cognitive function. Studies have shown an association between lower fitness and decreased cognitive performance, but the neural mechanisms underlying this relationship are unclear. To gain a deeper

understanding of the relationship between fitness and cognition in children, we employed effective connectivity (EC) measures, which examine the dynamic interactions between brain regions. We hypothesized that lower fitness would be correlated with decreased EC within the cinguloopercular network, a crucial brain network involved in domain-independent task performance that includes anterior regions of the cingulate cortex, insula, and prefrontal cortex.

METHODS: Preadolescent children (M age=10years) were bifurcated into two groups based on their aerobic fitness. Children with VO2max above 70th percentile (n=24) formed the higher-fit group (HFG), while those below the 30th percentile (n=24) formed the lower-fit group (LFG). Participants completed a modified flanker task while EEG and task performance were recorded. The EEG signal was filtered from 1-48Hz, segmented into 1 second epochs, and processed through independent component analysis to classify brain and artifactual components, which were then localized using the minimum norm solution (estimation of neuroelectric activity based on scalp potentials) and reconstructed into regions of interest: dorsal anterior cingulate (dACC); bilateral anterior insula (rAI/lAI); and bilateral anterior prefrontal cortex (raPFC/laPFC). The EC for correct trials was only estimated in the theta band using the Directed Transfer Function (a Granger causality and multivariate autoregressive modeling method).

RESULTS: LFG showed decreased overall response accuracy compared to HFG (M=78.2% vs. M=84.7 %, p = 0.02). LFG also showed decreased EC compared to HFG in the following five directions: dACC to lAI; rAI to lAI; rAI to raPFC; raPFC to dACC, and raPFC to lAI (p's<0.05). The first four of these connections were positively related to overall task accuracy (r=0.32 to 0.38; p's<0.05).

CONCLUSION: Our study confirms the link between lower cardiorespiratory fitness and poorer cognitive performance in children. This investigation extends prior studies by revealing that children with lower fitness levels exhibited weaker connectivity within the cinguloopercular network, which underlies task performance and was related to cognitive function in this study. Our study demonstrates the value of using EC measures to understand the relationship between cardiovascular fitness and brain function in children. These findings provide evidence for promoting physical activity and reducing sedentary behavior to improve children's brain health and cognition.

Oral presentations

OP-MH12 Physiotherapy/Ankle-Foot

DEFICITS IN NEUROCOGNITIVE PERFORMANCE IN PATIENTS WITH CAI PERFORMING A DYNAMIC BALANCE TASK.

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VUB

INTRODUCTION: Chronic ankle instability (CAI) is a common chronic condition characterised by a feeling of giving way, pain and persisting dysfunctions. While many patients recover from an initial ankle sprain and become copers, up to 40% of patients develop CAI, which implies an elevated ankle injury risk which impacts their daily lives. Recent literature shows that patients with CAI develop neural adaptations, which could contribute to the aetiology and chronic nature of CAI. Studies have suggested that deficiencies in neurocognitive performance may influence the incidence rates of musculoskeletal injuries, including LAS and CAI. However, we must be aware of performance differences between patients with CAI and healthy controls on neurocognitive balance tests commonly used in clinical practice as they have only recently been developed. These allow clinicians and researchers to evaluate the accuracy and VMRT, integrate these outcomes in injury prevention, and return to sport decision-making to gauge injury risk. Hence, why we used the reactive balance test (RBT) to evaluate the neurocognitive balance performance of patients with CAI compared to healthy controls.

METHODS: In this case-control study, we enrolled 27 patients with CAI and 21 recreationally active athletes based on the International Ankle Consortium Guidelines for inclusion and exclusion criteria. Each participant completed the reactive balance test (RBT) once on each leg, and we measured their accuracy based on previous research1. Additionally, we calculated the visuomotor response time (VMRT) corrected for the accuracy measure.

RESULTS: Patients with CAI had significantly lower RBT accuracy scores, 83.12% (± 8.04%), compared to healthy controls (CON), 91.80% (± 5.16%). There were no significant differences in accuracy or VMRT between the left and right sides in either group (regardless of the self-reported affected side), indicating consistency in performance. Notably, VMRT alone did not differ significantly between the CAI and CON groups, with reaction times of 776.03ms ± 107.77ms and 739.47ms ± 98.43ms, respectively (p = 0.584).

CONCLUSION: Compared to healthy controls, neurocognitive functional performance is impaired in patients with CAI, as evidenced by decreased accuracy scores in the RBT. Visuomotor response time did not differ between CAI and control. Therefore, it may be beneficial to incorporate neurocognitive stimuli into rehabilitation programs for patients with CAI, especially since previous research has demonstrated the value of visuomotor training in preventing injuries in football players. Furthermore, future research should explore whether neurocognitive training may avert ankle injuries in other sports, such as table tennis, basketball, or rugby, where neurocognitive performance is essential.

1 Verschueren, J., Tassignon, B., Pluym, B. et al. Bringing context to balance: development of a reactive balance test within the injury prevention and return to sport domain. Arch Physiother 9, 6 (2019).

THE EFFECTS OF AN ANKLE INJURY RISK REDUCTION PROGRAM IN ELITE JUNIOR AUSTRALIAN FOOTBALL PLAYERS

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INTRODUCTION: Published research indicates ankle injuries are consistently one of the most common injuries in junior Australian Football (AF) (1). Injury prevention programs have proven successful in reducing ankle injuries in similar sporting codes; however, there are time burden and associated compliance issues with more generalised programs (2). Therefore, the primary aim of this study was to evaluate the implementation of an ankle injury risk reduction program (AIRRP) in junior AF athletes. Secondly, the effectiveness of the AIRRP on ankle injuries and changes in ankle function and stability were explored.

METHODS: 214 healthy elite junior male (15-18 years) athletes from four clubs competing in the state level under-18 competition participated. The study was a non-randomised control trial using historical club control data for comparison (2015-21). Club medical staff reported injuries that resulted in a missed regular season game. Injury burden was the product of injury incidence (number of ankle injuries) and severity (missed games per ankle injury). Players at participating clubs undertook a multiple hop test (MHT) at the start of preseason to determine baseline ankle function and stability. The clubs implemented the program consisting of balance and sport specific exercises, increasing in intensity and difficulty over the course of the season. The players completed follow-up MHT at the start and conclusion of the regular season. Implementation evaluation was determined by conducting exit interviews with club strength and conditioning coaches and exit surveys with players.

RESULTS: Exit interviews with club strength and conditioning coaches concluded that the program was beneficial and served as an important addition to attempt to reduce the risk of ankle injuries, however, player adherence and engagement were common reported issues. 89% of players agreed that the AIRRP was a valuable use of training time. There were 12 new ankle injuries in the 2022 season compared to 12.5 in the control years across the four clubs. The burden in the 2022 season was 56 missed games compared to 40.5 missed games in the control years. There was no significant difference in ankle burden (IRR=1.6; 95% CI=0.8-3; P=0.159). There was a significant positive effect on ankle function and stability across the season as measured by the MHT (all $p<0.05$). Player exit surveys concluded that 91% of players perceived their ankle stability was better at the final MHT compared to the baseline MHT.

CONCLUSION: Coaches and players perceived the program to be beneficial. Although the AIRRP did not significantly reduce ankle injuries, the MHT analysis did note improvements in ankle function and stability.

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BRAIN PLASTICITY RELATED TO LIGAMENTEOUS ANKLE INJURIES: A SYSTEMATIC REVIEW

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INTRODUCTION: Lateral ankle sprains (LAS) are one of the most prevalent injuries in sports. Hitherto, it is still regarded as an innocuous sports injury despite an increased re-injury risk and almost half of LAS patients developing chronic ankle instability (CAI) with persistent dysfunctions and potential long-term sequelae. In addition, researchers found preliminary evidence of neuroplasticity at the spinal and supraspinal levels after (repeated) LAS. These alterations might explain persisting dysfunctions, an increased injury risk, and the likelihood of developing CAI. Nevertheless, an overview of possible brain adaptations after LAS and CAI is currently lacking. Therefore, this systematic review aims to synthesize scientific literature on brain plasticity related to ligamentous ankle injuries (and CAI).

METHODS: The PRISMA 2020 guidelines were followed to perform the systematic review. The Pubmed, Web of Science, Embase, Scopus, PEDro, The Cochrane Central Registry for Controlled Trials (CENTRAL) and SPORTDiscus databases were searched from conception to 14/12/2022. Studies eligible for inclusion researched brain outcome measures in patients with LAS or CAI. Studies investigating other injuries (e.g., ankle fractures, syndesmosis injuries or post-operative), animals or cadavers, effects of treatment interventions, or not investigating the brain's function or structure were excluded.

RESULTS: Two authors independently screened 1375 unique articles from seven databases using a two-stage process. In total, the systematic review included 20 studies. Patients with LAS showed lower white matter microstructure superior cerebellar peduncles than healthy controls. CAI populations displayed an increased sensitivity of intermediate inhibitory neurons and a decreased sensitivity of excitatory neurons in the corticospinal pathway. They also found more variability in cortical activation in the superior parietal lobe, pre-and postcentral gyrus and the supplementary motor area with lower corticomotor excitability in several lower limb muscles in patients with CAI.

CONCLUSION: Brain plasticity was found in patients experiencing a LAS and with CAI compared to healthy individuals and copers. Both functional and structural brain adaptations were observed in the motor cortex, supplementary motor area, somatosensory cortex, middle frontal gyrus and dorsal anterior cingulate cortex. These supraspinal adaptations might play a role in the persisting dysfunctions found in these patients. Some of these alterations correlate with worse patient-reported outcomes after ligamentous ankle injuries. Whilst these findings may support the hypothesis of brain plasticity in patients with ligamentous ankle injuries, all studies were either of a retrospective or cross-sectional nature. Most studies

used different measurement methods, making direct comparisons difficult and limiting the strength of this reviews evidence. Future research should focus on understanding the underlying neurophysiological mechanisms.

A RELIABLE FIELD METHOD TO QUANTIFY ANKLE EVERTORS, INVERTORS AND DORSIFLEXORS STRENGTH DEFICITS IN A POPULATION WITH CHRONIC ANKLE INSTABILITY

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INTRODUCTION: Ankle muscle strength is crucial for rehabilitation after a lateral ankle sprain (LAS) because a strength deficit could lead to chronic ankle instability (CAI). No field method is available to obtain quantitative ankle isotonic strength values. The purpose of this study was to validate a one-repetition maximale (1-RM) method to assess ankle muscle strength.

METHODS: We recruited 31 healthy adults (18 women, 13 men, 23 ± 2.2 years old) and 32 adults with CAI (18 women, 14 men, 24 ± 2.2 years old). The dorsiflexors, evertors and invertors 1-RM was performed twice by healthy and CAI volunteers at one-week intervals. The intraclass correlation coefficient (ICC) and minimal detectable change (MDC) were calculated. Then, strength values were compared between healthy and CAI population. Finally, we suggested normative strength values based on the healthy group using the 20th percentile as a limit.

RESULTS: The ICC ranged from 0.76 to 0.88 and the MDC range from 19% to 31%. CAI volunteers obtained evertors (3.0 vs 3.5 N/kg) and invertors (2.9 vs 3.7 N/kg) strength values lower than healthy volunteers ($p<0.03$). CAI volunteers also obtained weaker dorsiflexors strength ($p<0.05$), but the proportion of CAI volunteers with important dorsiflexors deficit (16%) is lower than the proportion of CAI volunteers with important evertors and invertors deficit (53% and 50%). The CAI volunteers have an evertors/invertors strength ratio similar to the healthy volunteers ($p > 0.05$).

CONCLUSION: The 1-RM method is a reliable field method to assess isotonic evertors, invertors and dorsiflexors strength in young and active patients. Although no evertors/invertors strength ratio imbalance was detected, the 1-RM method is able to detect an isotonic ankle strength deficit in CAI population. Thus, 1-RM method will help clinicians to obtain isotonic ankle strength values on the field. Then, quantitative strength field values will also help clinicians to decide whether a patient required to normalized strength or not, and finally to individualize a strengthening planning if necessary.

Oral presentations

OP-SH28 Technology and psychology

ACCEPTANCE BY ATHLETES OF A VIRTUAL REALITY HEAD-MOUNTED DISPLAY INTENDED TO ENHANCE SPORT PERFORMANCE

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Many technological devices are being used effectively to improve sports performance (e.g., sensors, heart rate monitors, cell phone applications). However, it is not because a technology is objectively efficient that it is automatically accepted by its potential users who may refuse to use these devices even before trying them or gradually stop using them in their training. This may also be the case for immersive virtual reality (VR) devices such as head-mounted displays (VR-HMD). However, in the literature on VR in sport, this acceptance is almost taken for granted ("Since VR-HMD is used to improve sports performance, it is bound to be accepted by athletes"). It is therefore necessary to question acceptance from a scientific point of view. The purpose of this communication is to identify the self-reported variables that influence the approval and use of VR-HMD in athletes, based on the most widely used theoretical model, the Technology Acceptance Model. This model identifies the variables that influence the intention to use a technology (perceived usefulness, perceived ease of use, perceived enjoyment, but also subjective norms, i.e., the social influence of the environment). It was recently applied to the study of acceptance by athletes of a VR-HMD intended to enhance sport performance.

A total of 1162 athletes usually involved in competitive sport (from recreational to international level) participated in this cross-sectional study. After reading a short text introducing the VR-HMD and its benefits for improving sport performance, the athletes completed a questionnaire assessing their acceptance of the VR-HMD prior to initial use. The results of the structural equation modeling analysis revealed that perceived usefulness, perceived ease of use, perceived enjoyment, and subjective norms were positive predictors of intention to use the VR-HMD. Overall, the VR-HMD is fairly well accepted by athletes to improve their sport performance, regardless of their level of competition, although recreational athletes had a mitigated opinion on its actual usefulness for them. On the other hand, athletes at all other levels felt that their environment (e.g., teammates, coaches) would not encourage them to use VR-HMD, unlike elite athletes. Finally, the results also revealed differences in acceptance between sports. Participants in some sports (e.g., swimming, gymnastics, athletics, cycling) did not find VR-HMD useful for improving their sport performance, while participants in other sports (e.g., soccer, tennis, badminton, fencing, basketball) did. Understanding the acceptance of a VR-HMD before it is first used seems crucial to identifying possible initial barriers to using this technology to improve sports performance.

This work is part of the REVEA project supported by a government grant managed by the French National Research Agency (ANR) as part of the "France 2030" program (20-STHP-0004).

DOES INTENSITY MODERATE THE ACUTE EFFECTS OF IMMERSIVE VIRTUAL REALITY EXERGAMING ON EXECUTIVE FUNCTION AMONG YOUNG ADULTS?

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INTRODUCTION: Virtual reality (VR) exergaming has emerged as a new physical activity intervention strategy designed to help people increase their exercise participation. VR exergaming may enhance the potential benefits by acting on the prefrontal cortex to improve emotional and executive function. However, the effects of immersive VR exergaming intensities on executive function have not been thoroughly investigated, nor have corresponding intervention strategies have not been established. The aim of this study was to investigate the effects of 15-min of immersive VR exergaming at different intensities on executive function and emotional response.

METHODS: In a cross-over study design, 33 sedentary young adults (mean age = 22.2 ± 2.5 years, 51.4% female) participated in three experimental conditions in the random order: active control (AC) VR exergaming, moderate-intensity (MI) VR exergaming, and high-intensity (HI) VR exergaming, each for 15 min. Executive function was assessed using the Eriksen flanker task and the task-switching paradigm programmed in E-Prime 3 professional (Psychology Software Tools, Inc., Sharpsburg, PA, USA), respectively. The Feeling Scale and the Felt Arousal Scale were used to measure participants' emotional valence and emotional arousal of participants during exercise. Repeated measures ANOVAs were used to assess the differences between the different interventions in terms of condition (AC/MI/HI VR exergaming) and task duration (pre/post).

RESULTS: A main effect of VR exergaming condition on reaction time for the flanker task was also observed, $F(2, 62) = 4.45$, $p = 0.02$, $\eta 2 = 0.13$. The results showed that the performance on the flanker task was improved after MI (332.96 ± 28.17ms) and HI (333.65 ± 38.31ms) immersive VR exergaming compared to AC (348.88 ± 29.41ms) VR exergaming (all $p < 0.05$). No such difference was observed between the MI and HI conditions. Conversely, the accuracy and reaction time in the task-switching paradigm were not affected by the VR exergaming ($p > 0.05$). Meanwhile, VR exergaming increased the level of emotional valence with increasing intensity $F(2, 64) = 4.41$, $P=0.02$ $\eta 2 = 0.12$. HI (3.76±1.12) VR exergaming increased emotional valence was significantly higher than AC(2.79±1.22) VR exergaming, and MI (3.39±1.25) VR exergaming increased emotional valence was significantly higher than AC VR exergaming (all $p< 0.001$).

CONCLUSION: The intensity of movement in a single VR exergaming plays a significant role. Our results suggest that immersive VR exergaming could increase the arousal levels, and acute moderate or high intensity could improve specific cognitive performance in young people.

SELF-CONTROLLED VIDEO FEEDBACK FACILITATES LEARNING TACTICAL SKILLS IN TENNIS

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Self-controlled video feedback facilitates learning tactical skills in tennis

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INTRODUCTION: Providing feedback effectively is highly relevant for supporting the acquisition of sport skills. One crucial aspect to enhance motor learning is to manipulate the feedback schedule, that it is the timing (i.e., after which trials do learners get feedback) and frequency (i.e., how often do learners get feedback) of feedback provision [1]. In recent years, researchers have demonstrated that giving learners control over the feedback schedule enhances motor learning compared to conditions in which a coach (or experimenter) decides upon the provision of feedback. Despite an increasing amount of evidence showing benefits of self-controlled feedback when learning technical motor skills, it is still unclear what the effect of self-controlled feedback is on learning tactical skills. Therefore, the main aim of this study was to investigate whether self-controlled video feedback enhanced learning of tactical skills in tennis.

METHODS: Twenty-three intermediately skilled tennis players were quasi-randomly assigned to a self-controlled video feedback group (SC) and a yoked video feedback group (YK). In three training sessions, once per week, participants practiced serve and volley play. A licensed tennis coach provided video feedback with attentional cueing and transitional statements that focused solely on individual tactical gameplay. Tactical performance was measured with a custom designed Tactical Tennis Tool (TTT) in a pretest, posttest (i.e., after the final practice session) and in a retention test one week after practice.

RESULTS: ANCOVA with pretest TTT score as covariate revealed that the self-controlled group showed significantly larger improvements from pre- to post and retention tests in tactical performance compared to the yoked group.

CONCLUSION: This study is the first to demonstrate that the advantage of self-controlled video feedback extends to the learning of tactical motor skills.

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MOBILE-COMPUTER-SUPPORTED COLLABORATIVE LEARNING IN DANCING

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Mobile-computer-supported collaborative learning (mCSCL) enables high learning effects and deeper collaboration among learners through the digital medium (Sung et al., 2017). In dancing, a digital learning environment can support dance students in describing and evaluating their practical experiences during a composition process, but the method used – teacher guided video observation – might not be sufficient to enable reflection on a more general level of practical experience (Leijen et al., 2009). In order to link the practical experiences of composition processes with theoretical content, we designed and implemented a learning environment in higher education in which we combined the digital and collaborative learning approach. Our aim is to explore the development process of a dance choreography in an mCSCL environment.

Method

Following the design research approach (Prediger et al., 2015), a teacher-researcher used a video analysis-app on tablet computers within the collaborative learning model to support student learning. During three intervention cycles (2021 – 2023) video recordings of group working processes of 15 groups with N = 61 physical education students were taken. In addition, 22 interviews were conducted. Data analysis includes qualitative content analysis as well as qualitative video analysis.

Results and Conclusion

The learners considered mutual video feedback within their groups and especially in exchange with other groups as useful. First results of the video analysis indicate that students work collaboratively with videos during the composition process. This collaborative engagement leads to profound analyses of the dance compositions. In addition to the reflection of their own video performances, design aspects are discussed due to the camera perspective. Besides these benefits, technological challenges by the use of digital media must also be considered. Further analyses will reveal more detailed insights into the developmental processes.

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DESIGNING COOLTACO: A DIGITAL HEALTH INTERVENTION WITH SMARTWATCHES TO PROMOTE SELF-REGULATION AND PHYSICAL ACTIVITY IN CHILDREN WITH ADHD

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Background. Attention Deficit Hyperactivity Disorder (ADHD) is the most prevalent childhood psychiatric condition, with an estimated worldwide pooled prevalence of 7.2%. ADHD is characterized by deficits in self-regulation, which can be improved through psychological interventions and physical activity (PA).

Methods. Using participatory design sessions with 40 participants (children, parents, teachers), we developed and piloted CoolTaco (Cool Technology Assisting Co-regulation), a smartwatch and mobile phone app that promotes self-regulation and daily PA in children with ADHD by augmenting the capabilities of the smartwatch of tracking PA (e.g., steps, calories, exercise) with an application that allows children and parents to set-up PA and other behavioral goals for children for which they earn tokens that can be exchanged for rewards. We studied children's and parents' perspectives of CoolTaco's potential to promote PA. We evaluated the feasibility and acceptability of this digital health intervention with two cohorts, each consisting of 10 children (ages 8 – 15 years) and their parent(s). Parents and children were individually interviewed after two and six weeks. We analyzed transcripts of semi-structured interviews.

Results. Qualitative analysis identified themes related to the use of CoolTaco to promote PA. 1) Children used their smartwatches to track a variety of PAs based on individual preferences, access to equipment, and opportunity; PAs tracked included riding a bicycle, jumping on a trampoline, walking, running, playing basketball, hiking, and riding a scooter. 2) They reported feeling motivated by prompts and visualized activity data (e.g., duration, speed, distance), which led to their perceptions of having promoted their health or fitness level. 3) Parents reported that the creation of goals directly related to the visualizations provided by the watch (e.g., circles to show the PA) and exercises (e.g., riding a bicycle) helped them obtain accurate and measurable information about their child's PA as well as measure their progress over time.

Conclusion. Children's and parents' use of smartwatch exercise tracking features to satisfy goals provided by CoolTaco (via the paired parent application) allows in-the-moment self- and parent-tracking for evaluation of progress increasing PA, which is an essential contributor to self-regulation. As computational systems grow smaller and more powerful and

promoting PA among children continues to be a high priority, it will become increasingly important and relevant for mobile tools to be integrated into health promotion. Our results illustrate the potential for wearable and mobile systems to promote health behaviors among children.

Oral presentations

OP-SH18 Mental health and disabilities

EFFECTS OF RECREATIONAL DIVING COMPANION SYSTEM ON EARLY ONSET DEPRESSION IN ADOLESCENTS

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INTRODUCTION: Depression is a significant concern among Chinese adolescents, with a detection rate of 24.6% and severe depression at 7.4%, reported by the Institute of Psychology of Chinese Academy of Sciences. Domestic and foreign research generally believe that exercise has a positive impact on improving early-onset depression in adolescents. The shadowing system refers to the need for a shadowing partner during the diving process. The main responsibilities of a diving partner during the diving process include equipment inspection before diving, assisting with dressing and undressing of equipment, identifying underwater hazards, etc. This article is based on research on recreational diving and recreational diving teaching activities, exploring effective influencing factors for early-onset depression in young divers and promoting educational innovation in water sports.

METHODS: Using the controlled variable method and data analysis, after obtaining the consent of the participants and their guardians, 12 adolescents aged 12-18 who were not taking medication, had obtained the Open Water Diver (OW) certification, and had scored 8-35 points on the Hamilton Depression Scale (indicating possible or definite depression but not severe depression) were randomly divided into a group with diving partners and a group without diving partners for a 12-session intervention training, with each session lasting approximately 50 minutes.

RESULTS: The results showed that both groups had a decrease in HAMD-17 score after the diving training process, with the experimental group showing a greater decrease than the control group. Before training, there was no significant difference in HAMD-17 scores between the two groups ($P>0.05$). After training, the HAMD-17 score of the experimental group was lower than that of the control group, and the difference was statistically significant ($p<0.05$). This indicates that leisure diving has an improving effect on adolescent depression. Diving with a partner has a better effect on improving adolescent depression than diving alone.

CONCLUSION: The companion system adds more emotional communication and tacit cooperation in the exercise process, cultivates the participants ability of empathy and communication, enhances the patients life hope and confidence, and enhances their sense of identity and belonging, which plays a positive role in the intervention of adolescent early-onset depression. Compared with traditional sports, the unique diving environment and the special companion system have a positive significance in improving early-onset depression in adolescents. It is suggested that more cooperation activities can be included in physical education.

ENHANCING MENTAL HEALTH AND LEARNING EXPERIENCES OF FIRST-YEAR SPORT, EXERCISE AND HEALTH SCIENCE AND PHYSIOTHERAPY STUDENTS THROUGH A FIELD-BASED, RESIDENTIAL OUTDOOR EDUCATION PRACTICUM

LUCAS, R.A.I., VELDHUIJZEN VAN ZANTEN, J.J.C.S., COOK, D., REED, W., NIGHTINGALE, T.E., WILLIAMS, S.E., QUINTON, M., LUCAS, S.L.E.

UNIVERSITY OF BIRMINGHAM

Introduction

For incoming undergraduate students, the transition to Higher Education is a high-risk period where maladaptive coping strategies and poor mental health can emerge. Student's mental health can be improved through outdoor education experiences, which promote a range of holistic benefits. The present study aimed to evaluate the efficacy of integrating a 4-day residential outdoor education practicum into year 1 of a Sport, Exercise and Health Science BSc (SEHS) and Physiotherapy MSci (Physio) undergraduate course at the University of Birmingham (UoB). The long-term goal is to examine if a practicum outdoor experience in first year improves programme-related theoretical understanding, as well as mental health outcomes in SEHS & Physio students.

Methods

298 first-year SEHS and Physio students were invited to attend a 4-day, 3-night outdoor practicum at the UoB's Raymond Priestley Outdoor Education Centre (RPC) in Coniston, Lake District. Students were able to select their preferred practicum dates (8 practica offered, each accommodating a maximum of 38 students). Upon arrival at the RPC centre, students were divided into smaller group (6-8 people) and performed a range of outdoor and team building activities with a RPC instructor (e.g., canoeing, abseiling, hill walking etc.). Students recorded their heart rate continuously and rated their perceived exertion periodically (modified Borg) during each activity. Each morning and evening students were asked to record their mood using a modified 8-item ecological momentary assessment questionnaire (Daily) to assess affect and physical feeling states (e.g., sad, happy, energetic) and questions on their perceptions of the day. Before (Pre) and after (Post) at-

tending their practicum, students were asked to complete questionnaire packs to assess their mental well-being, their sense of belonging, and their study/learning intentions.

Results

Six practica have been completed with 149 first-year undergraduate students attending (65% attendance rate). Practica run during the semester were the most popular (76% attendance rate). All students attempted to collected heart rate data, achieving successful data collection for at least one activity. There was high engagement in completing Daily, Pre- and Post- questionnaire packs. Qualitative data indicated that students felt outdoor activities improve their overall wellbeing, that they enjoyed the personal challenge, and that the practicum improved their sense of community/belonging.

Discussion

This practicum offers students an opportunity to engage in experiential learning and reflect on behavioural, physiological, and psychological factors that promote good mental health. Attending student's feedback has been very positive, with this practicum improving their sense of connectedness. There is a need to identify potential barriers for students choosing to not attend. Long-term, this practicum may improve help-seeking behaviour and mental health.

EMOTIONAL INTELLIGENCE AND MENTAL HEALTH IN JUDO

ACEBES-SÁNCHEZ, J., GARCÍA-MERINO, S., GARRIDO-MUÑOZ, M., BLANCO-GARCÍA, C., RODRÍGUEZ-ROMO, G.

UNIVERSIDAD FRANCISCO DE VITORIA; UNIVERSIDAD POLITÉCNICA DE MADRID

Introduction

Different research has evaluated the importance of sport in the development of psychological skills. Likewise, it has also been studied the other way around, how the role of psychological factors is related to better sports performance. Combat sports, such as judo, seem to have internal characteristics that develop the emotional intelligence of judokas. On the other hand, the practice of sports has also been linked to better mental health. However, the relationships of both variables within a group of judokas have not been investigated in a general way and by gender.

Method

The sample consisted of 703 judokas. 469 were male (40.32 ± 14.09 years) and 234 were female (31.42 ± 10.97 years). For the assessment of emotional intelligence, the Trait Meta Mood Scale (TMMS-24) was used, which reports information on three dimensions (attention, clarity, and emotional intelligence). For the assessment of mental health, the GHQ-12 was used. The higher the score on the GHQ-12.

Results

The results show that there is a significant correlation between the three dimensions of emotional intelligence and the GHQ-12, being emotional attention r =.233, p ≤ .001; emotional clarity r = -.370, p ≤ .001; and emotional repair r = -.418, p ≤ .001. In addition, there is also a significant correlation in relation to the number of years practising judo (r = -.195, p ≤ .001), years spent in competition (r = -.077, p ≤ .001) and the judokas grade (r = -.198, p ≤ .001). These results are similar when segmented by gender. If we compare the results of emotional intelligence between healthy people (score <4 in GHQ-12) and people with potential pathologies (score ≥ 4 in GHQ-12), the results are equally significant (p≤ .001) with lower emotional attention and higher emotional clarity and repair in the group of healthy judokas. The same behaviour was observed when segmented by gender. Finally, it should be noted that those judokas with high sports performance show significantly better mental health segmented by gender.

Discussion

The results show that the more years of practice, the more years competing and the higher the rank achieved, the better the emotional intelligence. Emotional clarity and emotional repair behave in a direct way and emotional attention in an inverse way. This is good, as paying too much attention to emotions is a negative aspect. On the other hand, these results are related to better mental health. Also, by splitting the sample analysed on the basis of the GHQ-12 scores, our results continue to point in the same direction. Finally, those judokas with high sporting performance, i.e. who have been selected by the country as high-performance athletes, who have been in the national team or who have been in the world ranking in the top 70, show significantly higher levels of emotional intelligence and better mental health than the rest of judokas. This could highlight the need for optimal psychological qualities to be among the elite.

EFFICACY OF INDIVIDUALIZED SENSORY-BASED MHEALTH INTERVENTIONS TO IMPROVE DISTRESS COPING IN HEALTHCARE PROFESSIONALS WITH PHYSICAL ACTIVITY: A MULTI-ARM PARALLEL-GROUP RANDOMIZED CONTROLLED TRIAL

BAUMANN, H.

UNIVERSITY OF HAMBURG

Psychosocial distress among healthcare professionals can lead to negative health outcomes such as psychological, musculoskeletal, and cardiovascular diseases. Physical activity has been shown to reduce chronic distress by decreasing the release of stress hormones, promoting relaxation, and improving physical and emotional well-being. Mobile health (mHealth) interventions incorporating sensor feedback have been proposed as a promising approach to deliver person-centered interventions that vary in individual needs and empower individuals to actively monitor their health. This study aimed to investigate the impact of individualized, sensor-based mHealth interventions on stress coping in healthcare

professionals by focusing on stress and physical activity. We hypothesize that individualized interventions would result in small to moderate positive effects on physical activity and stress-related outcomes, while non-individualized interventions would be ineffective.

The study utilized a multi-arm, parallel group randomized controlled trial design, comparing five intervention groups that represented varying levels of individualization to a control group (Interventiongroups: 1=web-based training, 2=need oriented web-based training, 3=need oriented web-based training with telephone coaching; 4=individualized app with sensory biofeedback, 5= individualized app with sensory biofeedback and personalized Health report). Both self-reported questionnaire data as well as electrocardiography and accelerometry-based sensory data were assessed at baseline and post-intervention (after eight weeks). Of the 995 eligible participants, 170 (26%) completed the post-intervention measurement (Group 1: N=21; Group 2: N=23; Group 3: N=7; Group 4: N=34; Group 5: N=16; Control Group: N=69). The baseline data showed no significant differences in demographic characteristics between the intervention and control groups. The average age of the participants was 41.1 ± 10.9 years, and the sample consisted of more female than male participants. MANOVA results indicated small to moderate time-by-group interaction effects for physical activity-related outcomes, including moderate to vigorous physical activity ($F(1,5)=5.8$, $p=<.001$, $\eta^2p=.057$) and inactivity disruption ($F(1,5)=11.2$, $p=<.001$, $\eta^2p=.100$), in the app-based intervention groups, but not for step counts and inactivity.

The findings suggest that interventions aimed at increasing physical activity in a work setting may not necessarily reduce stress levels, and that individualized app-based interventions may be more effective. However, further research is needed to determine the optimal level of individualization and design of interventions. Probably, more specific and continuous training is necessary to achieve cognitive and psychophysical adaptations through physical activity. The 8-week intervention may not be long enough to activate physiological mechanisms that have a stress-buffering effect.

DOES PARTICIPATION IN SPORT ACT AS A RESILIENCE FACTOR FOR ADOLESCENTS WITH A HISTORY OF CHILD MALTREATMENT?

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UNIVERSITÉ DU QUÉBEC À CHICOUTIMI

The prevalence of child maltreatment (sexual, physical, and emotional abuse, exposure to inter-parental violence, and neglect), is overwhelming worldwide. In Canada, a third of the population has endured at least one form of child maltreatment. Considering the deleterious consequences associated with child maltreatment, it is essential to identify protective factors to help promote resilience in victims. This study investigated the potential role of an understudied factor, that is, sports participation in an organized context, in sustaining positive psychological adaptation. Overall, 825 adolescents aged 15–19 years ($M = 15.84$ years; $SD = 0.73$) completed self-reported questionnaires in their classrooms on electronic tablets assessing history of child maltreatment, sports participation, violence toward athletes, and a host of outcomes related to psychological adaptation (body satisfaction, self-esteem, life satisfaction, internalized and externalized symptoms, COVID-19-related-distress). More than 56.1% of the sample (80.8% non-binary adolescents, 62.4% girls, 50.7% boys) reported having experienced at least one form of child maltreatment. Moreover, 54.4% of the sample (19.2% non-binary adolescents, 52.9% girls, 56.7% boys) reported sports participation in an organized context. Among them, 58.6% also reported experiencing sports violence from coaches, teammates, or parents. Child maltreatment was significantly associated with all outcomes (i.e., lower levels of life satisfaction and self-esteem, and higher levels of body dissatisfaction, internalized and externalized symptoms). Controlling for sports violence, sports participation was significantly associated with positive adaptation. However, it only moderated the association between child maltreatment and body dissatisfaction, i.e., the association between child maltreatment and body dissatisfaction was weaker among those who participated in an organized sport. Moreover, COVID-19-related distress was associated with all outcomes (i.e., lower levels of life satisfaction and self-esteem, and higher levels of body dissatisfaction, internalized and externalized symptoms). Overall, these results suggest that sports participation reduces the consequences of child maltreatment, but only for body dissatisfaction, partly supporting the role of sports participation as a resilience factor. To play its protective role, sports participation should also be free of violence. Besides, as COVID-19-related distress was associated with worsened outcomes, one may wonder if it mitigates the protective role of sports participation for maltreated victims. Nonetheless, as sports participation was associated with positive outcomes, the current results reiterate the importance of promoting sports participation for all youth. Finally, considering the high level of violence experienced in the context of sports in the present sample, there is an urgent need to promote a safe and secure sports environment.

14:45 - 16:00

Invited symposia

IS-BM06 Losing and retraining balance while ageing: perspectives for innovative interventions

POSTURAL TRACKING OF CONSTANT AND COMPLEX VISUAL MOTION CUES: IMPLICATIONS FOR VISUOMOTOR PLASTICITY IN OLD AGE

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Ageing is associated with progressive degeneration at the central and peripheral levels of the nervous system. This results in a less efficient sensory motor integration which together with central slowness of information processing increases reliance on predictive control and proneness to falling (1). Postural tracking of visual cues has expanded into an exercise gaming intervention promising to strengthen the link between perception and action (2). Visuo-postural tracking paradigms are based on our current knowledge that humans can match their voluntary sway to a moving visual target when provided with online visual feedback (VF) of sway. With practice, spatiotemporal error, the discrepancy between the target motion and the VF signal, is reduced across sway cycles. However, due to neural conduction delays and noise in the processing of visual information, the transformation of visual error signals to appropriate motor commands is time consuming (3). To compensate for this, a forward model of the outgoing motor commands is acquired which allows prediction of the sensory consequences of action at a very short latency (4). This assumes that the pattern of the visual target motion remains constant across sway cycles. The problem with tracking of constant target motions is its limited generalization to other sensorimotor balance tasks, a problem known in the learning literature as task specificity of practice (5). Alternatively, tracking of complex visual target motions evokes sustained perception-based action which results in more persistent postural control (6) that is resilient to balance perturbations (7). Can tracking of complex visual motion cues generalize to functional balance control? The present talk will review evidence addressing this question in the context of balance retraining in ageing.

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FALL-RESISTING SKILL TRANSFER AND RETENTION OF BALANCE RECOVERY RESPONSE ADAPTATIONS FROM TRIP-LIKE PERTURBATIONS

KARAMANIDIS, K.

LONDON SOUTH BANK UNIVERSITY

Daily-life locomotion constantly challenges the human neuromotor system to respond to changing environments. Thus, the ability to select and execute appropriate motor actions for external disturbances during gait, and to improve as well as to retain such skills are important for providing safe locomotion (1). Moreover, scoping fall resilience requires knowledge of factors enabling the neuromotor system to transfer stability control mechanisms between different environmental conditions (2, 3). In a series of studies (4, 5) we investigated how gait stability and adaptability during trip-like perturbations are affected by age and examined the impact of various exercise modalities and neuromuscular function on adaptation, retention, and transfer of improved stability recovery mechanisms to novel perturbations. Our data provide evidence that the ability to adjust and recalibrate locomotor commands is preserved with ageing, as older adults can learn and cope with repeated unexpected trip-like perturbations. A single session of balance perturbation exercise has the potential to elicit long-term retention of stability recovery performance and transfer to non-exercised tasks . However, transfer of stability recovery mechanisms from one task to another may be partly subject to the degree of similarity in recovery motor responses and neuromuscular control patterns between perturbations, which need to be considered to effectively assess

and influence balance recovery mechanisms in ageing. Currently, we are investigating whether locomotor training based in virtual reality stimulates motor skill learning and benefits gait in physical environments.

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MOVING ON FROM INTERVENING ON MUSCLE STRENGTH TO IMPROVING SPECIFIC FALL-RESISTING SKILLS IN OLDER ADULTS

MCCRUM, C.

MAASTRICHT UNIVERSITY

One of the many physiological effects of ageing is the gradual decline in skeletal muscle size and strength. This has multiple effects on health and wellbeing and is frequently described as a causal factor in the increasing risk of falls with ageing. In the first part of this talk, evidence at multiple levels will be presented that dispute this supposed causal link. In addition to literature evidence, I will present results from a correlation analysis (1) looking at type II muscle fibre properties and a cross-sectional study looking at physical activity and sport participation levels in older adults (2) each in relation to performance of trip-like gait perturbation tasks and demonstrate that these properties alone do not seem to play a causal role in reactive balance recovery following balance perturbations. In the second part of the talk, the issue of falls will be approached from a motor skill, rather than skeletal muscle property perspective. Evidence from laboratory-based studies will be presented that demonstrate that older adults can rapidly improve their reactive balance recovery performance (3) and that this is feasible to apply in clinical settings (4). >From a motor skill perspective, three distinct fall-resisting skills (adaptability, robustness and reactive recovery) emerge and there is evidence that these can be trained successfully in older adults using innovative, technology-assisted interventions. To close, a framework for fall risk assessment and training through this fall-resisting skills lens will be proposed.

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Invited symposia

IS-PN06 Fuelling the Paralympic Athlete

ASSESSMENT OF ATHLETES ENERGY EXPENDITURE USING DOUBLY LABELLED WATER

PLASQUI, G.

MAASTRICHT UNIVERSITY

To assess energy expenditure in athletes, indirect calorimetry can be used in a lab setting or for short observation intervals (e.g. a training session) in the field using a portable system. However, to assess the true energy needs, a measurement in daily life is necessary that allows to accurately quantify the daily energy needs of an athlete in order to assure optimal nutritional strategies and hence performance.

Doubly labelled water can be used to accurately assess total daily energy expenditure, over observation intervals of 3-14 days with minimal interference for the athlete. The technique uses the two stable isotopes deuterium (2H) and oxygen-18 (18O) to obtain a measure of CO2-production. Once a measure of CO2-production is obtained, a respiratory quotient (RQ) needs to be assumed to calculate energy expenditure from CO2-production.

The technique can be used everywhere in daily life with minimal burden for the athlete. It only requires the collection of urine samples at specific time-points. It provides an accurate measure of energy expenditure over several days to weeks and hence represents the true energy needs of the athlete studied. This presentation gives an overview of the doubly labeled water method to assess energy expenditure athletes, and Paralympic athletes in particular.

ENERGY REQUIREMENTS OF PARALYMPIC ATHLETES

VAN DIJK, J.

HAN UNIVERSITY OF APPLIED SCIENCES

Along with the rapidly growing number of Paralympic athletes, there is an increased need for nutritional support in this population. Compared to non-disabled athletes, Paralympic athletes may differ with regard to body composition, physiological responses to exercise, and training load and habitual physical activity patterns. Therefore, Paralympic athletes have their own specific nutritional needs. So far, the energy requirements of Paralympic athletes have been based primarily on prediction equations of resting metabolism combined with estimates of exercise energy expenditure.

In a recent collaborative project between the Netherlands and Norway (ParaNut), we applied the gold standard doubly labeled method to assess energy expenditure in a large cohort of Dutch and Norwegian Paralympic athletes. The doubly labeled water method was combined with indirect calorimetry measurements at rest and during exercise. As such, this project generated comprehensive data on the total daily energy expenditure and its components in Paralympic athletes competing in various sport disciplines. This information also allowed to evaluate the nutritional intake of the Paralympic athletes in light of their energy requirements. Furthermore, based on this data, the energy availability of Paralympic athletes was assessed.

During this presentation, the latest insights regarding the energy needs and energy availability of Paralympic athletes will be shared. This information forms the basis for new dietary guidelines and nutritional strategies for Paralympic athletes. The presentation is therefore of interest to professionals working with Paralympic athletes, as well as physiology and nutrition scientists.

STRATEGIES TO FUEL PARALYMPIC ATHLETES

JONVIK, K.

NORWEGIAN SCHOOL OF SPORT SCIENCES

Currently, the dietary counseling of Paralympic athletes is mostly based on nutritional guidelines for non-disabled athletes. Nutritionists are actively searching for knowledge and effective strategies to provide evidence-based dietary recommendations to this group.

Although there is very little research available in Paralympic athletes, it has been suggested that individuals with a disability may experience altered physiology related to relative energy deficiency in sports (RED-S) symptoms when compared with non-disabled athletes. A chronically low energy availability can lead to impaired bone health, which will be further magnified in Paralympic athletes who remain non-weight-bearing and wheelchair bound. By improving the quality of dietary intake as well as energy expenditure methodology, we may be able to more accurately estimate and monitor the energy availability of individual athletes. Big data from several Paralympic sports and countries are needed, including particular focus on energy availability as well as bone health and body composition, in order to develop Paralympic specific dietary guidelines for energy and macro nutrient intakes. Furthermore, more knowledge is needed to identify RED-S symptoms in Paralympic athletes and whether these reflect nutritional status or is a result of the disability itself.

Based on the findings of the ParaNut project, as well as other recent relevant work, possible nutrition strategies for Paralympic athletes will be discussed in this presentation. Relevant questions to be considered are:

1. What are the main focus points for nutritional counseling and dietary intakes in Paralympic athletes competing in various sports disciplines?

2. How can nutrition strategies structurally develop the para sport and facilitate improved health and performance?

3. What are the focus points for research interventions in Paralympic athletes?

Oral presentations

OP-PN17 Muscle Damage and Repair

COMPARISON OF DELAYED ONSET MUSCLE SORENESS LEVELS AFTER ACUTE RESISTANCE EXERCISE BETWEEN VEGANS AND OMNIVORES

KARELIS, A.D.1, NJEIM, P.1, FAUST, A.2, BOUTROS, G.H.2

1. UNIVERSITÉ DU QUÉBEC À MONTRÉAL; 2. RESEARCH INSTITUTE OF THE MCGILL UNIVERSITY HEALTH CENTER

INTRODUCTION: Acute resistance exercise could lead to delayed onset muscle soreness (DOMS), which in itself is an inflammatory response. There is evidence to suggest that a vegan diet may be associated with a lower inflammation profile. Thus, one can argue that a vegan diet may lead to a lower inflammation response following resistance exercise

and in turn to lower levels of DOMS. Therefore, the purpose of the present study was to examine the levels of DOMS markers between vegans and omnivores after acute resistance exercise.

METHODS: We recruited 54 young lean women (age: 26.8 ± 4.1 years; body mass index: 22.5 ± 2.7 kg/m2). Participants were classified as vegan (n = 27) or omnivore (n = 27) based on their eating habits. All volunteers followed either a vegan or an omnivore diet for at least 2 years. DOMS was induced by performing one eccentric resistance exercise session, which consisted of 4 exercises (leg press, chest press, leg curls and arm curls) with 4 sets of 8 repetitions. Body composition (DXA), dietary factors, muscle strength (1 RM leg and chest press), grip strength, perception of soreness as well as pressure point thresholds of the quadriceps, calf, chest and biceps muscles (algometer) were measured before and 48 hours after the exercise session.

RESULTS: At baseline, both groups were comparable for percent body fat, lean body mass, muscle strength, grip strength and pressure point thresholds. No differences in the change of the perception of muscle soreness between groups were found after acute resistance exercise. However, changes in pressure point thresholds were significantly better in vegans compared to omnivores for the quadriceps (Pre: 36.0 ± 15.7 vs. 37.1 ± 16.0; Post: 38.5 ± 20.3 vs. 29.5 ± 11.4 Newtons (N), respectively ($p<0.002$), calf (Pre: 34.6 ± 12.9 vs. 37.6 ± 15.8; Post: 39.6 ± 18.0 vs. 34.6 ± 15.3 N, respectively ($p<0.008$), chest (Pre: 23.3 ± 8.8 vs. 23.1 ± 10.4; Post: 27.5 ± 15.8 vs. 19.7 ± 11.7 N, respectively ($p<0.012$) and biceps (Pre: 25.1 ± 11.4 vs. 25.6 ± 12.3; Post: 29.2 ± 16.2 vs. 19.8 ± 9.5 N, respectively ($p<0.002$) muscles. Significant favourable changes were also observed for grip strength in vegans vs. omnivores (Pre: 231.2 ± 60.1 vs. 228.4 ± 59.9; Post: 233.5 ± 56.5 vs. 213.7 ± 57.7 N, respectively ($p<0.04$).

CONCLUSION: Vegans were associated with better changes in DOMS levels after acute resistance exercise compared to omnivores, which could suggest greater improvements in muscle recovery.

MUSCLE ANKYRIN REPEAT PROTEIN 1 (MARP1) ALTERS SARCOMERE STRUCTURES IN MAMMALIAN SKELETAL MUSCLE VIA TITIN ASSOCIATION

KUEHN, M.1, MA, W.2, HAN, S.W.1, FLEMING, J.3, MAYANS, O.3, IRVING, T.2, LINKE, W.1, HESSEL, A.1

UNIVERSITY OF MUENSTER, 1., ILLINOIS INSTITUTE OF TECHNOLOGY, 2., UNIVERSITY OF KONSTANZ, 3.

INTRODUCTION: The muscle ankyrin repeat protein (MARP) family are comprised of three isoforms that are binding partners with titin in striated muscle and play a role in regulating mechanical and mechano-signalling properties, sarcomeric integrity, force production, and muscle remodelling. During some myopathies, the MARP1 isoform upregulates from trace levels, translocates to the sarcomeric I-band region, and tethers titin to actin in a way that increases titin-based passive stiffness. To explore this phenomenon, we used small-angle X-ray diffraction to study the sarcomeric myofilaments before and after MARP1 incubation in permeabilized psoas myofibers.

METHODS: Small-angle X-ray diffraction is a specialized experiment that uses brilliant-spectrum X-ray beams to measure sarcomere structures in fibers at near-physiological conditions. X-ray data provided details about lattice spacing, myosin motor orientation, troponin orientation, and myofilament strain. Permeabilized fiber bundles were prepared from human anterior tibialis biopsies and placed in a muscle mechanics rig within the X-ray apparatus. X-ray diffraction data were collected at 2.4, 2.7, and 3.0 µm sarcomere length (SL) before and after MARP1 incubation. X-ray diffraction data were processed using the freeware MuscleX.

RESULTS: MARP1 incubation significantly increased equatorial intensity ratios, which is indicative of a closer proximity of myosin heads to the thin filaments, which is a typical feature of passive muscle that is linked to increased force development upon activation. Moreover, we found that the typical thick filament elongation for a given stretch amplitude was further increased after MARP1 incubation, which is most likely caused by an associated increase in titin-based forces against the thick filament. Taken together, our preliminary results suggest that, compared to controls, fibers incubated with MARP1 presented structural evidence of increased calcium sensitivity and force at longer SLs.

CONCLUSION: Clinically, MARP1 is present only after eccentric overload training or disease, suggesting a distinctive but as yet unclear signal transduction and remodeling pathway. Our data suggests its function is to "prime" passive muscles for enhanced force production upon activation. The purpose may be to serve as a compensation mechanism for force-deficient myopathic and/or damaged fibers. To our knowledge, this is the first demonstration of length-dependent structural priming in passive fibers of human skeletal muscle and should be further evaluated during contraction.

EFFECTS OF FAR-INFRARED RADIATION LAMP THERAPY ON RECOVERY FROM ECCENTRIC EXERCISE-INDUCED MUSCLE DAMAGE

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INTRODUCTION: Muscle damage represented by a prolonged loss of muscle function such as maximal voluntary contraction (MVC) torque, delayed onset muscle soreness (DOMS), and impaired proprioception is often inevitable after performing eccentric exercise, thus treatments to enhance recovery are necessary. A variety of treatments and interventions have been explored to facilitate the recovery, but none of them appears to be highly effective. Far-infrared radiation (FIR) therapy is a phototherapy in which a wavelength of 8-14 µm is used to increase cell growth and development in animal studies (Leung. Chin J Physiol 2015). However, no previous study has investigated the therapeutic effects of FIR lamp therapy on humans in a laboratory setting. Thus, the present study investigated the effects of a FIR lamp therapy on changes in mus-

cle damage and proprioception markers after maximal eccentric exercise of the elbow flexors (EF: Study 1) and the knee flexors (KF: Study 2) in comparison to a sham treatment condition.

METHODS: In each study, healthy sedentary women (20-24 y) were assigned to a FIR or a sham treatment group (n=12/group). They performed 72 maximal EF eccentric contractions (Study 1) or 100 maximal KF eccentric contractions (Study 2) with their non-dominant limbs. They received a 30-min FIR (wavelength: 8-14 μm) or sham treatment at 1, 25, 49, 73 and 97 hours post-exercise to the exercised muscles. MVC torque, muscle soreness, plasma CK activity, and proprioception assessed by position sense, joint reaction angle, and force match were measured before, and 0.5, 24, 48, 72, 96 and 120 hours post-exercise. Changes in the variables were compared between the FIR and sham groups in each study by a mixed-design of two-way ANOVA.

RESULTS: The outcome measures showed significant changes ($P<0.05$) at 0.5-hour post-exercise (before treatment) similarly ($P>0.05$) between the conditions; however, changes in all measures at 24-120 hours post-exercise were smaller ($P<0.05$) for the FIR than sham condition in both studies. For example, MVC torque returned to the baseline by 72 hours post-exercise for the FIR condition in both studies, but was still 19 ± 6% (Study 1) or 17 ± 12% (Study 2) lower ($P<0.05$) than the baseline at 120 hours post-exercise for the sham condition.

CONCLUSION: These results showed that the FIR lamp therapy enhanced the recovery from muscle damage induced by unaccustomed eccentric exercise, when the 30-minute FIR lamp treatment was provided at 1 hour post-exercise, and every 24 hours for 4 days thereafter in both studies. It appears that the FIR lamp therapy is effective for alleviating muscle damage in the days after eccentric exercise. The FIR lamp treatment effects shown in the present study appear to be much greater than those of other treatment modalities that have been reported in the previous studies (e.g., Chang et al. Evid Based Comple Altern Med 2021). The mechanisms underpinning the effects require further studies.

COMPARATIVE ANALYSIS OF RUNNING-INDUCED STRUCTURAL MUSCLE CHANGES BETWEEN MEN AND WOMEN

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INTRODUCTION: The repeated ground impacts occurring during running can induce muscle damage [1], which could differ between sex [2,3]. However, due to the difficulty of assessing muscle microstructure in humans (e.g., muscle biopsy), the effect of sex on structural muscle damage and recovery patterns after running has been scarcely investigated. Alternatively, microstructural changes and subsequent muscle inflammation can be investigated using diffusion tensor magnetic resonance imaging (MRI) [4]. The purpose of the present study was to determine the effect of sex on different indirect markers of exercise-induced muscle damage.

METHODS: A group of recreational runners (8 men and 8 women) performed a 20-km graded running race, while the control group (8 men and 8 women) did not participate in the run. Muscle volume, ultrastructural muscle changes (mean diffusivity: MD and fractional anisotropy: FA) for 12 lower limb muscles, muscle group soreness, and drop jump performance were measured using MRI, visual analog scale, and force plate once before the race (PRE), and twice in the following 4 days (D1-2 and D3-4), respectively. The control group performed the same measurements twice one day apart. A two-way (session*sex) ANOVA was performed for each group separately.

RESULTS: Regardless of sex, at D1-2, the experimental group showed a 4 ± 3 % decreased rebound height in drop jump ($p<0.05$), delayed onset muscle soreness (DOMS) in the quadriceps muscle group ($p<0.05$), and an increased volume of the semitendinosus muscle ($p<0.05$). Only women reported DOMS in the hamstrings ($p<0.05$). The MRI analyses revealed only a trend of increase ($p=0.07$) in MDs of the vastus lateralis, biceps femoris long head, semitendinosus, and semimembranosus muscles through D3-4, regardless of sex, while FAs did not change. In the control group, none of the parameters changed between sessions.

CONCLUSION: MR diffusion tensor imaging only revealed a trend of increase in MD while FA did not change in the thigh muscles until 4 days after the 20-km graded running race. This could reflect slightly increased muscle fibre bundle size in both transverse and longitudinal directions. Of interest, a sex difference was only found in the hamstring muscle soreness at D1-2. The discrepancy found between DOMS, jump performance, and diffusion parameters over the 4-day post-race period indicates that the commonly used DOMS reflects neither the amplitude nor the time course of the ultrastructural recovery. Our results provide the first evidence of the absence of a sex effect on ultrastructural muscle changes in-vivo human muscles after running.

Oral presentations

OP-AP37 Warm-Up and Recovery

EFFECTS OF FORCE-POWER-VELOCITY RESISTED SPRINTS DURING WARM-UP ON RUNNING SPRINT PERFORMANCE AND MECHANICAL PROFILE IN NATIONAL ATHLETES: A PRELIMINARY STUDY

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INTRODUCTION: Resisted sprints are a useful training strategy to improve the early acceleration phases of a sprint (1), and may be an effective post-activation potentiation stimulus used to acutely improve sprint performance (2). A simple field method has been validated to compute the main sprint acceleration mechanical outputs (3,4), and several on-field systems can be used to do so such as radar and motorized linear encoder (5). Warm-up content for sprint races has not been often studied and explored, especially regarding the use of resistances to cover the full force-velocity spectrum of sprint acceleration. The aim of this preliminary study was to determine the effectiveness of an implementation of a force, power and velocity resisted sprints during warm-up on the force-velocity profile and the 40-m linear sprint running performance.

METHODS: Five national level sprinters performed two warm-up sessions separated by one week. During the first warm-up session (CON), athletes performed their own individual warm-up followed by a load-velocity test. During the second warm-up session (FPV), athletes implemented at the end of their individual warm-up 3 resisted sprints (Force: 10-m against a load eliciting a 75% velocity decrease compared to their individual maximal unresisted velocity (Vdec), Power: 20-m at 50% Vdec, Velocity 30-m at 25% Vdec, and a final unresisted acceleration).

Running times were computed every 5-m with the motorized linear encoder (1080 Sprint; 333 Hz), and the Force-velocity profiles for the best time trial of each session were computed from the radar (Stalker Pro II; 48 Hz) data with the method proposed by Samozino et al. Maximal velocity (Vmax), theoretical maximal velocity (V0) and horizontal component of the ground reaction force (F0), and maximal power (Pmax) were calculated. Mean, percentages of differences and effect sizes (ES) were computed.

RESULTS: 40-m time was similar (5.52±0.40 vs 5.53±0.36 s; +0.6%; ES=0.03) between CON and FPV warm-up sessions. Regarding the main sprint-acceleration variables computed from the radar raw data, Vmax (8.94±0.76 vs 8.97±0.67 m.s-1;+0.3%; ES=0.04) and V0 (9.47±0.90 vs 9.43±0.86 m.s-1;-0.4%; ES=0.05) were similar. Despite very small percentage of difference for relative F0 (7.18±1.07 vs 7.28±0.76 N.kg-1; +1.4%; ES=0.11) and Pmax (16.86±3.40 vs 17.04±2.72 W.kg-1; +1.1%; ES=0.06) no statistical differences were found between warm-up sessions.

CONCLUSION: The results of this preliminary study on a small sample size of national athletes seem to show that implementing force, power and velocity resisted sprints during warm-up is a feasible strategy. Indeed, this could have no negative effects on sprint-acceleration mechanical profile and 40-m sprint performance. However, a larger number of athletes from various level should be included to confirm the results obtained.

1) Petrakos et al. (2016)

2) Zisi et al. (2022)

3) Samozino et al. (2016)

4) Morin et al. (2019)

5) Fornasier-Santos et al. (2022)

THE EFFECT OF WARM-UP ON DETERMINING THE PRESSURE DIFFERENCES NECESSARY TO OBTAIN ARTERIAL OCCLUSION PRESSURE (AOP).

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INTRODUCTION: Partial or total occlusion of blood flow to the working muscles, also known as blood flow restriction (BFR), has been used as a complementary training method, aimed to further increase acute as well as chronic adaptation changes. Completely occluding arterial blood flow into the limb is referred to as arterial occlusion pressure (AOP). However, the previous research procedures assumed the measurement of AOP either before (pre warm-up) or after the warm-up (post warm-up). The pressure required to obtain AOP may depend on whether the measurement was made before or after the warm-up. Therefore, the main goal of the study was to determine the differences in pressure necessary to obtain AOP in the measurements made before and after the warm-up.

METHODS: Twenty-one healthy resistance trained women and men volunteered for the study (aged 24.1±5.8 years, body mass 75.6±19.4 kg, height 177.8± 10.7 cm). The measurements of AOP were conducted twice on each lower limb during rest. The first measurement of the AOP was made before the warm-up and the second one after the 15-minute warm-up. For BFR the 10-cm wide cuffs were used. The warm-up contained jogging (5-min) and dynamic exercises (10-min) such as the gluteal stretch walk (10 repetitions (reps)), quadriceps grab walk (10 reps), bouncing on spot (double leg) (28 reps),

gluteal run (14 reps per leg), walking lunges (6 reps) and jump CMJ (4 reps) (O'Grady et al. 2021). The protocol of the study was approved by the Bioethical Committee at the Regional Medical Chamber in Gdansk (11/22).

RESULTS: The 2-way ANOVA [2 legs (right, left) x 2 time (pre, post warm-up)] showed a statistically significant main effect for time AOP measurement p <0.001 (pre vs. post warm-up). The post hoc analysis for main effect showed significant higher pressure required to AOP in post warm-up measurement compared to pre warm-up (206.05 vs. 193.19 mm/Hg; p <0.001). There were no significant interaction effect (p= 0.26) as well as no significant main effect (p = 0.45) for comparison between the left and right legs.

CONCLUSION: The main finding of the study was that the pressure needed to obtain AOP was significantly different between the measurements performed before and after the warm-up. Therefore, it is necessary to consider whether pre or post warm-up AOP should be taken into account in the programming of scientific research and implementation of sports training. In addition, despite the increase in AOP after warm-up compared to pre warm-up values, there were no significant differences in the pressure needed to obtain AOP between the right and left leg. The increase in the AOP can be explained by the increase of the total blood pressure and heart rate resulting from the warm-up. As a result, higher total blood pressure may require a higher cuff pressure in order to occlude the limb. Moreover, the timing of AOP determination in the upper or lower limbs is important in the selection of the appropriate BFR pressure during exercise.

COMPARISON OF THE EFFECTS OF COLD-WATER IMMERSION AND PERCUSSIVE MASSAGE ON THE RECOVERY AFTER EXHAUSTING ECCENTRIC EXERCISE: A THREE-ARMED RANDOMIZED CONTROL TRIAL

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INTRODUCTION: Athletic training has to involve an overloading stimulus to induce adaptions of the organism, but also adequate recovery is needed to enhance athletic performance. Recovery by cold water immersion (CWI) has become particularly popular in various sports, and in recent years, even handheld percussive massage (PM) devices have been widely-used as a recovery tool, but with lacking scientific evidence. Therefore, this study aimed to investigate and compare the effects of CWI and PM treatment on performance recovery after exhausting eccentric exercises.

METHODS: 23 healthy sport students (f = 7, m = 16, 24.4 ± 4.1 y, 178 ± 9.8 cm, 74.3 ± 13.1 kg) were randomly assigned to CWI (n = 8), PM (n = 8) or a passive rest group (PR, n = 7). On five separated laboratory sessions, all participants completed a familiarization, an exhausting eccentric protocol as well as 24, 48, and 72 h posttests. Immediately before (PRE) and after (POST) the eccentric protocol as well as during the posttests (POSTrec, 24, 48 & 72h) subjective perception of muscle soreness (0 to 10 scale), perceived stiffness (visual analog scale, VAS), skin temperature, as well as the creatine kinase activity (CK), squat jump (SJ) and countermovement jump height (CMJ) on a force platform were measured. The exhaustion protocol consisted of the following tasks: 15 min downhill-running on a treadmill (slope: -12%, speed: 10 km/h) and 3 sets of successive depth jumps from a dropping height of 60 cm. Within the first 2 sets, participants performed 20 jumps. In the final set, participants continued the jumps until they could not maintain at least 90% of the mean jump height of the first sets in 3 consecutive jumps. After POST measurements, participants received 12 min of either CWI (11 ± 0,5°C), PM (40 Hz) or PR (supine posture) recovery treatment.

RESULTS: Subjective performance recovery parameters (soreness, VAS) and CK revealed no group * time interaction effects. Group * time interactions were only found in skin temperature ($F(4.45,42.27) = 37.55$, $p < .001$, $\eta p^2 = .80$) as well as SJ ($F(4.6,43.73) = 2.78$, $p = .03$, $\eta p^2 = .23$) and CMJ ($4.93,46.8) = 2.82$, $p = .03$, $\eta p^2 = .23$). Post hoc pairwise comparison for SJ ($p < .001$; CWI: -24.9 ± 5.9%, PM: -12.5 ± 4.7%, PR: -14.7 ± 3.5%) and CMJ ($p < .001$; CWI: -24.9 ± 4.4%, PM: -16.5 ± 3.4%, PR: -17.1 ± 4.2%) showed group differences only at POSTrec, revealing higher jump heights reduction in in the CWI group.

CONCLUSION: Neither CWI nor PM showed enhanced recovery in the course of 72 h after exhausting eccentric exercise in comparison to PR. Acute performance losses immediately after CWI may be explained via a significantly lowered skin temperature further associated with a potential reduction in muscle temperature as well as an alteration in nerve conduction velocity.

USE OF RECOVERY STRATEGIES IN ENDURANCE ATHLETES AT DIFFERENT LEVELS OF COMPETITION-A SURVEY STUDY

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INTRODUCTION: In general, numerous studies have been conducted on recovery strategies in athletes. However, only few studies took the level of competition into account when examining recovery strategies. This study aims to explore the use and perceived barriers of recovery strategies among endurance athletes of various competitive levels.

METHODS: Endurance athletes were asked to fill out an online survey on recovery strategies, which included 25 subcategories across five main recovery strategies (active, nutrition, massage, temperature-base and other strategies) using Qualtrics. The survey was conducted from April 2022 to January 2023. The athletes competition level, type of sport, and gender between groups were compared using the chi-square test. Each answer was reported as the group percentage or frequency.

RESULTS: A total of 91 (53 male, 38 female) endurance athletes completed the survey. Athletes were divided into four competition levels, namely international (n=15), national (n=48), regional (n=22), and recreational (n=6). There was no signifi-

cant difference (p=0.29) between athletes competing at different levels and the sources of recovery strategies. Athletes primarily got information via their coaches (32.1%) and websites (23.7%) but less from scientific magazines (8.9%) or scientific staff and conferences/workshops (5.8%). Surprisingly, athletes at the national level had the highest use of recovery strategies (56%) compared with regional (29.7%), international (16.5%), and recreational (8.8%). Barriers for the use of recovery strategies were too little time (73.9%), too little knowledge (60.9%), and lack of motivation (54.5%). As with all strategies, warm baths, cold showers, cold packs, and caffeine were most used (in total 30.8, 69.2, 60, and 16.7%) by international, national, regional, and recreational levels, respectively. 46.2% of all athletes reported being satisfied with the recovery strategies they use.

CONCLUSION: The study results reveals that in daily practice athletes are more likely to follow coaches or other athletes for recovery suggestions instead of scientific knowledge. Given the shortage of time, most athletes seem to prefer relatively simple recovery strategies that are easy to implement (like baths or showers). To optimize recovery in endurance athletes, future research should focus on implementing scientific knowledge/resources/information on effective recovery strategies.

EFFECTS OF TIME EXPOSURE OF CRYOSTIMULATION BEFORE BEDTIME ON SLEEP AND RECOVERY OF WELL-TRAINED ATHLETES

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INTRODUCTION: To accelerate recovery from intense training sessions, athletes usually employ various techniques. Among these practices, cold therapies have demonstrated their effectiveness in the athlete population. Whole body cryostimulation (WBC) consists of total body exposure to dry air at a cryogenic temperature below -90°, becoming democratized in high-level athletes as a recovery strategy. Indeed, WBC leads to numerous valuable physiological effects. It produces analgesic effects, improves well-being, and reduces inflammation and muscle damage. In the context of an athletes recovery, WBC may help prevent the detrimental effects of intense training sessions. Indeed, intense exercises increase body core temperature (BCT), sympathetic nervous system activation and muscle soreness. Especially when training is performed in the evening, all these perturbations can induce sleep disturbances and finally impair athletes abilities to recover appropriately.

The objectives of the study were (i) to evaluate the effect of WBC after training as an effective tool to improve sleep and recovery, (ii) to state which exposure schedule for WBC (immediately after training vs 1h before bedtime) is the most appropriate to improve sleep and recovery.

METHODS: Twenty-two well-trained male athletes or triathletes were recruited in this controlled cross-over protocol. It consisted of 3 experimental sessions, each composed of a running training session followed by one night of sleep analysis. Depending on the experimental condition, subjects were exposed - or not - to WBC immediately after training (7 pm) or 1h before going to bed. All participants were randomly assigned to each condition (CONT; CRYO 7 pm; CRYO 10 pm), spaced 7 days apart. During the 3 nights of analysis, sleep was monitored via actimetry and cerebral activity recordings. Heart rate variability (HRV), body core temperature (BCT) and various perceptual measures were also assessed during the entire protocol.

RESULTS: WBC after training did not modify subjective or objective sleep parameters the following night. However, WBC, whatever the timing was, significantly improved recovery perception, muscle soreness, and HRV parameters. More specifically, the parasympathetic branch of the autonomic nervous system was more activated during the night when WBC took place 1h before bedtime. It was attested by reduced LF/HF ratio, resting HR and increased PNS index, especially during the slow wave sleep period. Body core temperature 1h after bedtime was the lowest in the CRYO 10 pm condition, coinciding with a more significant drop in BCT after the WBC session.

CONCLUSION: This study confirmed the effectiveness of WBC as a recovery technique after intense evening training. It suggested that WBC may exhibit the most significant benefit on recovery if the session is realized 1h before bedtime, acting on subsequent parasympathetic activation and body core temperature drop.

Oral presentations

OP-BM08 Neuromuscular Physiology: Fatigue III

PURELY EXPLOSIVE ISOMETRIC CONTRACTIONS INDUCE MOSTLY CENTRAL FATIGUE

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INTRODUCTION: The neural drive to the muscle is the primary determinant of the rate of force development (RFD) in the first 50 ms of an explosive contraction. However, it is still unproven if repetitive explosive contractions specifically induce central fatigue, thus impairing the net neural drive. Indeed, previous studies on this topic adopted repetitive maximal contractions characterized by a first phase of explosiveness followed by a holding phase of 1 to 3 s. Thus they could not

distinguish the peculiar way the rapidity/explosiveness induces fatigue. Indeed, while the explosive phase of a contraction lasts about 200 ms, adding even just 1 s of holding phase makes most of the contraction a holding maximum contraction (200 ms of explosive phase vs 1 s of holding phase).

METHODS: To isolate the fatiguing effect of contraction explosiveness, 17 male adult volunteers performed 100 purely explosive isometric contractions - i.e. brief force pulses without holding phase - of the knee extensors. The response to electrically-evoked single and octet femoral nerve stimulation was measured together with high-density surface electromyography (HD-sEMG) from the vastus lateralis and medialis muscles. Root mean square (RMS) and muscle fiber conduction velocity (MFCV) were normalized to M-wave peak-to-peak amplitude and MFCV, respectively, to compensate for peripheral properties changes.

RESULTS: We found a decrease in early RFD ($d = -0.56$, $P < 0.001$) and an increase in time to peak force ($d = 0.90$, $P < 0.001$) and time to peak RFD ($d = 0.56$, $P = 0.034$). While we did not find clear signs of peripheral fatigue, there was a substantial decrease in neural efficacy, i.e. voluntary/octet force ratio ($d = -1.50$, $P < 0.001$). Relative RMS ($d = -1.10$, $P = 0.006$) and MFCV ($d = -0.53$, $P = 0.007$) also decreased.

CONCLUSION: We isolated the fatiguing impact of contraction explosiveness by adopting a protocol constituted by purely explosive contractions, i.e. brief force pulses without any holding phase. We found that the high level of neural drive required to repeat purely explosive contractions resulted in mostly central fatigue that caused a slowing in voluntary force production. The slowing was mainly evident in the first 50 ms of contractions.

IMMEDIATE AND PROLONGED EFFECTS OF KNEE FLEXOR FATIGUING EXERCISES ON POSITION SENSE USING POSITION-POINTING TASKS

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INTRODUCTION: The effect of exercise-induced neuromuscular fatigue on kinesthesia has mainly been studied using bilateral joint position-matching tasks [1,2]. However, these tasks are limited in evaluating fatigue effects in unilateral contexts since they require a non-fatigued reference limb. The recent development of unilateral position-pointing tasks that involve extrapersonal body representation offers an alternative method to assess position sense in ecological settings. However, to date, no study has investigated fatigue-induced effects on position sense with such tasks that seem highly dependent on central processes [3]. Therefore, we designed a study to compare the immediate and prolonged effects of submaximal isometric, concentric and eccentric fatiguing exercises of knee flexors (KF) on position-pointing accuracy.

METHODS: Fourteen healthy young men were recruited. Isometric and dynamic KF fatiguing exercises were performed one week apart on the right limb and were stopped when the maximal voluntary isometric contraction torque dropped to 80% of its initial value. Position-pointing tasks were performed at 40° and 70° of knee flexion in both the fatigued and the non-fatigued limb. Electrical myostimulations were used to assess KF neuromuscular fatigue etiology (central and peripheral factors). Measurements were taken before, immediately after (POST), and 24 hours (POST24) after each fatiguing exercise. All parameters were analyzed using repeated measures ANOVAs.

RESULTS: Alterations in KF neuromuscular function were identified only at POST regardless of the fatiguing exercise performed, with contributions from central and peripheral factors considering the significant reductions in voluntary activation levels ($p < .05$) and electrically evoked torques ($p < .05$).

Additionally, irrespective of the fatiguing exercise performed, position sense alterations were evidenced after the exercise-induced neuromuscular fatigue. After the isometric and dynamic KF fatiguing exercises, position-pointing accuracy was impaired only at 40° of knee flexion in the fatigued limb at POST ($p < .01$) and POST24 ($p < .05$).

CONCLUSION: This study provides the first evidence that exercise-induced neuromuscular fatigue can affect position-pointing accuracy. Contrary to recent hypotheses that pointed to the involvement of central mechanisms in fatigue-induced position sense alterations [2], the results of this study suggest that peripheral mechanisms (e.g., altered muscle spindle sensitivity at long muscle length in the fatigued limb) may disturb extrapersonal body representations.

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INDIVIDUALIZED MENTAL FATIGUE DOES NOT IMPACT NEUROMUSCULAR FUNCTION AND EXERCISE PERFORMANCE

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INTRODUCTION: Previous work has shown that mental fatigue may have negative consequences on physical performance. Although recent reports question this previous empirical evidence. In this study, neurophysiological and physical responses to an individualized mental fatigue task are analyzed in order to investigate the critical role of individual differences in susceptibility to mental fatigue.

METHODS: We conducted a pre-registered (https://osf.io/xc8nr/), randomized, within-participant design experiment. Twenty-two active recreational athletes completed a cycling time to failure at 80% of their peak power output in two separate sessions, under mental fatigue (individualized mental effort) or control (low mental effort). Subjective feeling of mental fatigue, rate of perceived exertion, knee extensor neuromuscular function and corticospinal excitability were measured before and after the cognitive tasks. We conducted sequential Bayesian analysis until it reached strong evidence in favor of the alternative hypothesis (BF10 > 6) or the null hypothesis (BF10 < 1/6).

RESULTS: The individualized mental effort task resulted in a higher subjective feeling of mental fatigue in the mental fatigue condition: 0.50 (95%CI 0.39 - 0.62) compared to control: 0.19 (95%CI 0.06 - 0.339). However, exercise performance was not impaired. Control: 410 (95%CI 357 – 463) seconds and mental fatigue: 422 (95%CI 367 – 477) seconds. The Bayes factor (BF10 = 0.15) indicated that the observed data moderately to strongly supported the null hypothesis that the individualized mental fatigue did not have a detrimental effect on physical performance. Likewise, mental fatigue did not impair knee extensor maximal force generating capacity (BF10 = 0.928) and did not change the extent of fatigability or its origin after the cycling exercise.

CONCLUSION: Our data does not suggest that mental fatigue has a detrimental effect on physical exercise and neuromuscular function. Even when mental fatigue is individualized, this does not seem to affect physical performance when it is induced by computerized tasks. Future studies should seek to assess mental fatigue in a more realistic and meaningful context for an individual and its impact on training and performance.

MENTAL FATIGUE AND FORCE PRODUCTION CAPACITIES DURING A HANDGRIP CONTRACTION

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INTRODUCTION: Mental fatigue is a psychobiological state caused by prolonged periods of demanding cognitive activity and characterized by subjective feelings of tiredness and lack of energy. Although its impact on physical performance is now well documented, these effects on force production capabilities remain uncertain. Studies have mainly focused on the effects of mental fatigue on maximal force production capacities. However, the rate of force development (RFD), a neuromuscular parameter related to most performances in both sport-specific and functional daily tasks, is poorly investigated and could provide valuable information about the effects of mental fatigue on force production capacities. As most activities of daily living are performed at submaximal intensities, RFD measured during contraction at submaximal intensities could have a higher ecological validity than RFD measured during maximal contractions. This study aimed to investigate the effects of mental fatigue on maximal force production, neuromuscular quickness, and force steadiness during handgrip contractions.

METHODS: Fourteen participants performed two randomized sessions, during which either they carried out a cognitively demanding task or a documentary watching for 62 min. The mental fatigue was evaluated subjectively (visual analogue scale) and objectively (cognitive performances and EEG). Sleepiness was also evaluated after both tasks. Maximal voluntary contraction (MVC) force and neuromuscular quickness using RFD-SF were recorded before and after the cognitively demanding task and documentary watching.

RESULTS: Feeling of mental fatigue was higher after completing the cognitively demanding task than after the documentary watching ($p < .001$), objectively evidenced by an increase in errors, missed trials and a decrease in N100 amplitude over time. Alpha power was higher (all ps < .002) during the completion cognitively demanding, but no specific changes overtime were reported. Sleepiness did not differ after the cognitively demanding task or the documentary watching ($p = .730$). Decrease in MVC ($p = .040$), lower slope ($p = .011$), and a reduction in R^2 ($p = .011$) of RFD-SF relation were observed after both cognitively demanding task and documentary watching.

CONCLUSION: These results indicate that both cognitively demanding task and documentary watching induced a decrease in maximal force production and in neuromuscular quickness at submaximal contraction intensities. Although the results of this study cannot be specifically attributed to mental fatigue, it is possible that, because of its effect on anterior cingulate cortex activity, mental fatigue impacts central control of muscles during contractions (e.g., motor unit firing rate and agonist-antagonist coordination). This would explain the effects on maximal force production and neuromuscular quickness. Future studies with more robust control tasks are needed to confirm our findings.

ADAPTIVE FORCE IN PATIENTS WITH LONG COVID AND DURING RECOVERY: MAXIMAL HOLDING CAPACITY MIGHT SERVE AS BIOMECHANICAL MARKER

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INTRODUCTION: Long COVID is frequently accompanied by symptoms like fatigue, muscle weakness and pain.[1] Since suitable diagnostics are still missing,[2] examining muscle function could be a supportive approach. The maximal isometric Adaptive Force (AFisomax) was previously suggested to be especially sensitive for disruptive stimuli.[3] It was assumed that this holding capacity would also be reduced in post-infectious diseases as Long COVID. The study aimed at investigating the Adaptive Force (AF) in patients with long COVID and their recovery process.

METHODS: This non-clinical study examined AF parameters of elbow/hip flexors in long COVID patients at three timepoints (pre: long COVID state, post: immediately after first treatment; end: substantial health improvement/recovery). The AF of each muscle was assessed three times by a manual muscle test objectified by a handheld device which captures force

and angle simoultaneously. The patient's task was to maintain an isometric position for as long as possible while the tester applied an increasing force on the patient's limb. Main parameters for comparison between the three timepoints (RM ANOVA) were the maximal isometric AF (AFisomax; highest force under isometric conditions) and the maximal AF (AFmax; peak value of one trial). Moreover, the intensity of 13 common symptoms was queried for baseline (prior to COVID-infection; retrospectively), in long COVID state, and at recovery.

RESULTS: In long COVID state patients could maintain the isometric position up to 46.58 ± 15.91% and 49.25 ± 12.01% of the AFmax for elbow and hip flexors, respectively. AFmax was then reached during muscle lengthening, indicating an unstable adaptation. AFisomax increased significantly to 98.63 ± 3.20% of AFmax at post and to 99.78 ± 0.71% at end (average of both muscles). This reflects stable adaptation. In turn, AFmax was statistically similar between all timepoints for both muscles. Symptoms intensity decreased significantly from long COVID state to end.

CONCLUSION: Long COVID patients showed initially an impaired length-tension control during adaptation to an external increasing force reflected by the significantly reduced AFisomax. With substantial health improvement, the muscular adaptation returned to normal function. The maximal AF did not show this behavior. It is suggested that especially the maximal holding capacity – not maximal forces as the AFmax – might be a suitable sensitive functional parameter to assess long COVID patients and to support their therapy process.

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Oral presentations

OP-AP36 Technology for Training and Recovery

A VIDEO-BASED TRAINING TO IMPROVE SURFERS INTUITIVE DECISION MAKING IN COMPETITION: A MIXED-METHOD PILOT STUDY

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INTRODUCTION: Surfers' performance in competition is evaluated while they are riding a wave, even though they spend far more time paddling, sitting or lying on their boards (Mendez-Villanueva et al., 2006). Athletes spend the majority of their time understanding their environment and making decisions, such as which wave to ride or which maneuver to use. Given the increasing demands of performance in sports situations (Klingner et al., 2022), how to develop decision making is an important research issue. The aim of this pilot study was to explore the effects of video-based training on intuitive decision-making during competition.

METHODS: Five athletes (2 females and 3 males) from a national surfing center participated in a 4-week video training intervention, including 3 sessions per week. A video based training session consisted of watching 5 waves of international surfers, frozen at a point that was considered appropriate for making a decision. Based on the study of Klatt et al. (2019), the athletes were then asked to (1) name outloud, (2) write down the first decision they think and (3) write down as many additional appropriate solutions that they can think of how to continue the sequence by imagining they were the athlete on the screen. Over the 4 weeks, quantitative data was collected: the responses of each athlete in each session as well as the responses of the coaches, in order to evaluate the accuracy of the decisions made by the athlete. To assess potential changes in the participants intuitive decision-making, a qualitative analysis was conducted during real competitions before and after the video-based training.

RESULTS: During video-based training, repeated measures ANOVAs show an increase in the accuracy of all decisions and especially the first one (from 75% to 84.1%). The video-based training seems to have contrasting effects on decisions in real competition: significant inter-individual differences in accuracy and decision processes.

CONCLUSION: This pilot-study highlights the potential impact of video-based training on intuitive decision-making of surfers, which should in future take into account practice variability and familiarity with the competition venue.

Keywords : intuitive decision-making, video-based training, performance, surfing

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MODULATION OF PHYSICAL EXERCISE INTENSITY IN MOTOR-COGNITIVE BRAIN TRAINING USING THE SKILLCOURT TECHNOLOGY

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INTRODUCTION: Cognitive abilities substantially contribute to sport performance and numerous trainings aiming to improve cognitive functions were created. While computer-based interventions have been criticized due to their limited transferability, the suggestion to combine cognitive tasks with physical activity resulted in the development of motor-cognitive training. One major argument is the release of neurotrophic factors during exercise that should support neural plasticity according to the concept of guided plasticity facilitation. However, motor-cognitive tasks typically involve low to moderate intensities and provide limited flexibility to modulate physical effort which limits its integration into training apart from a "fun-factor". Therefore, this study evaluated the physiological profile of motor-cognitive trainings on the novel SKILLCOURT technology aiming to cover a broad range of exercise intensities.

METHODS: 28 healthy university students performed five motor-cognitive trainings combining physical and cognitive tasks using the SKILLCOURT technology. In the cognitive domain, the tasks required decision making, conflict inhibition, working memory, dual-task ability, logical thinking, and planning ability. Physical demands were modulated by varying the motor response between stationary stepping movements and highly dynamic agility runs on a 4x4 m court that was continuously scanned by a LiDAR system. Each training was performed 3 times with a standardized break of 30 seconds between trials. To determine the physiological demands of the motor-cognitive trainings, VO2 was measured using a mobile gas analyzer and compared to the individual VO2max determined during a ramp-test on a treadmill. In addition, average heart rate (HR) and metabolic equivalents (MET) were calculated. Differences in physical demands between the training tasks were determined using repeated measures ANOVA analysis.

RESULTS: Exercise intensity as reflected by oxygen uptake (VO2) ($p<0.001$, eta2 = 0.92) as well as average heart rate ($p<0.001$, eta2 = 0.93) revealed significant differences between trainings. Across the 5 training tasks, intensity varied between 50% to 88% for maximum HR and 22% to 77% for VO2max. The same applied to the MET ($p<0.001$, eta2 = 0.91) that covered a range between 4.1 to 14.9 MET's. Overall, the training tasks covered all categories from light to high exercise intensity.

CONCLUSION: The results suggest that physical exercise intensity in motor-cognitive training can be systematically modulated on the SKILLCOURT by changing the cognitive and motor task demands. While more stationary training involves minimal physical effort corresponding to light intensity, dynamic tasks can be considered vigorous to high intensity exercises. Since the release of neurotrophic factors depends on exercise intensity, the type of physical exercise incorporated into the cognitive task may have a major influence on neural plasticity which should be considered when using motor-cognitive training in sports.

GETTING PAST BASKETBALL DEFENDER IS NOT JUST A MATTER OF SIZE

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INTRODUCTION: Affordance theory (Gibson, 1977) has been promoted as a relevant framework for understanding information-movement coupling in sport (Fajen et al., 2009). With virtual reality, it is now possible to show how decision-making is shaped by the perception of affordance, notability in "duel" situations against a virtual opponent (Watson et al., 2011). We explored the perception of affordances in basketball, by scrutinizing the possibility to throw without being contested by a virtual defender. We investigated whether expertise, player size, and permission to jump, affect the throwing decision.

METHODS: 20 experienced and 19 novice basketball players were divided into two comparable subgroups, tall and short, based on their median height. Participants had to decide whether it was possible to throw an instrumented ball into a virtual basket without the shot being contested by a virtual animated defender. We manipulated the distance to the virtual defender (0.755, 1.055, 1.3355, 1.655, 1.955, 2.255m) as well as the "permission" to jump for throwing.

RESULTS: Both experienced and novice players threw more frequently as distance to the virtual defender increased ($p < 0.05$). In the jump-allowed condition, all players also had 6% more throws ($p < 0.05$) as compared to the no-jump-allowed condition, shifting the threshold for triggering throws from 1.05 to 1.4m from the virtual defender. Finally, experienced short and tall players behaved similarly (64.58%), while tall novice players threw 20% more frequently than their short counterparts (68.40 vs. 48.93%; $p < 0.05$).

CONCLUSION: These results suggest that the throwing decision is rooted in the perception of both body-scaled (Warren & Whang, 1987) and action-scaled affordances (Fajen & Matthis, 2011). With expertise, the action-scaled can override the body-scaled affordances, particularly by providing sufficient muscle power to propel the ball and compensate short height of release. This may have practical implications for coaches who wish to train their athletes specifically in "duel" situations.

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COMPARATIVE EFFICACY OF ROBOTIC AND MANUAL MASSAGE INTERVENTIONS ON PERFORMANCE AND WELL-BEING: A RANDOMIZED CROSSOVER TRIAL

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INTRODUCTION: Both autogenic and manual massage are proven beneficial in eliciting greater relaxation. However, manual massage elicits more pronounced relaxation state than autogenic massage, as revealed by our previous study comparing both objective and subjective indexes. Also in regards to motor control frameworks, both massage interventions differ. Manual massage mainly engages the person in a retroactive mode of action control. Conversely, autogenic massage involves voluntary actions and therefore engages the person in a proactive mode of action control. With the arise of interactive robotic massage solutions participants can now engage in a novel sensorimotor experience. Real-time interactions with the massage gestures through remote control of the robot allow participants to switch between proactive and retroactive modes of action control. Robotic innovation is represented as a support solution for repetitive and simple tasks, and recently paving the way to sustainability and reproduction of manual massage gestures. Manual massage (MM) interventions can improve psychophysiological states relaxation and well-being. In the present, robotic massage (RM) represents a promising, but currently understudied, solution.

The present single-blind randomized crossover trial aimed at comparing the effects of MM and RM on psychometric, behavioral, and neurophysiological indexes of motor/cognitive performances and well-being.

METHODS: Twenty-one participants experienced two massage intervention targeting back soft tissues. During a first condition, the intervention was performed by a physiotherapist, whereas during a second condition the intervention was performed by a collaborative robot. We collected a series objective and subjective indexes of performances and well-being before and after each massage intervention. We also collected physiotherapist's self-reports of perceived fatigue, tension, and ability to maintain the massage routine.

RESULTS: Skin conductance decreased from the pretest to the posttest in both conditions (partial R-squared = 0.44, 95% CI [0.30, 1.00], $p < 0.001$), although the decrease was more pronounced after MM. While both interventions were associated with improved subjective sensations, e.g. pain, warmth, well-being (partial R-squared = 0.08, 95% CI [0.06, 1.00], $p < 0.001$), MM yielded additional benefits compared to RM. The physiotherapist reported greater fatigue and tension and reduced perceived massage efficiency along with repeated massage interventions. MM outperformed RM to elicit a psychophysiological state of relaxation.

CONCLUSION: RM exhibited a comparable pattern of changes to that of MM, for both objective and subjective indexes of relaxation and well-being. Clinical relevance: RM could represent a prophylactic option to prevent the onset of counter-productive fatigability states in physiotherapists' professional.

THE EFFECTS OF NOVEL GRAPHENE-BASED HEATED GARMENTS ON BODY TEMPERATURE AND PEAK POWER OUTPUT POST-WARM-UP

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INTRODUCTION: Heated garments can attenuate the drop in muscle temperature often observed during 'heat loss windows' prior to competition (1). However, these garments traditionally use wire heater elements, which are limited by an inability to generate heat uniformly. A printed graphene-based solution enables more uniform heating over larger areas and avoids local hot spots (2). This study aimed to quantify the technical performance of garments containing graphene-based heaters, and the effects of the use of these garments on lower-body peak power output (PPO) following a simulated post-warm up 'heat loss window'.

METHODS: Firstly, in off-person testing, the graphene-based garments were hung inside out whilst images of the heater panels were captured using a thermal imaging camera. Time to reach target temperature, mean temperature, battery life, and rate of temperature decline over battery life were quantified. These were compared to two wire heater-based commercially available garments. Secondly, the graphene-based garments were worn by six participants resting in a controlled 20°C environment for 15-min to assess the effects on body surface temperature using thermal imaging immediately after their removal. Finally, nine participants completed a standardised cycling warm-up, followed by 30-min passive rest in cold (5°C) and temperate (20°C) environments with the graphene-based garment heating either enabled or

disabled (i.e. four trials in total). PPO during counter-movement jumps was assessed at various times pre and post warm-up.

RESULTS: In the off-person testing, the trousers and jacket took 4.4-min and 10.6-min to reach target temperature, respectively. The mean temperature across all panels was 47.0°C (trousers) and 42.7°C (jacket). On full power, the batteries lasted for 2.49-h (trousers) and 3.22-h (jacket), with a temperature decline of 0.6 and 1.2°C/h, respectively. When activated, the garments led to an increase in body surface temperature in all heated regions after just 15-min. Post warm-up, compared to an inactivated worn garment, the activated garments significantly increased skin temperature, thermal comfort and thermal sensation in both cold and temperate conditions (all $p < 0.05$). Core temperature was raised but not significantly at any measured timepoint. When the garments were activated, PPO was 57 W (1.6%) to 145 W (3.9%) greater in the 30-min post warm-up, and this difference was significant in the cold environment after 30-min.

CONCLUSION: Graphene-based heaters integrated into competition-ready garments provided greater heat output than commercial wire-heater garments. The graphene-based garments increased body surface and skin temperature, and attenuated the reduction in PPO during the 30-min post warm-up. Further consideration of garment control and design could improve the practicality and performance further.

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Oral presentations

OP-BM23 Jumping and landing II

CONTRIBUTIONS OF ANKLE JOINT AND GASTROCNEMIUS MUSCLE-TENDON UNIT BEHAVIOR TO REBOUND JUMP PERFORMANCE

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INTRODUCTION: The stretch shortening cycle (SSC) type or joint movement has been known as an important aspect of explosive sports activities (1). In the SSC movement such as jumping, involved joints store elastic energy in the flexion (negative) phase, and then release it in the extension (positive) phase which can be optimized by muscle activity (2, 3). However, limited information is available about how inter-individual differences in ankle joint, MTU mechanics and muscle activities affect jumping performance. The purpose of this study is to clarify the inter-relationships of the ankle joint, MTU mechanical work and muscle activity for optimizing the vertical jump performance.

METHODS: Nine subjects (21.5 ± 1.2 yr; mean ± SD) participated in this study. The jump trial was consisted of 5 consecutive rebound jumps (RJ) from the stand position with their arms set at the hips. Subjects were instructed to mainly use the ankle joint, avoiding knee flexion as much as possible, to achieve the highest performance at the final jump. The height of the center of gravity in the final jump was used for the RJ performance. During the RJ trial, the ground reaction force and joint angles (knee/ankle) were recorded using force platforms and goniometers, which were used to calculate the jump height and the mechanical work at the ankle joint and the gastrocnemius MTU. Muscle activities of the gastrocnemius medialis (GM), soleus (SOL) and tibialis anterior (TA) were recorded with surface electromyography (EMG). The relationship of RJ performance and other variables were tested by Pearson's correlation analysis.

RESULTS: The absolute negative work of the ankle joint and GM-MTU were positively correlated with the RJ performance ($r = 0.81$, $p = 0.01$, and $r = 0.77$, $p = 0.02$ respectively). It was suggested that better jumpers stored more elastic energy in the ankle joint as well as the major agonist (GM) during the negative phase, and utilized it for the later jump. There was a significant relationship between RJ performance and the GM muscle activity in the negative phase ($r = -0.77$ $p = 0.02$), suggesting the importance of deactivating the agonist muscle in this phase for achieving a higher jump. The subject showing the greatest amount of negative joint and GM-MTU work was characterized by the largest ankle joint range of motion. It is suggested that the amount of negative ankle joint and GM-MTU work is affected by the excursion of ankle joint, allowing for the storage and release of elastic energy.

CONCLUSION: CONCLUSION: The negative phase in SSC is important, in such a way that the mechanical work of the joint and agonist MTU store the sufficient amount of elastic energy for the better jump performance. Making the ankle joint range of motion larger by deactivating the agonist muscle in its stretch phase, can be the strategy for it.

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MUSCLE TENDON KINEMATICS PRECEDING CONTACT DURING LANDING AND DROP-JUMPING

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INTRODUCTION: To coordinate joint rotations with the external constraints of a motor task, our Central Nervous System (CNS) programs muscular anticipatory activations [1]. In movements involving large momentum, such as landing (L) or drop-jumping (DJ), electromyography studies suggested that anticipatory activity in bi-articular muscles crossing the hip and knee are mainly responsible for energy absorption rather than propulsion [2]. However, their role during anticipation remains unclear, partly because the kinematic consequences of this anticipatory muscular activity have not been described. This role can be determined with the change in length of muscle tendon unit (MTU). The objective of this study was to characterize the evolution of lower-limb MTU lengths during the anticipation phase and for a 50 ms period following the ground contact (GC), during L and DJ tasks.

METHODS: Ten young healthy participants (5 females and 5 males, 25±5 years old) performed L and DJ from a 50-cm elevated platform, on two forceplates recording the 3D ground reaction forces (GRF) at 2000 Hz. For each subject, only the best trial for L (i.e. the lowest vertical GRF peak) and for DJ (i.e. the shortest contact time) was analyzed. GC was determined when the vertical GRF exceeded 20N. The 3D trajectories of 64 reflective markers placed on anatomical landmarks were recorded by 19 infrared cameras at 200 Hz. MTU lengths of rectus femoris (RF), biceps femoris long head (BF) and psoas major (P), were computed with an individualized full-body musculoskeletal model [3]. MTU kinematics were then computed using MTU length derivatives (negative values for shortening). The onset of MTU length change before GC was also identified. Paired t-tests were performed for each variable to compare between L and DJ.

RESULTS: For all muscles, participants and trials, all MTU changed length before GC and their kinematics where the same before and during the first 50 ms of GC: P shortened and RF lengthened in both L and DJ; whereas BF lengthened in 9 out of 10 subjects during L and shortened in 7 out of 10 subjects during DJ. P tended to shorten later during DJ than during L (56±50 vs 106±62 ms, p=0.08), while there was no difference for the onset of RF lengthening (68±27 vs 66±35 ms, p=0.88). BF started shortening during DJ later than it started lengthening during L (82±64 vs 208±128 ms, p=0.02).

CONCLUSION: These results show that the CNS anticipates by preparing muscle kinematics to the forthcoming constraints of the motor task. These results also suggest that BF could prepare for hip extension rather than favor energy dissipation. Analysis of MTU kinematics reveals how the CNS anticipates for external motor constraints, can inform about the muscular contraction consequences, and could be a biomarker of optimal coordination in sport.

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KINEMATIC PROFILE OF ELITE HIGH JUMPERS – WHAT DISTINGUISHES GOOD FROM GREAT HIGH JUMPERS?

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INTRODUCTION: It has been shown that the success in high jump very often relies on the ability of a jumper to manipulate biomechanical factors that are closely related with optimization of the. Effectiveness in high jumping largely depends on the take-off (TO) action, contact time with the ground, ankle, and knee angles at touch-down (TD) and TO, height of the center of mass (CoM) at TO. We hypothesized that the highest successful attempt will be correlated with kinematic parameters related to peak CoM and peak pelvis position.

METHODS: Data were obtained from the report of Nicholson et al. (2019), on 12 female (body height 182.3±6.9 cm; body weight 63.4±6.8 kg) and 11 male (body height 192.5±2.3 cm; body weight 75.9±6.67 kg) finalist of the IAAF World Championship, that was held in March 2017 in Birmingham, UK. Following variables were analysed and presented: body height; body weight; H1: the height of the centre of mas (CoM) at the instant of touchdown (TD) during the final contact; H2: the height of the CoM at the instant of toe-off (TO) during the take-off phase; H3: peak CoM location; peak pelvis height; knee angle at TD/TO; ankle angle at TD/TO; time spent in knee flexion; time spent in knee extension; TO contact time. Correlations between the highest successful attempt and kinematical parameters, for both women and men, were obtained by calculating Pearson's correlation, by using Jamovi.

RESULTS: In women, significant correlations were found among highest successful jump and peak CoM location (r=0.61, p=0.033) and peak pelvis height (r=0.85, p=0.001). On the other hand, in men, significant correlations were obtained among highest successful attempt and the height of the CoM at the instant TO (r=0.60, p=0.05); peak CoM location (r=0.85, p=0.001); peak pelvis height (r=0.83, p=0.001); and ankle angle at TD (r=0.67, p=0.024).

CONCLUSION: Similar to Čoh & Supej (2008), our study has shown that success in high jump often depends on CoM and pelvis position as well as ankle angle at TD. All jumpers in this study achieved excellent results despite very large variability in kinematic parameters, proving that coordination, strength, and speed patterns are different, but they have not been a disadvantage. From the coaching perspective, training program must be tailormade individually, considering one's physical attributes, strength, and speed qualities as well as individual technical aspects.

CHARACTERISTICS OF KNEE JOINT KINEMATICS IN THE MODIFIED SIDE HOP TEST

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INTRODUCTION: The side hop test (SHT) is a performance test for the functional assessment of the lower extremities after injuries. For assessment using SHT, the patients are asked to hop as quickly as possible on one leg from side-to-side in a 30-cm-wide area. However, because there are no detailed specifications regarding jump height, the jump heights may differ among the patients undergoing SHT. Differences in jump height may affect hopping motion during SHT, and the joint angle or moment in the lower extremity is expected to change. In this study, we aimed to analyze knee joint kinematics during SHT conducted at a defined jump height (modified side hop test, MSHT).

METHODS: Fourteen male with no lower extremity injuries participated in this study (age 19.9 ± 0.9 years ; mean ± SD). All participants underwent SHT and MSHT. The SHT was repeated 10 times for each participant as follows: the participant stood on the test leg and then jumped from side-to-side as fast as possible between two parallel lines placed 30 cm apart. MSHT was performed following the same method as that of SHT, but with the added condition that a 15 cm-high rubber tube was placed in the center of a defined 30 cm-wide area, and the participant was asked to jump without touching the tube. The knee joint angle and moment (flexion/extension, varus/valgus, and internal/external rotation) during both tests were measured and calculated using a 3D motion analysis system and a force plate. The calculated data were normalized based on the results of one cycle of SHT or MSHT (medial landing, lateral hop, lateral landing, and medial hop). Principal component analysis was conducted for statistical analysis. Paired t-tests were used to compare principal component scores for both tests.

RESULTS: Differences were observed in the shape and the size of the graphical curves depicting the knee joint angle and moment data. The principal component scores revealed that the angles of knee flexion during the lateral and the medial hop phases in MSHT were significantly greater than those in SHT ($p < 0.01$). The peak knee extension moments during the lateral and the medial landing phases in MSHT occurred earlier than those in SHT. The magnitude of change in the knee extension moment in MSHT was larger than that in SHT. The values of the knee varus moment during the medial landing phase and the knee valgus moment during the lateral landing phase were higher in MSHT than those in SHT ($p < 0.01$). Moreover, in MSHT, a large knee external rotation moment during the medial landing phase and a large knee internal rotation moment during the lateral landing phase were observed ($p < 0.01$).

CONCLUSION: It was found that when SHT was performed at a certain height, the varus/valgus and the internal/external rotation stresses on the knee joints increased. We suggest that MSHT is an appropriate method for the assessment of functional limitations in patients returning to sports following knee injuries.

Oral presentations

OP-MH16 Ageing and resistance training

ASSOCIATION BETWEEN QUALITY OF LIFE AND GAIT VARIABILITY DURING DUAL-TASK IN THE ELDERLY

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INTRODUCTION: The decrease of executive functions is a physiological condition associated with aging. In the elderly it becomes essential to focus on the cognitive aspect that intervenes in brain tasks such as memory, but also in motor tasks such as walking. To demonstrate the association between cognition and gait, the dual-task paradigm is widely used, which allows to estimate brain functions in the early stages of cognitive decline, thus allowing to identify the elderly at high risk of progression of dementia, loss of mobility and falls1. The dual-task reflects everyday life situations in which walking must be integrated into another activity2. The aim of this study was to define associations between physical and mental well-being, physical performance and gait variability.

METHODS: Fifteen older adults (8 women and 7 men) were involved in the study (age: 67,7±2,7 yrs; BMI: 25,2±2,5 kg/m2). Quality of life (36 Health Status Survey_SF-36v2)3, physical performance (preferred walking speed_PWS)4, and gait variability (expressed as coefficient of variability_CV of spatiotemporal parameters of gait during dual-task treadmill walking)5 were measured. The dual-task consisted in a counting backward task6.

RESULTS: A significant and positive correlation was found between both SF-36v2 Mental Component Summary (MCS) and Physical Component Summary (PCS) and PWS (MCS: r=0,6; p=0,0250; PCS: r=0,6; p=0,0154). A significant and negative correlation was found between CV stride length and both PWS and MCS (PWS: r=-0,6; p=0,0208; MCS: r=-0,6; p=0,0198). The ability to walk at higher speed was explained by participant quality of life (R2=0,511; p=0,0137), whereas a less variable gait performing a dual-task was explained only by MCS (R2=0,344; p=0,0215).

CONCLUSION: Gait is an attention-demanding task, and any concurrent cognitive task, disturbed walking performance7. Elevated quality of life, both physically and mentally, has been directly related to augmented gait speed. Mental health status affected the ability to walk while performing a dual-task. It seems reasonable to assume that improved mental health would allow to manage the proposed cognitive load and to reduce gait variability.

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MUSCLE POWER THROUGH THE CHAIR STAND-UP TEST IN THE SPPB BATTERY

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INTRODUCTION: The five sit-to-stand test (5STS), a clinically valid tool, assesses the trajectory of functional capacity in relation to age by calculating muscle power using the Power-frail app (1). Similarly, the Short Physical Performance Battery (SPPB), which is one of the most widely tests used in the field of assessment of older adults (2), includes the same test but with a different protocol. The present study analyses the muscle power values obtained in the SPPB batterys chair stand-up test, using the Power Frail application in order to compare power outcomes with the 5STS. and study the possibility of unifying the contribution of both proposals in a single measurement.

METHODS: Sixty-five participants (72.55 ± 10.75 years; 70.47 ± 13.11 kg; 27.40 kg/m2 ± 4.57 of BMI; 51 of them women) performed both tests (5STS and SPPB) in randomised order, following the indications of their authors. The protocol was approved by the scientific ethics committee of the University Clinical Hospital of Valencia (2022/172). Later on, both tests were analyzed with the Power-Frail app, adapting its formula (from 5 to 4 cycles). The main percentiles were also considered on normalized and allometric power, as proposed by Alcazar et al. (1): P3, P10, P25, P50, P75, P90, P97, both in the five sit-to-stand test and the SPPB batterys chair stand-up test.

RESULTS: The average values (P50) of 5STS (2.95 W/kg; 80.79 W/m2) and SPPB (3.03 W/kg; 82.47 W/m2) tests showed a Chronbachs α and ICC of 0.89 and 0.94 for normalised power (W/kg), and 0.90 and 0.94 for allometric power (W/m2) respectively. The other muscle power percentiles both for 5STS (P25: 2.51W/kg; 66.20 W/m2; P75: 3.33W/kg; 95.19 W/m2) and SPPB (P25: 2.43W/kg; 68.01 W/m2; P75: 3.51W/kg; 96.11 W/m2) showed within similarity, as wells as with the Spanish sample in the study of Alcazar et al. (3), with identical age, body weight and BMI values.

CONCLUSION: The power values, both relative and allometric, show a high between correlation, confirming their similarity. Percentiles corroborate it, also regarding previous outcomes in the 5STS literature (3). The slight differences among tests could be due to the lower fatigue experienced in 4 complete cycles of the SPPB compared to the 5 cycles of the 5STS. Considering the low energy availability of older adults (4), future studies might confirm the use of the SPPB sit-to-stand test as a valid measure of power, avoiding duplication of tests in those studies that already use the SPPB battery aiming to assess also balance and gait speed.

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AN EDUCATIONAL PROGRAM IMPROVES PHYSICAL FUNCTION IN OLDER ADULTS WITH FRAILTY PHENOTYPE: THE FRAGSALUD PROJECT

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INTRODUCTION: Frailty has become a common state in older adults (1). This state has been defined as a progressive physiological and functional decline. Physical function outcomes have been associated as protective factors against frailty (2). Thus, interventions to reduce the impairment of physical frailty are required. This study aims to determine the effect of a health-focused educational program on physical function of older adults with frailty phenotype.

METHODS: This study includes preliminary results from the FRAGSALUD randomized clinical trial. A total of 80 participants with frailty phenotype were randomly allocated in to the intervention group (n=40) and control group (n=40). The invention group assisted to 4 different 1-hour sessions during 6 months focused on key components of frailty such as frailty development, physical activity, nutritional recommendations, and mental well-being. Pre- and post-intervention outcomes included lower body performance (5 repetition sit to stand test) and handgrip strength. Results were analysed with a mixed factorial ANOVA with Bonferroni post hoc comparisons, significance was set at $p<0.05$.

RESULTS: After 6 months of the educational program, the intervention group significantly reduced the time in performing the 5 repetition sit to stand test in 6.5±14.3 seconds ($p<0.05$) and maintained handgrip strength in 0.06±2.27 kg ($p>0.05$),

whereas the control group remained stable for 5 repetition sit to stand test (0.2±11.9 seconds, p>0.05) and decreased handgrip strength (3.42±6.29 kg, p<0.05). A time-by-group interaction was found for both variables (p<0.035).

CONCLUSION: Our results showed that a 6-month educational program focused on the prevention of frailty is able to improve the lower body performance and handgrip strength of older adults with frailty phenotype. Thus, the FRAGSALUD educational program is an effective strategy to reduce the physical function decline in older adults with frailty phenotype which is relevant in an increasingly aging population.

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PHYSIOLOGICAL AND PSYCHOLOGICAL EFFECTS OF SHORT-TERM WALKING FOOTBALL IN OLDER ADULTS

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INTRODUCTION: Physical activity (PA) is recommended across the lifespan to maintain good health. PA is also known as an effective and preventive strategy to counteract the detrimental adaptations of the aging process. An active lifestyle and participation in sport are protective factors that play a key role in determining quality of life and well-being in older adults. In this context, walking football (WF) which is a small-sided football games mostly played recreationally at a walking pace is in line with the recommendations for PA in older adults (King & Guralnik, 2010). However, while the physiological effects of WF are well demonstrated (Arnold et al, 2015), there remains a lack of research examining physiological and psychological effects in shorter periods. The aim of this study was then to examine both physiological and psychological effects of short-term walking football in older adults.

METHODS: Fifteen participants (12 men and 3 women; 68.28 ± 5.07 (mean ± SD) years old, range 60-80 years old; 76.33 ± 12.83 kg; 1.73 ± 0.08 m; 25.49 ± 3.00 kg/m2) were asked to practice sessions of walking football during 90 min (including warm-up and cooling) twice a week, during 6 weeks. Before (PRE) and after (POST) the 6 weeks training they performed physiological tests including anthropometric measures and tests from the Senior Fitness Test Manual which gives functional evaluation tools for people over 60 years old. Basic Psychological Need Satisfaction and Frustration questionnaire was also submitted to subjects before and after training.

RESULTS: Body mass and BMI significantly decreased respectively by 1.44% (p<0.5) and 1.57% (p<0.5) in average after the training intervention. There was no significant PRE – POST differences in functional evaluation tests performed for people over 60 years old. A significant difference was found between PRE and POST intervention for the dimensions "frustration of need for autonomy" (p<.05) and "frustration of need for competence" (p<.05). In addition, changes in autonomy need frustration were significantly correlated with changes in body mass (p<0.05, r=0.62) and body mass index (p<0.05, r=0.59).

CONCLUSION: It was expected that regular physical activity could improve general physical fitness. Finally, 6 weeks of walking football were not sufficient to affect significantly physiological parameters except body mass and BMI. At the same time significant psychological benefits were observed and associated with a decrease of body mass and BMI. Further investigations should focus on the influence of longer training periods especially for physical parameters.

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THE 12-WEEK RESISTANCE AND AEROBIC EXERCISE INTERVENTIONS ON COMMUNITY-DWELLING OLDER WOMEN: STUDY ON FUNCTIONAL FITNESS BY MEANS OF THE SENIOR FITNESS TEST

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INTRODUCTION: Increasing or maintaining mobility, functional independence and quality of life in older adults are vital in healthy aging. From this perspective, the Senior Fitness Test (SFT) was developed to evaluate functional fitness in older adults, including strength, aerobic endurance, agility/dynamic balance, and flexibility. Evidence has emphasized the significance of physical activities on health-related outcomes in older adults. The purpose of this study was to assess the effects of 12-week resistance and aerobic exercise on functional fitness by means of the SFT in a group of community-dwelling older women.

METHODS: A total of 118 older women (60 to 79 years old) who were willing to participate in program were recruited from communities of Shanghai, China. They were assigned to the resistance training (RT) group, aerobic training (AT) group and control (CON) group. Participants assigned to the RT group received elastic band resistance training (20 minutes/time, 3

times/week) for several body parts. Each body part engaged in 2 to 3 sets of 10 to 15 repetitions for every set, with a rest period of 60 to 90 seconds among sets. Participants assigned to the AT group received moderate-intensity aerobic dance exercises (45 to 60 minutes/time, 3 times/week). The intensity of the exercise was controlled at a moderate intensity through the combination of heart rate and subjective perceived rate of exertion. All trainings involved warm up and recovery activities and were supervised by social sports instructors or fitness coaches. No intervention was applied to the CON group. Anthropometric variables, demographic variables, strength aerobic endurance, agility/dynamic balance, and flexibility were measured at baseline (T0) and immediately after the 12-week period intervention (T1).

RESULTS: In total, 97 female participants (mean age: 65.0 ± 4.3 years) completed 12-week intervention program. The RT group consisted of 32 participants (65.0 ± 3.4 years), and the AT group consisted of 36 participants (63.8 ± 4.3 years), and the CON group consisted of 29 participants (66.6 ± 4.7 years). Four performances out of six tests of the SFT were found significantly changed. In the RT group, upper-body flexibility significantly improved (back scratch test: T0 = -1.3 ± 12.1, T1 = 1.2 ± 7.9, $p < 0.05$). In the AT group, upper-body strength significantly decreased (30-second arm curl test: T0 = 24.7 ± 4.3, T1 = 22.8 ± 3.7, $p < 0.05$). In the CON group, upper-body strength (30-second arm curl test: T0 = 24.7 ± 5.2, T1 = 21.6 ± 4.5, $p < 0.05$), lower-body strength (30-second chair stand test: T0 = 24.4 ± 6.4, T1 = 21.8 ± 5.8, $p < 0.05$), and lower-body flexibility significantly declined (chair sit-and-reach test: T0 = 12.5 ± 7.9 cm, T1 = 9.4 ± 8.5 cm, $p < 0.05$)

CONCLUSION: The 12-week resistance and aerobic exercise programs was efficient in improving flexibility, and preventing strength decline in community-dwelling older women. However, no effects on aerobic endurance, and agility/dynamic balance were observed.

Oral presentations

OP-MH15 Aerobic exercise in cancer patients

EFFECT OF EXERCISE BEFORE AND/OR DURING TAXANE-CONTAINING CHEMOTHERAPY TREATMENT ON CHEMOTHERAPY-INDUCED PERIPHERAL NEUROPATHY IN WOMEN WITH BREAST CANCER

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INTRODUCTION: Taxane-containing chemotherapy regimens can lead to dose-limiting chemotherapy-induced peripheral neuropathy (CIPN) in breast cancer patients. CIPN often persists beyond treatment termination and is accompanied by fatigue. Both CIPN and cancer-related fatigue are associated with reduced health-related quality of life (HR-QoL). Current reviews of the literature indicate that exercise peri-chemotherapy (including after) can improve CIPN, HR-QoL and fatigue levels. However, post-chemotherapy interventions could be tracking a natural easing of CIPN symptoms and improvement of QoL, therefore aiding rehabilitation as opposed to modulating CIPN symptom severity. A review is yet to be conducted that investigates how exercise only before and/or during taxanes impacts these outcomes. The purpose of this systematic review with meta-analysis was to assess the efficacy of exercise intervention implemented before and/or during taxane-containing chemotherapy regimens on CIPN, HR-QoL and fatigue in women undergoing breast cancer treatment.

METHODS: An electronic search of PubMed, EMBASE, Cochrane Central, SPORTDiscus, CINAHL, ClinicalTrials.gov, and ISRTCN was run independently by two authors from inception to 15th September 2022. Randomised controlled trials (RCTs) reporting on the effects of exercise interventions in women with breast cancer who were receiving taxane-containing chemotherapeutic treatment were selected. Two independent reviewers screened the search results and extracted data from eligible trials. Meta-analyses were performed to evaluate the effects of exercise on CIPN symptoms, HR-QoL and fatigue. Standardised mean differences (SMDs) with 95% confidence intervals (CIs) were pooled using random effects models. The review was registered via PROSPERO (CRD42021272036).

RESULTS: Ten trials involving exercise interventions ranging between 2-12 months were included. The combined results of four RCTs consisting of 171 participants showed a reduction in CIPN symptoms in women who exercised versus usual care controls (standardised mean difference -0.71, 95% CI -1.24 to -0.17; p=0.012; moderate-quality evidence, I2=76.9%, (p<0.001)). A meta-analysis which included data from six RCTs with 609 participants showed that exercise interventions before and/or during taxanes-containing chemotherapy improved HR-QoL (SMD 0.42, 95% CI 0.07 to 0.76; p=0.03; moderate-quality evidence, I2=49.6% (p=0.06)). There was no difference in cancer-related fatigue between exercise and usual care groups (SMD -0.39, 95% CI -0.95 to 0.18; p=0.15).

CONCLUSION: This systematic review found reduced levels of CIPN symptoms and an improvement in HR-QoL in women with breast cancer who exercised before and/or during taxane-based chemotherapy versus usual care controls. This evidence supports the role of exercise as an adjunctive treatment for attenuating the adverse effects of taxane-containing chemotherapy on CIPN symptoms and HR-QoL.

ASSOCIATION BETWEEN SELF-REPORTED HEALTH MONITORING OUTCOMES WITH QUALITY OF LIFE IN PATIENTS WITH BREAST CANCER INVOLVED IN HIGH INTENSITY INTERVAL TRAINING DURING CHEMOTHERAPY

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INTRODUCTION: During chemotherapy patients with breast cancer (BC) often exposed to physical discomfort, sleep disturbances, psychological and emotional stress that adversely effects their quality of life. Physical exercise interventions for patients with BC may reduce fatigue, decline of functional skills, improve physical fitness, self-esteem and quality of life. Traditionally, quality of life is assessed before and after intervention, while no studies have explored association between health symptoms and overall quality of life of patients with BC involved in high-intensity interval training (HIIT) throughout the NT therapy. In this study we examined the relationship between quality of life and weekly self-reported health monitoring outcomes in women with BC participating in HIIT during NT.

METHODS: Fifteen women (mean age 47.40, SD = 8.38 years) with newly diagnosed breast cancer (stage II and III) and prescribed neoadjuvant chemotherapy were randomized to HIIT group (n= 8) and control group (CG) (n = 7). The HIIT group participated in 4x4 min interval walking training at 85–95% HRmax with 3 min of active resting periods at 70% HRmax between each interval 3x/week for 6 months. All participants completed the European Organisation for Research and Treatment of Cancer questionnaire (EORTC QLQC30) with the BR module supplement (BR23) before and after the study. In addition, weekly self-reported health monitoring was applied by using online survey including seven questions related to physical and psychological complaints, pain, fatigue, social life and side effects of the chemotherapy.

RESULTS: After NT treatment the HIIT group in total presented 32 (28%) high significant correlations between weekly health monitoring and quality of life outcomes. For example, the psychological and social health variables presented high significant correlations with eight EORTC QLQC30, BR23 subscale outcomes related to Symptom Scale (r = -.826, p =.001; r = -.970, p = .00, respectively), Functional Scale (r = .862, p = .006 and r = 814, p = .014, respectively), Body Image (r = 723, p = .043 and r = .723, p = .043), NT Side Effects (r = -.934, p = .000 and r = - 852, r = .006) and Breast Symptoms (r = -.814, p = .014 and r = -.951, p = .000, respectively). In opposite, CG presented only one significant correlation between the weekly social health variables and Social Scale of the EORTC QLQC30 (r = -.971, p = .001).

CONCLUSION: HIIT improved health, reduced side-effects of NT and contributed quality of life of patients with BC during six months of the neoadjuvant chemotherapy in patients with breast cancer.

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SUGGESTED TARGETS FOR IMPROVING EXERCISE INTERVENTION COMPLETION IN CANCER PATIENTS – AN INDIVIDUAL PATIENT DATA META-ANALYSIS FROM THE POLARIS STUDY

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INTRODUCTION: Physical activity has been associated with reduced cancer morbidity and mortality, improved health, reduced treatment side effects, and better quality of life in patients with cancer. Targeted exercise prescriptions accounting for individual prerequisites have been called for to support physical activity promotion in the cancer follow-up and to ensure feasibility of exercise programs. Exercise intervention effectiveness and feasibility depends on the participants' ability to complete the interventions. Patients with cancer not completing exercise interventions are often insufficiently assessed and dropout rates differ considerably between studies. The objective of the present study was to assess which participant- and intervention characteristics were associated with non-completion across different exercise interventions in patients with cancer.

METHODS: We used harmonized individual patient data from the intervention arms of 34 RCTs (n= 2487) investigating effects of exercise in patients with cancer treated with curative intent, available through the POLARIS database. Participant characteristics included age, sex, educational level, body mass index (BMI), and cancer type. Intervention characteristics included intervention timing, exercise type, exercise intensity, supervision, number of weekly exercise sessions, exercise session duration, and intervention duration. An adjusted logistic regression model was used to study associations with non-completion in the total sample. A decision tree was further applied to assess interactions between variables resulting in the greatest separation of intervention completers and non-completers.

RESULTS: In the total sample, post treatment interventions (OR 2.5, p<0.01)), durations >6 months (OR 3.2, p<0.01), resistance (OR 7.5, p<0.01) and mixed exercise (OR 4.6, p<0.01), BMI (OR 1.06, p<0.01), and low-medium education (OR 1.6, p<0.05) was positively associated with non-completion of exercise interventions. The decision tree split the sample on BMI 28.4, intervention timing and intervention duration, resulting in four distinct subgroups. In participants with BMI ≤28.4, non-completion was 5.1% in patients exercising during treatment and 9.8% in patients exercising post treatment. In participants with BMI >28.4, non-completion was 10.8% in patients assigned to interventions lasting ≤6 months and 20.7% for durations >6 months.

CONCLUSION: Significant associations with non-completion were observed for intervention timing, intervention duration, exercise type, BMI and education. BMI, and intervention timing and duration divided the sample into subgroups with the highest and lowest levels of non-completion ranging from 5.1-20.7%. These associations may have implications for the feasibility and effectiveness of exercise interventions in patients with cancer. Approaches to facilitate completion should be further assessed in cancer patients with high levels of non-completion, informing the development of tailored exercise prescriptions.

CANCER-RELATED FATIGUE OF BREAST CANCER PATIENTS IS MAINLY CAUSED BY THE EMOTIONAL DIMENSIONS AT DIAGNOSIS: PRELIMINARY RESULTS OF THE BIOCARE FACTORY COHORT

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INTRODUCTION: Cancer-related fatigue (CRF) is defined by persistent and distressing tiredness, and lack of energy associated with cancer and its treatment, that does not subside with adequate sleep or rest, and is disproportionate to recent activity [1]. CRF is multidimensional in its manifestation involving physical, emotional, and cognitive dimensions. Little research has been done to identify the CRF specific dimensions at diagnosis moment. This study aimed to identify correlates of CRF based on sleep disturbance, depression, cognitive ability and neuromuscular fatigability parameters.

METHODS: This study is part of the BIOCARE Factory project, that aims to build a biopsychosocial model of CRF. Fifty-three patients (54±12 years) volunteered to participate in this study. CRF were assessed using the FA12 questionnaire. Patients were classified as 'Fatigued' when the FA12 total score was higher than 22 [2]. Critical force (FCr) of the ankle plantar flexors was determined during an all-out isometric test as the mean force during the last minute (in N.kg-1). Cognitive ability, Depression symptoms and sleep quality were assessed respectively with MOCA, HAD and PSQI questionnaire. The depression and sleep scores were reversed (the higher the better) so being in the same direction as the other variables. Fatigue vs. non-fatigue groups were compared using a T-test. A principal component analysis (PCA) was used to describe the variation of FA12 with a combination of MOCA, Depression, PSQI scores and FCr.

RESULTS: T-tests and PCA revealed that the non-fatigue group was less depressed, sleep better and has fewer cognitive impairments than the fatigue group, the FCr being not different. Principal components 1 and 2 accounted for 33.5% and 30.1% respectively. PCA reveals that Depression and FCr, were independently related on fatigue (orthogonal directions of the PCA).

CONCLUSION: The comparison between breast cancer patients before any treatment, and a healthy population matched in age reveals no difference in the physical dimension of CRF with the FA12 [3]. However, differences between the two populations are observed in the emotional and cognitive dimensions of CRF. Only the depression, The MOCA and the PSQI stand out as significant, unlike FCr. So, neuromuscular fatigability is not a defining feature of CRF at diagnosis although the physical dimension is known to became of major importance after the first line of treatment and in particular after chemotherapy. The heterogeneity of fatigue profiles, as suggesting by the PCA, could be relevant to insist on individualized supportive care according to each profile.

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BEYOND FASTING SUGAR LEVEL IN POSTMENOPAUSAL WOMEN WITH PREVIOUS BREAST CANCER ENROLLED IN THE MOVIS TRIAL (CLINICALTRIALS.GOV IDENTIFIER: NCT04818359) – THE SWEET_MOVIS STUDY

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INTRODUCTION: Breast cancer survivor (BCS) women are at increased risk for developing diabetes and metabolic syndrome compared to cancer-free women [1]. Aerobic exercise is an effective strategy for improving glycemic control; however, the association between exercise and glucose homeostasis in BCS has remained inconclusive [2]. The main aim of this study is to evaluate the effects of a supervised aerobic exercise training program on glycemic control in BCS.

METHODS: Sixteen non-diabetic BCS were randomly assigned to an intervention arm (IA; n = 8) or control arm (CA; n = 8). Both groups received lifestyle recommendations, in addition the IA received a 12-week aerobic exercise training program with a progressive increase of exercise intensity (40%-70% of HRR) and duration (20-60 min). Anthropometric measurements (BMI, weight, waist circumference, % body fat) and metabolic markers (glucose, insulin, triglycerides, LDL and HDL) were analysed at baseline and after the 12-week intervention period. Moreover, food intake and indices of glycemic variability obtained by continuous glucose monitoring (CGM) were analysed in the first and last 14 days of the study intervention.

RESULTS: At the end of the study, the VO2max increased by 2.2% in the CA group (p=0.64) and by 16.4 % in the IA group (p=0.02). The fasted insulin level was reduced in both CA (–34%, p=0.01) and IA (–18.5%, p=0.05) groups. Anthropometric measurements and other metabolic markers did not improve after the intervention period. The caloric intake was increased at the end of the study both in CA (19%, p=0.06) and IA (28.1%, p=0.03). The analysis of 24h CGM data reveals that time spent in hyperglycemic state (glucose >140 mg/dL) slightly increased in the CA group after the intervention period, while it remained stable throughout the study in the IA group. The baseline patients BMI and the improvement of VO2max were strong predictors for the reduction of intraday glucose variability indices.

CONCLUSION: Anthropometric and metabolic parameters were only slightly modified after the 12-week aerobic exercise program in BCS, despite a significant improvement in the cardiorespiratory fitness. The increased caloric intake observed at the end of the study might at least partially explain these findings. Interestingly, the CGM data showed that BCS with high BMI and those who strongly improved their VO2max ameliorated the time spent in hyperglycemic ranges and glucose variability indices.

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Oral presentations

OP-MH13 Health and fitness/Lifestyle

MORNING AND EVENING PHYSICAL EXERCISE PROLONG NON-REM SLEEP: AN ECOLOGICAL STUDY

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INTRODUCTION: Relationship between physical exercise and sleep has received considerable attention with the ultimate goal to promote health and wellbeing [1]. Sleep hygiene guidelines advised to avoid vigorous exercise 3h before bedtime as the increasing of arousal, body temperature and heart rate may disturb sleep quality [1]. Yet, such recommendation is challenged by recent findings that did not find any objective (i.e. architecture) or subjective sleep deteriorations following evening vigorous exercise [2], and some emphasized even positive changes on sleep architecture [3]. Besides, there is a lack of knowledge on the comparison between morning and evening vigorous exercise on sleep features, while morning being the recommended training time [1]. Nowadays, recent advances in ambulatory EEG-sleep technologies provide the opportunity to examine the influence of exercise timing on both combined objective and subjective outputs in daily life context. Here, we investigated whether a vigorous aerobic exercise performed either in the morning or in the evening influences the objective and subjective sleep features in an ecological context.

METHODS: Sixteen recreational runners were tested during two sessions of three successive days separated by a week. Participants had to perform a 45 to 60 min completed-run (70 % VO2) in their own environment either in the MORNING (30 min to 2h after waking up) or in the EVENING (2h to 30 min before sleep); a REST control day separated the two exercise conditions. Sleep was objectively assessed by means of wireless electroencephalography -headband and subjectively using the Spiegel sleep inventory. Actimeters were further used to control both exercise timing and intensity.

RESULTS: As compared to REST, we found that both MORNING and EVENING exercises significantly increased the durations of non-rapid eye movement sleep (NREM, +24.9 min and +22.7 min [p = 0.01], respectively). Such NREM lengthening was mainly due to the increase in sleep stage 2 (N2) duration after both MORNING (+20.8 min) and EVENING (+22.8 min) relative to REST (p = 0.02). No effect of exercise timing was found on the subjective perception of sleep quality.

CONCLUSION: The main finding revealed that independently of the training time (MORNING or EVENING), vigorous exercise extends NREM duration and especially stage N2 duration. Prior studies observed that prolactin and growth hormone secretions occur mainly during NREM, and have been associated to neural and peripheral restoration [4]. This ecological study provide evidence that evening vigorous exercise has no adverse effect on sleep compared to morning exercise and may even adjust sleep architecture required to recover compared to no physical exercise. Because of the numerous health beneficial effects of physical exercise, sleep hygiene guidelines should be updated to promote vigorous exercise regardless the time of the day.

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IMPROVED SLEEP QUALITY AFTER THREE MONTHS OF BALANCE LEARNING IN OLDER ADULTS

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INTRODUCTION: Almost every second adult over the age of 60 reports having sleep problems [1]. Cognitive behavioural therapy and pharmacotherapy are the most commonly employed treatments against insomnia. Unfortunately, these two treatments are either associated with high costs or increased mortality and fall rates [2]. Therefore, there is a need for new effective and affordable treatments without severe adverse effects. An important role for the initiation and maintenance of sleep is attributed to the modulation of cortical inhibition [3]. Moreover, it has been shown that cortical inhibitory control is reduced in older adults compared to younger adults [4]. As intracortical inhibition was enhanced following balance learning in young adults [5], we hypothesized that three months of balance learning would enhance intracortical inhibition in older adults. Accordingly, we also hypothesized that balance learning would improve sleep quality in older adults.

METHODS: Thirty-six healthy volunteers aged 65-85 years were randomly assigned to either follow a three-month balance learning intervention (minimum of 30 training sessions) or to continue with their daily routines. Before and after the three-month period, balance performance and short interval intracortical inhibition (SICI) while balancing on a wobble board were evaluated. Furthermore, sleep quality was assessed before and after the intervention with the Pittsburgh Sleep Quality Questionnaire (PSQI). Differences between pre and post measurements were analysed using paired t-tests and Wilcoxon signed-rank tests.

RESULTS: Balance performance improved significantly after balance learning (decrease of sway area on the wobble board by 29 %, p = 0.005) while SICI measured on the wobble board slightly increased by 5.1 % (+ 42 %, p = 0.066). Most importantly, the overall PSQI score decreased significantly by 1.2 score points (- 21 %, p =0.037), indicating better sleep quality after balance learning. No significant changes were observed for the passive control group.

CONCLUSION: After three months of balance learning, older adults showed an improvement in balance performance, a task-specific upregulation of intracortical inhibition and an improvement in their subjective sleep quality. These results suggest that balance learning improves sleep quality in older adults. Furthermore, enhanced GABA-mediated cortical inhibition might be one of the underlying mechanisms driving this change.

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THE EFFECT OF LONG-TIME ENDURANCE EXERCISE ON SLEEP CHARACTERISTICS IN ELDERLY

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INTRODUCTION: Ageing is associated with changes in sleep characteristics. The senior population generally experience a higher frequency of nocturnal awakenings, lower sleep efficiency and shorter sleep time. Aerobic exercise helps to improve sleep quality, there is a reduced frequency of night awakenings and preservation of the length of sleep stages compared to seniors with a sedentary lifestyle. This study aims to investigate effects of long-term endurance exercise on sleep characteristics in elderly.

METHODS: The study involved a total of 20 healthy male subjects divided into two groups: 1) master endurance runners (MA; n = 10, age range 65–80 years); 2) elderly sedentary (ES; n = 10, age range 65–80 years). The group of master endurance runners involved only the active marathon runners performing more than 150 minutes of running activity in higher intensity (for at least 15 years). Sleep characteristics were measured by the MotionWatch8© wrist-worn actigraphy unit (MW8) (CamNtech; Cambridge, UK). Participants wore the actigraphy on a non-dominant wrist during the entire 10-day period. Obtained data were analyzed by using the MotionWare software. To detect the difference between groups in sleep characteristics including assumed sleep (AS), actual sleep time (AST), immobile mins (IM), sleep efficiency (SE) and fragmentation index (FI), Mann Whitney U-test was used.

RESULTS: Mean AS was 7:42 ± 0:28 h in MA and 6:34 ± 0:49 h in ES. Significant differences were found between the groups (U = 11.5; P = 0.002). Mean AST was 6:33 ± 0:25 h in MA and 5:33 ± 0:45 h in ES. The difference between groups was significant (U = 9; P =0.001). IM was significantly longer in MA (6:39±0:26 h) compared to ES (5:40 ± 0:43 h; U = 10; P = 0.002). Surprisingly, no significant difference was found in SE (MA = 84.53±7.6 % and ES = 82.88±4.08 %; P = 0.218). The FI score was 29.15 ± 14.95 in MA and 30.81 ± 6 in ES. There is no significant difference between these groups either (U = 35; P = 0.2799).

CONCLUSION: As hypothesized, endurance running exercise seems to be an effective tool to maintain sleep duration even when ageing occurs. There was no significant difference in sleep efficiency and fragmentation index. Master endurance runners had significantly longer immobile mins than elderly sedentary.

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THE LIKELIHOOD OF TACKLER SUCCESS WHEN CONTACTING THE BALL-CARRIER AT DIFFERENT HEIGHTS FOR DIFFERENT TYPES OF TACKLES ACROSS YOUTH, SENIOR AND ELITE LEVELS

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INTRODUCTION: Reducing head injury, at all levels, is a top priority for rugby stakeholders and governing bodies. Accordingly, World Rugby and national governing bodies have proposed tackle law changes to lower the height of a legal tackle. Any tackle technique injury prevention strategy that negatively affects tackle performance is not likely to be accepted and implemented by players or coaches. If where the tackler contacts the ball-carrier (i.e. tackle height) is going to be a key tackle injury prevention strategy, its relationship to tackle success needs to be studied at the different levels of play. The purpose of this study was to compare the probability of tackler success when contacting the ball-carrier at different heights for different types of tackles across seven levels of play.

METHODS: Video footage of 271 male rugby union matches were analysed for tackle characteristics across seven independent playing groups (Under(U) 12, n=25 matches; U14, n=35; U16, n=39; U18 Amateur n=39; U18 Elite n=38; Senior Amateur, n=40; Senior Elite, n=50) within England, New Zealand, South Africa, Portugal and USA. This equated to a total of 52 204 tackle events. A logistic regression model with type of tackle, tackle direction, first point of contact, tackle sequence, number of players, and attacker intention as explanatory variables and tackle success as the outcome variable was computed. Based on the model, post-estimation marginal effects were used to determine the probability of success (Pr Tackler Success) for the interaction between type of tackle (arm, active shoulder, passive shoulder, smother) and the first point of contact (head/neck, shoulder, mid-torso and legs). Differences between Pr margins were also calculated, with the a priori alpha level set at $p<0.05$.

RESULTS: Within senior elite, senior amateur, U18 amateur, U14 and U12, for all four types of tackles, the probability of success did not significantly change ($p>0.05$) when contacting the head/neck compared to the other points of contact (for instance, for active shoulder tackles within senior elite: head/neck Pr 0.84 95% CI 0.86-0.89; shoulder Pr 0.87 95% CI 0.86-0.89, mid-torso Pr 0.83 95%CI 0.81-0.85, legs Pr 0.81 95%CI 0.79-0.83). For tackles within the legal tackle height, irrespective of type of tackle, the contact point with a high probability of success at all levels was the shoulder (for instance, at the senior elite arm Pr 0.75 95% CI 0.74-0.77; active shoulder Pr 0.87 95% CI 0.86-0.89, passive shoulder Pr 0.84 95%CI 0.82-0.86, smother Pr 0.86 95%CI 0.84-0.87).

CONCLUSION: Contacting the head/neck area does not benefit tackling performance and contacting lower areas of the ball-carrier has a higher likelihood of tackler success. These findings complement video analyses studies on tackle injuries. Knowing that contacting the head/neck area does not benefit the tackler's ability to succeed strengthens and supports injury prevention initiatives that is aimed at encouraging players to contact the ball-carrier lower.

Oral presentations

OP-BM26 Kinematic

EFFECT OF COMPUTING JOINT ANGLES IN 2D OR 3D DURING FATIGUING DOUBLE POLING CROSS-COUNTRY SKIING EXERCISE

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INTRODUCTION: Human movement typically occurs in all three planes in three-dimensional (3D) space, and it is often recommended to use 3D analysis when studying kinematics such as joint angles. In movements that appear to be uniplanar, e.g., cycling (sagittal plane), the difference between computing the knee angle using 3D or 2D (sagittal plane) kinematics is trivial. In double poling (DP) cross-country (XC) skiing, most of the movement appear to take place in the sagittal plane but considerable movement occur also in the other planes. However, much of the XC-skiing literature on kinematics are inconsistent and unclear in the reporting of how joint angles are computed, and both 2D and 3D analyses are used. It is likely that kinematic results presented across studies are affected by whether 2D or 3D analyses were performed. The purpose of this study was to examine the difference between XC-skiing kinematics obtained using 2D and 3D methodology. In addition, we examined if a possible fatiguing effect exists on kinematics and whether this effect is dependent on methodology.

METHODS: Nine XC-skiers performed 2 h of continuous roller skiing on a large treadmill, utilizing the DP technique only. Each skier performed at an individual constant speed of 65% of their DP VO2peak (at 6% incline). Motion capture (Qualisys, 100 Hz) tracked reflective markers for ~60 s for each 20 min of the 2 h protocol. Ankle, knee, hip, shoulder, and elbow

joint angles were computed using both 2D and 3D kinematics1,2. Linear mixed models were fitted, with participants as random effects (intercept only), and method (2D vs 3D) and time as fixed effects.

RESULTS: For sagittal plane range of motion (ROM), there were no interaction effects between time and method for any joint (all p>0.6). There was a significant effect of fatigue on ROM for the hip joint (p=0.046), with reduced ROM (~2-3deg), with no effect of fatigue on any other joint. The 2D yielded slightly smaller sagittal plane ROM for the ankle and knee (both ~2-3 deg, p<0.001), while it yielded considerably larger sagittal plane ROM for the hip (~25 deg), shoulder (~10 deg) and elbow (~9 deg, all p<0.001). In the frontal plane, there was a large effect of method on (abduction-adduction) ROM for the shoulder, (p<0.001), with 2D yielding ~47 deg larger ROM, while there was no effect of fatigue here.

CONCLUSION: These results indicate that computation method used (2D or 3D) in the study of XC-skiing kinematics may have a major impact on the calculated joint angles. However, we found no interaction effects between method and fatigue, which suggest that the differences due to method are not dependent on fatiguing exercise. Further, we found only small effects of fatigue in general, with joint angles becoming somewhat smaller over time. Both science and practice must take computation method used into account when comparing XC-skiing kinematics across studies.

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ESTIMATING ABSOLUTE 3D HUMAN POSE ESTIMATION WITH INDIVIDUAL BODY SHAPE INFORMATION FROM A SINGLE CALIBRATED CAMERA

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INTRODUCTION: Accurate sports biomechanical analysis often requires an understanding of joint locations. Conventionally, this was typically achieved by the use of multiple cameras to measure 3D joint locations. Recently, advanced machine learning techniques have been developed to estimate 3D human poses from images captured from a single camera. However, this kind of method usually does not consider the individual body shape information thoroughly. As a result, only joint rotation can be obtained. The accurate absolute joint position including the body translation cannot be acquired for sports biomechanical analysis. This research aims to examine whether absolute 3D human pose can be estimated from the image captured by a single calibrated camera with known body shape information.

METHODS: The BML-MoVi dataset (Ghorbani et al., 2021) was used to generate data to evaluate the developed method. This dataset, acquired from the Archive of Motion Capture As Surface Shapes (AMASS) database (Mahmood et al., 2019), includes 3D joint positions, joint rotations, and body shape information for 86 participants performing different movements. The 2D pose estimation results were generated by projecting 3D joint points. The non-translated 3D joint locations were estimated using the deformable human models with inputted joint rotations and body shape information. The body translations were predicted from these 2D pose estimation results and non-translated 3D joint locations using the pose computation techniques. The mean error between the ground truth and the predicted absolute 3D joint location was calculated to determine the performance of the developed method.

RESULTS: The mean error between the ground truth and the prediction with body information is 0.018 m which is better than the performance of the estimation with mean body shape (0.023 m) and random body shape (0.063 m). The findings suggest that considering body shape information can improve the absolute pose estimation with the accuracy of 3D joint locations.

CONCLUSION: The results showed that incorporating body shape information can enhance absolute 3D human pose estimation from the images captured by a single calibrated camera. Further tests with real-world data are necessary to investigate the effect of error in joint rotation on the accuracy of the developed methods.

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ANALYSIS OF KEY KINEMATIC FACTORS AFFECTING PERFORMANCE OF MENS SINGLE 10M PLATFORM 109C

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INTRODUCTION: To analyze the correlation and regression results of kinematic parameters and performance in each stage of 109C, and to determine the key kinematic parameters affecting the performance of mens single 10m platform 109C.

METHODS: Three digital 4K all-in-one recording machines (Sony FDRAX700) were used to shoot the 109C movements of 6 high-level mens single 10m platform divers with two-dimensional fixed points, and the Fastmove 3D Motion analysis system was used to analyze the 21 human body points frame by frame. The coordinates and kinematic parameters of the human body in two-dimensional space are obtained.

RESULTS: The overall movement time in the air had a significant positive predictive effect on the 109C score (t = 7.842, P < 0.01), while the average time of the somersaults had a significant negative predictive effect on the 109C score (t = -2.817, P < 0.05).

CONCLUSION: The time in the air and the average time of the four somersaults are the key kinematic parameters affecting the mens single 10-meter platform 109C diving score. Increasing the take-off height is the key to extending the time in the air. The average time of the four somersaults is an important part of the time in the air. Thus, it is extremely important to shorten the average time of the four somersaults to improve the performance of the 109C movement.

INFLUENCE OF A SOFT-BACK EXOSKELETON ON TRUNK KINEMATICS AND MUSCLE ACTIVITY DURING SIMULATED ORDER PICKING

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INTRODUCTION: Due to required handling flexibility in intralogistics, most of the working tasks in this field, such as palletizing, are performed manually [1]. However, low back pain (LBP) risk factors are associated with this type of task, i.e repetitive lifting, forward bending and heavy weight manipulation. The use of exoskeletons might be a solution to reduce the prevalence of LBP [2], and could reduce kinematics and muscular stress during manual palletizing [3].

The aim of this study was to evaluate the effects of an exoskeleton during a simulated manual palletizing task on trunk kinematics and neuromuscular activity.

METHODS: Eight male volunteers performed a simulated manual palletizing task with the soft-back exoskeleton CORFOR® (EXO) and without (FREE), using two different lifting techniques as usually found in the industry, i.e the STOOP and SQUAT techniques. This exoskeleton is made of a pair of elastic bands attached to shoulders and knees, stretched during hip and trunk flexion. The participants had to move a 7kg box from one pallet to another for 2 minutes at a rate of 5 handlings/min. Participants were familiarized to the exoskeleton before starting the experiment. The configuration of the task replicated the one typically carried out in the company and a soundtrack recording of the work environment was played during the task execution.

3D kinematics data were collected (Arqus A12, Qualisys, Sweden) to access trunk sagittal inclination (TSI) and trunk angular velocity (TAV). Muscle activity of erector spinae (ES), rectus abdominis (RA), obliquus externus (OE), rectus femoris (RF) and biceps femoris (BF) was recorded with surface EMG (Trigno, Delsys, USA) and their RMS value was averaged over all cycles.

RESULTS: No difference was observed for TSI or TAV during palletizing with EXO compared to FREE.

Also, no difference was found on the ES muscle activity in EXO compared to FREE (p=0.17), despite some slight reductions observed when using the exoskeleton during the STOOP (-4.0 ± 3.3%) or the SQUAT (-5.5 ± 3.6%). During STOOP, OE and RF muscle activities significantly increased in EXO compared to FREE (OE: +23.1 ± 45.8%, p=0.037.; RF: +27.2 ± 43.6%, p=0.048).

CONCLUSION: The lack of influence of the CORFOR® exoskeleton on ES muscle activity might be explained by the complexity of the manual palletizing task, involving motions out of the sagittal plane, and therefore reducing the effectiveness of its designed assistance through the elastic bands. However, the CORFOR® exoskeleton did not alter trunk kinematics. The increase of OE and RF muscle activities with EXO during STOOP could be due to the additional effort participants had to make to stretch the exoskeleton while bending the trunk forward. Further evaluations over a longer period of time should be carried out to confirm these results.

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COMPARISON OF PEAK LUMBAR LORDOSIS BETWEEN SOME TYPICAL SKILLS OF WOMENS ARTISTIC GYMNASTICS

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INTRODUCTION: Back pain is prevalent among gymnast populations (1). One of the known risk factor is the repetition of lumbar hyperextensions which increase intervertebral stress and may lead to acute lumbar spine traumatic events or overuse injuries (2,3). A better understanding of the risks associated with each gymnastics skill would help to preserve gymnasts' health. From the hypothesis that extreme lumbar lordosis (LL) would be associated with low back injury risk, this study aimed at quantifying the maximum of LL reached in five typical floor skills of womens artistic gymnastic (split leap, front handspring, round off back handspring, front and back walkovers) performed by seven national level gymnasts.

METHODS: Data collection involved a motion capture session (one static acquisition in upright standing posture and one to five successful trials of each skill), 82 reflective markers being placed on the skin of the subject. Then, a micro-dose biplanar radiograph (EOS system) in neutral standing posture was done, with the subject still equipped with the markers, allowing both bones and markers to be seen on the radiographs (4).

To get 3D kinematics of the spine during gymnastics skills, a full body kinematic model, previously developed with Opensim software (5), and fed by motion capture data was used (4). This generic model having a fully articulated spine, was scaled and personalised to each gymnast for the thoraco-lumbar spine and the pelvis from bones 3D reconstructions based on EOS images (4). Joints and bodies kinematics were determined using OpenSim multibody kinematics optimization algorithm (4,5). The LL, defined as the angle between the sacral endplate and the first lumbar vertebra was then calculated throughout each trial. Peaks of LL were extracted. Non-parametric statistical tests for paired data of Wilcoxon (rank sum test) were conducted, with a significance level at 0.05.

RESULTS: The skills requiring the most lumbar extension were the front and the back walkovers (mean LL: 106°±23° and 103°±21°, respectively) followed by the back handspring (96°±14°), the front handspring (93°±16°) and finally the split leap (88°±15°). High variability can be observed between the gymnasts in particular for skills requiring the most lumbar extension. Peaks of LL were not significantly different between skills at the threshold of 0.05 (p-values ranging from 0.06 to 0.31).

CONCLUSION: Skills requiring the most lumbar extension were identified but more gymnasts would be necessary to conclude with significant differences. In addition, another identified risk factor for back pain in gymnastics is ground impact (1,3). However, these first results may help coaches and medical staff to build more spine friendly training sessions.

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Oral presentations

OP-SH27 Ageing

ACTIVELY RESPOND TO THE AGING POPULATION: THE CHARACTERISTICS AND INFLUENCING FACTORS OF PHYSICAL ACTIVITY OF THE ELDERLY IN CHINA

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Actively Respond to the Aging Population: the Characteristics and Influencing Factors of Physical Activity of the Elderly in China

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Introdution:

Promoting the physical activity level of the elderly is an important measure to actively respond to the aging population in the new era. In order to improve the development level of physical activities of the elderly, it is necessary to fully understand the characteristics and related factors of activities of the elderly in China, and provide strategic basis for promoting the health of the elderly

METHODS: This study was based on 20897 survey data from the 60-90 year old people in 2020 Physical Activity Survey. The elderlys exercise type, physical activity level, individual cognition and PA support environment are analyzed, and the factors affecting the elderlys participation in PA are analyzed by regression model.

RESULTS: 1) 48% of the elderly participated in exercise at least once a week, and 26.1% of the elderly participated in exercise at least three times a week; the exercise intensity of the elderly is mainly of moderrate intensity, and the duration is concentrated in 30-60 minutes. The most popular PA items are walking and running, and Square Dance is the most popular among urban elderly women.

2) There are differences between urban and rural areas, gender, and age and exercise behavior in the cognitive level of physical activity of the elderly, which are the important factors to promote the elderly becoming active.

3) About 70% of the elderly live in the "15-minute fitness circle" built by the government. The elderly take part in exercise organizations and activities with the characteristics of "being around". Less than half of the elderly have received exercise guidance, of which about 10% have received professional guidance;

4) The elderly who live in a 15-minute fitness circle, participate in exercise organizations, and have received guidance are 2 to 3 times more likely to be active in physical activities than those who are not active in physical activities.

CONCLUSION: The physical activity of the elderly in China is becoming more and more active. In order to further improve the activity level of the elderly, it is suggested that developing the strategic layout of physical activity in Life Circle of the elderly, strengthening the supporting environment for convenient to participate in exercise, and improving the cognitive level of individual exercise.

THE ASSOCIATION BETWEEN SOCIAL PROVISIONS AND PHYSICAL ACTIVITY LEVELS IN SENIORS LIVING IN RESIDENTIAL HOMES: A TEN MONTHS OF FOLLOW-UP.

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Introduction.

The coronavirus disease 2019 (COVID-19) has adversely affected seniors social contact and physical activity (PA) levels. Social isolation due to the COVID-19 pandemic has been a health determinant for seniors living in communities. Keeping seniors active and independent through PA practice during the pandemic can improve health and well-being and reduce health risks in this population. Social provisions are a psychosocial determinant of health that may improve PA in seniors and reduce their sedentary behaviour time, but this association has yet to be studied. This study investigated the relationship between PA, social provisions, and sedentary time among seniors during the COVID-19 pandemic.

Methods

This study was ten months of follow-up. Participants (N=27; 82% women) were seniors between 60 and 94 years (M=82.3, SD=8.96) living in aged care residences. Participants completed a questionnaire on the Social Provisions Scale: emotional support, social integration, reassurance of worth, tangible help and orientation. Seniors wore an accelerometer at the beginning of the intervention, at the three-month mark, and at the end of the study. Data analysis included three mixed models. The first model determines the relationship between sedentary behaviour and social provisions variables. The second established the relationship between low-light physical activity and social provisions. The third indicated the relationship between high light physical activity and social provisions.

Results

Seniors with high levels of reassurance of worth were the ones who most significantly reduced the time spent in sedentary behaviours ($p \leq .05$). In the case of physical activity behaviours, seniors who felt emotionally supported had higher levels of low-light physical activity. There was no relationship between high light intensity and social provisions.

Discussion

In order to have a more active and healthy ageing population, it is vital to investigate ways to increase physical activity levels and reduce sedentary behaviours in older adults.

This study on the relationship between physical activity and sedentary behaviours objectively measured, and social provisions highlight the importance of psychosocial factors.

Seniors with higher reassurance of worth were likelier to spend less time in sedentary behaviours. Identifying whether this feeling comes from family, friends, nursing home staff, or other residents is essential.

Emotional support represents emotional closeness from which one derives a sense of security. Thus, it is understandable that this factor has played an essential role in the levels of light physical activity. Seniors describe security as manageable living conditions where they achieve a good end of life, balancing dependency and independence.

Interventions to reduce sedentary behaviour and increase physical activity in seniors who live in a care residence should consider these factors.

PARTICIPATION IN OCCUPATIONAL HEALTH-PROMOTION PROGRAMS IN NURSING HOME FACILITIES: THE ROLE OF OCCUPATIONAL AND PERSONAL FACTORS

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INTRODUCTION: As a result of the growing ageing population, the need for nursing staff has increased significantly. Nursing staff in nursing home facilities are exposed to demanding occupational conditions, which can lead to job fluctuations, might promote unhealthy behaviour or sickness. In addition, mental and musculoskeletal disorders are prominent in this occupational field. Occupational health promotion interventions are offered to counteract this unfavourable trend; however, participation is limited. Overall, it is known that company size and sex have an influence on participation in occupational health-promotion programs. Further, different physical load, psychological stress, culture of the facility and personal factors have been shown to affect health outcomes. The factors that favour or reduce participation in health-promotion programs among nursing staff have not been analysed. Consequently, we aimed to investigate which factors have an impact on nurses participation in health-promotion programs.

METHODS: This cross-sectional study was conducted in 47 nursing home facilities in Germany, between April 2017 and March 2020. After recruitment and the baseline assessment, participants randomly were allocated to an ergonomic and posture training and/or the subsequent back-fitness training program. Participation was assessed using a questionnaire administered after the intervention. A logistic regression was used to identify factors that influence participation. Psychological stress, physical load, working environment as well as institutional and personal factors were included in the analysis.

RESULTS: Overall 310 nurses (mean age = 42.3 ± 11.7 years, female = 77.1%) were included in the analysis. 39,4 % of the subjects did participate in the program. The regression model was statistically significant, explaining 18.3% of the variance, and predicting 64.3% of the cases correctly. The regression indicated that variations in participation depended on psychological stress (OR = 0.338), psychological demand (OR = 0.694), work atmosphere among colleagues (OR = 0.727), physical activity resources (OR = 0.750), and information-sharing and co-determination rights in the workplace (OR = 1.456).

DISCUSSION:

The results showed that psychological stress, good occupational communication and co-determination negatively affected participation. Good team cohesion and a high level of personal physical activity resources favour participation. As we explained only 18.3% of the variance, other barriers, such as personal intentions and other occupational factors such as specific barriers in the occupational sector, should be analysed in further studies to provide a comprehensive picture of health promotion program implementation. Similarly, the programs should be analysed more closely in order to assess whether intervention components have an impact.

OLD DOGS CAN LEARN NEW TRICKS! RE-ANALYSIS OF BBC UK DATA COMPARING THE EFFECTS OF BRIEF PSYCHOLOGICAL SKILLS TRAINING BY AGE

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Almost worldwide, both the numbers and percentage of older people are rapidly increasing. Ageing comes with an inevitable decline in our physical and mental capacity. Government agenda in many countries has focussed on encouraging healthy ageing and to look toward maintaining the quality of life as people age. The present study considers this issue and does so by re-examining data from a largescale project that investigated the effects of brief psychological skills training on performance (Lane et al., 2016). Using an online performance test which required participants identify numbers in a randomly assorted grid as quickly as possible, Lane et al. (2016) found watching a training video of <2 mins led to improved performance over the control group. Each training video was presented by former Olympian Michael Johnson, a successful athlete who delivered persuasive messages (see Lane et al., 2021).

In the present study data were grouped into one of 4 groups and data were analysed by comparing baseline data against post intervention data. We compared active psychological skills training, where participants learned one of 12 different interventions – imagery, self-talk, and if-then planning which were focused on an outcome goal, process goal, skill instructions, and arousal regulation against a no-treatment data. The control group were a no-treatment group that emerged from participants who skipped doing the intervention (Lane et al., 2021). It is expected that younger participants would attain a higher score (find more sequential numbers within the time provided) than older participants. However, we tested the extent to which the age would influence the effects of following the intervention, an intervention which we knew was positive (Lane et al., 2016, 2021).

We analysed data from the extended sample of 74,205 (Age: M = 34.65, SD = 14.11) with 46,819 participants in the intervention group and 13,864 in the no-treatment group. In terms of age-group membership, 27,299 were in the 16-29 age group, 23,483 aged 30-49 years, 9,259 aged 50-67 years, and 642 in the 68-92 years age group. Repeated measures ANOVA results indicated no significant 2-way interaction effect for differences in performance by intervention-control and age group. As expected, younger participants were significantly faster at identifying sequential numbers than older participants. However, the absence of a significant interaction for older participants indicates that they also benefited from engaging in brief psychological skills training.

As psychological skills are associated with enhanced performance and range of positive mental health outcomes, finding offer encouraging results for focusing future work on teaching psychological skills to elderly participants. We suggest future research considers developing and testing brief interventions that target elderly participants to examine if learning effects can be enhanced for the benefit of physical and mental health.

INSUFFICIENTLY PHYSICALLY ACTIVE ELDERLY ADULTS: CHARACTERISTICS AND FACTORS INFLUENCING INCREASED PHYSICAL ACTIVITY

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Introduction

The need to promote healthy and active aging is crucial both for individuals and society, and is also emphasized in the global development goals. One way to enhance healthy aging is through regular physical activity. There is extensive research on the motivations for exercise among younger and middle-aged individuals. However, what motivates elderly adults is not as well investigated. Hence, it is particularly important to investigate what characterizes elderly adults who are insufficiently physically active and what factors that are influencing them to become more physically active.

Methods

Using a questionnaire with a mix of validated instruments (e.g., Godin-Leisure-Time Exercise Questionnaire; EQ-5D) and self-constructed questions (e.g., what would make you more physically active?) data from 242 elderly adults (65-100 years; female 70%), living in senior safety housing in Sweden were collected.

Results

The results indicated that the majority of elderly adults were physically active enough from a health perspective, but also that a significant proportion (25%) were sedentary or insufficiently physically active. Furthermore, it was found that those belonging to the group of insufficiently physically active i) reported having lower health ii) reported lower socioeconomic status, and to a greater extent iii) lived alone, iv) needed assistive devices, and v) required home care. Additionally, the results showed that those who were insufficiently physically active would like to be more physically active provided that the activities are available in close proximity to their home, if they have the opportunity to engage in the activities with someone, if the activities have low or no costs at all, and/or if they receive support from educated and competent staff who can demonstrate how to perform the activities without risking their health.

Discussion

Based on these results, suggestions for interventions that could promote the insufficiently physically active elderly adults are discussed, such as organizing activities close to seniors homes, starting up regular walking groups, establishing accessible and adaptable gyms both indoors and outdoors, adapting activities to meet mobility needs, training staff to coach the elderly in physical activity, and sports clubs engaging in outreach activities.

Oral presentations

OP-SH09 Cognition II

AN ACUTE BOUT OF ORIENTEERING ENHANCES HUMAN COGNITION

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Introduction: Exercise can augment human cognition and its effects may be additive when combined with a cognitively challenging task. Orienteering is a sport that simultaneously combines high-intensity exercise with spatial navigation, and expert orienteers report greater hippocampal-dependent memory than non-orienteers (Waddington & Heisz, 2023). The present study examined whether lactate mediates the acute effects of orienteering on hippocampal cognition. Research in animal models suggests that the lactate produced by contracting muscles during high-intensity exercise increases brain-derived neurotrophic factor and improves cognition (El Hayek et al., 2019). Therefore, it was hypothesized that orienteering at a higher intensity would increase lactate and boost cognition more than orienteering at a moderate intensity.

Method: Recreationally active, healthy young adults (N = 38, Mage = 20.8 ± 2.5 years) with no orienteering experience were recruited to navigate an outdoor orienteering course while exercising at a high (80-85% of HRR) or moderate (40-50% of HRR) exercise intensity. A control group engaged in high-intensity exercise without navigation to test for the additive effects of orienteering above that of exercise alone. Lactate was measured throughout the acute session and the measurement taken at the end of the course was analyzed. Immediately before and after the acute session, spatial memory was assessed using the Groton Maze Learning Test.

Results: High-intensity exercise with (5.2±2.5 mmol/L) or without orienteering (5.3±2.4 mmol/L) increased lactate more than moderate-intensity orienteering (1.7±1.3 mmol/L). Higher lactate correlated with better spatial memory ($r(36) = .35$, $p = .015$). The largest percent change in spatial memory was observed for the high-intensity orienteering group (35±45%) over high-intensity exercise without orienteering (27±35%) and was lowest for moderate-intensity orienteering (16±24%).

Discussion: These preliminary results suggest that lactate may drive the acute effects of exercise on human cognition and that combining high-intensity exercise with navigation via orienteering may improve spatial memory more than high-intensity exercise alone.

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EFFECT OF MOTOR COMPLEXITY ON COORDINATIVE EXERCISE-INDUCED ACUTE CHANGE IN PROACTIVE CONTROL

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Introduction

Recent studies have shown that acute exercise can temporarily improve cognitive control, with evidence suggesting that manipulating exercise doses such as intensity and duration can moderate these changes. However, it is not yet clear if the level of motor complexity involved in exercise also affects this outcome. This is interesting given that some research suggests that exercises requiring complex motor skills (i.e., coordinative exercises) may enhance cognitive control more effectively. This study thus aims to investigate if motor complexity level of coordinative exercise moderates the acute change in proactive control and uses event-related potential (ERP) to examine the underlying neurocognitive mechanisms.

Methods

Forty-four college students were recruited and randomly assigned to a low complexity coordinative exercise (LCCE) group (n = 22, mean age = 19.9 ± 1.3) or a high complexity coordinative exercise (HCCE) group (n = 22, mean age = 21.5 ± 1.8). The exercise complexity was manipulated by two difficulty levels of drills using a rope ladder. Behavioral and ERP outcomes during a cognitive control task (i.e., AX-CPT task) were measured before and after a 20-min exercise intervention. The proactive behavioral index (PBI) and the early contingent negative variation (CNV) were used to evaluate the changes in proactive control process at the behavioral and neural levels, respectively.

Results

Our results revealed that the LCCE group exhibited a decrease in PBI from pretest to posttest, suggesting weaker use of proactive control. On the other hand, the HCCE group showed maintained PBI following exercise. Further, the HCCE group exhibited a larger early CNV amplitude for the condition requiring higher level of proactive control compared to the LCCE group in the post-test stage, suggesting an enhancement in the neural processing related to proactive control. In contrast, LCCE group showed a trend of decreased CNV amplitude from pretest to posttest, reflecting a weaker engaging in proactive behavior.

Conclusion

We concluded that increasing motor complexity during exercise may induce acute effect on the proactive control process, as reflected by a stronger neural index of proactive control, and result in stability in the index of cognitive processes underlying proactive behavior. Taken together, our findings suggest the potential benefit of engaging in coordinatively-challenging physical activity for preventing failure to proactively recruit goal-relevant information.

ENVIRONMENTAL ENRICHMENT MODULATES AEROBIC EXERCISE-INDUCED CHANGES IN NEUROCOGNITIVE PROCESSES ASSOCIATED WITH COGNITIVE CONTROL

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Introduction

The Adaptive Capacity Model suggests that combining an engaging environment with aerobic exercise enhances cognitive benefits. However, the effect of environmental stimulation on exercise-related cognitive benefits is unclear. Thus, this study aimed to address this issue directly through a randomized controlled trial (RCT).

Method

Forty-two participants were recruited and assigned randomly to two groups: an outdoor exercise group (OE, n = 21, aged 21.14 ± 1.01 years) and an indoor exercise group (IE, n = 21, aged 21.43 ± 1.33 years). Both groups participated in a 5-km moderate-to-vigorous run, 3 times a week for 4 weeks. Specifically, the IE group ran on a treadmill, while the OE group ran outdoors, with the route being manipulated to increase cognitive engagement during exercise. The effects of exercise on aerobic fitness and cognitive control were measured using a Progressive Aerobic Cardiovascular Endurance Run (PACER) test and a flanker task with concurrent electroencephalography (EEG) recording.

Results

The results showed that both groups improved aerobic fitness while the OE group had faster reaction time and lower accuracy after the exercise intervention, possibly due to the speed-accuracy tradeoff. In contrast, the IE groups performance remained similar level between pre- and post-tests. Further, EEG results showed that the OE group had smaller frontal-midline theta power in the condition involving higher level of cognitive control compared to the IE group after the intervention, indicating that the OE might lead to consuming less degree of cognitive control while processing conflicting information.

Discussion

In summary, our findings indicate that the exercise environment can have a moderating effect on exercise-induced cognitive changes. This supports the Adaptive Capacity Model that emphasizes the role of the exercise environment in optimizing cognitive benefits through physical exercise.

INHIBITORY CONTROL IN ELITE YOUNG SOCCER PLAYERS: A PROPENSITY-SCORE MATCHED CROSS-SECTIONAL STUDY

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INTRODUCTION: Inhibitory control is suggested to be critical for success in soccer since players are required to stop inappropriate or ongoing movements, to suppress irrelevant or interfering information and to keep their attentional focus on what is most important. A few studies have in fact found that adult and youth elite players outperform non-elites in response inhibition ranging from medium to large effects. In order to further substantiate these findings, we compared the Stop-Signal Task performance of the top Austrian youth soccer players with a carefully matched sample of lower-league players within the framework of an fMRI study.

METHODS: The study included 28 (16.9±0.5 yrs of age) out of 32 male field players of the highest national soccer talent program and 30 (16.9±0.5 yrs) non-elite peers. For the reference sample, 115 players of 21 local-league clubs were preselected and 71 of them who regularly trained and competed but never had been part of any development program were matched by the logistic propensity score according to their exact age, training years, education and video gaming. The Stop-Signal Task created and evaluated in accordance with the consensus paper (1) was conducted during the fMRI scans. To get familiar with the tracking procedure, all subjects completed the same task more than 4 weeks prior to the scans in an online version and another 1-2 weeks prior to that in a shorter version without stop-signals to get the baseline RT.

RESULTS: During task-based fMRI, elite and non-elite players showed similar stop-signal RT (183±32 ms vs 188±24 ms: p=.505) and RT on go trials (340±34 ms vs 344±27 ms: p=.695) with trivial effects (SSRT: d=0.176; RTgo: d=0.104). Two-sided Bayesian t-tests (with a Cauchy prior centred at zero and a scaling parameter of 0.707) revealed moderate evidence in favour of H0 (SSRT: BF01=3.1; RTgo: BF01=3.5). In contrast, elite players outperformed non-elites during familiarization with 23 ms faster SSRT (228±41 ms vs 250±32 ms: p=.037; d=0.622; BF10=1.8) and 28 ms faster RTgo (390±59 ms vs 418±41 ms: p=.058; d=0.561; BF10=1.3) and showed a trend towards faster baseline RT (348±39 ms vs 367±36 ms: p=.071; d=0.496; BF10=1.1).

CONCLUSION: The comparable response inhibition performance of the best national youth soccer players and their matched non-elite peers contradicts previous findings of better stop-signal inhibitory control in elite players than in lower-level athletes. Such differences were only apparent in our study when the players completed the task for the first time, despite the fact that detailed instructions, block-based feedback and a practice block prevented proactive, progressive and post-error slowing. In this first run, the included matching variables did not eliminate the group effect. We expect the analysis of the fMRI data to provide insights on whether the behavioural outcomes of the first run are also evident at the neural level in the second test run.

1 Verbruggen et al. 2019

INHIBITION CONTROL TRAINING FOR PERFORMANCE IN SPORT AND OTHER HIGH-PRESSURE CONTEXTS

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INTRODUCTION: Performance in sport and other high-pressure contexts may be adversely impacted as pressure-induced increases in anxiety cause individuals to experience difficulty inhibiting stimulus-driven thought and action. Two pilot experiments – one in soccer and one in a policing context – were conducted to examine whether inhibition control training (ICT) that is conducted under low-pressure circumstances, may help to improve inhibitory performance and prevent negative effects of pressure during (simulated) task performance.

METHODS: Both experiments employed a pretest-intervention-posttest design. Experiment 1 included 12 participants (male soccer players) and examined effects of soccer-specific Go-NoGo training (3x20min sessions; n=6) vs. active control (video watching; 3x20min sessions; n=6), on participant's inhibitory performance during an in-vivo 'stop-signal' penalty shooting task under low- and high-pressure. Experiment 2 included 29 participants (14 male / 15 female; 9 working police officers) and examined effects of home-based Go-NoGo training (3x20min sessions; n=12) vs. passive control (n=17), on muscle activity and performance during a computer-based shoot-don't shoot task under low- and high threat.

RESULTS: Experiment 1 (soccer) showed improved training task performance for the ICT group across the three training sessions (GoRT S1: 701±23ms, S3: 655±36ms, P=.027; NoGo accuracy S1: 79±4%, S3: 93±2%, P=.017). After training, under low-pressure conditions, inhibitory performance during penalty shooting was better for the ICT group than for the active control group (stopping success ICT: 80±10%, Control: 49±10%, P=.067), whereas no between-group difference existed at the pretest (before training; P=.864). At the posttest, inhibitory performance was maintained under high-pressure. Experiment 2 (policing) showed marginal improvement in inhibitory performance during the shoot-don't shoot task for both the ICT and passive control group (NoGo accuracy PRE: 92±1%, POST: 96±1%, P=.038). Significant improvements in Go response times were observed for the ICT group only (GoRT PRE: 423±8ms, POST: 380±8ms, P<.001). Improvements in behavioural responding were largely matched by corresponding changes in task-relevant muscle activity (EMG burst analyses). No effect of threat on inhibitory performance was observed.

CONCLUSION: Across both pilot experiments, findings indicate that inhibition control training can help to improve relevant aspects of task performance in sport and other high-pressure contexts. Within-task effects of training transferred to reflect superior inhibitory performance during in-vivo penalty shooting in soccer (Experiment 1) and faster (correct) responding across a wide range of shoot-don't shoot scenarios (Experiment 2). Future studies with larger sample sizes are required to corroborate the current findings, examine transfer to increasingly realistic task conditions, and consider the durability of observed effects

Oral presentations

OP-MH33 Metabolic fitness/Flexibility

LOW ENERGY AVAILABILITY REDUCE CUMULATIVE MYOFIBRILLAR AND SARCOPLASMIC PROTEIN SYNTHESIS IN TRAINED FEMALES

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INTRODUCTION: Background

Low energy availability (LEA) describes a state where the energy intake is not sufficient to cover the energy costs for exercise and that needed to support and maintain basal body functions. Cross-sectional studies in female athletes have shown that LEA is associated with impaired bone health, endocrine function, and mental health. However, the influence of LEA on skeletal muscle protein synthesis in females performing exercise training is still uncertain. Consequently, we aimed to investigate the impact of 10 days of LEA on cumulative myofibrillar and sarcoplasmic protein synthesis in young trained females.

Methods

Thirty young trained eumenorrheic females were matched in pairs based on training history and randomized into two groups; 10 days of LEA (25 kcal/kg Fat-Free Mass (FFM)/day) or 10 days with an energy-balanced diet (EB, 50 kcal/kg FFM/day). The diets were matched for protein content (2.2 g/kg lean mass/day). Before the intervention, both groups underwent a five-day energy-balanced 'run-in' period. A standardized supervised exercise training program was performed over the experimental period. Deuterium oxide (D2O) was ingested daily, and saliva samples were collected to determine body-water tracer enrichment. Pre- and post-intervention testing included muscle biopsies for tracer enrichment and protein expression analysis, and 24h urine collection for urinary nitrogen balance.

Results

In comparison to EB, LEA resulted in significant reductions in cumulative myofibrillar protein synthesis ($p<0.001$, LEA: -0.082%/day 95%CI [-0.13 to -0.034] vs. EB: 0.095%/day 95%CI [0.047 to 0.143]) and sarcoplasmic protein synthesis ($p<0.001$, LEA: -0.197%/day 95%CI [-0.263 to -0.131] vs. EB: -0.005%/day 95%CI [0.070 to 0.060]. In addition, urinary nitrogen balance in the last 24h of the intervention period compared to the last 24hrs of the control period was negative in the LEA group (LEA: -0.24g/day 95%CI [-0.01 to -0.47]) and significantly different ($p=0.022$) from the EB group who was in nitrogen balance (0.09g/day 95%CI [-0.14 to 0.31]). Total-S6K protein expression was lower in the LEA group but not in the EB group ($p=0.024$, LEA: -0.27 AU 95%CI [-0.45 to -0.05] vs. EB: 0.08 AU 95%CI [-0.13 to 0.31].

Conclusion

Ten days of LEA results in marked reductions in cumulative myofibrillar and sarcoplasmic protein synthesis and negative urinary nitrogen balance in trained females. Our results highlight that LEA may have consequences for skeletal muscle adaptations when performing exercise training.

This study was funded by Team Denmark and the Danish Ministry of Culture.

METHODS: RESULTS: CONCLUSION: GENOTYPE-PHENOTYPE MODELS PREDICTING VO2MAX RESPONSE TO HIGH-INTENSITY INTERVAL TRAINING IN PHYSICALLY INACTIVE CHINESE

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INTRODUCTION: Exercise training contributes to improvement of VO2max, however 16%~31% adults were non-responders after standardized exercise. Distinguishing these non-responders before exercise may help to recommend personally tailored exercise protocols to enhance individual health. The aim of our study was to analyze the inter-individual differences of the VO2max response of 12 weeks High-Intensity Interval Training (HIIT), the genotype-phenotype models were constructed to predict the effect of HIIT on VO2max, and these models were used to provide recommendations for precision exercise protocols.

METHODS: A total of 228 physically inactive healthy adults who completed a 12-week HIIT were analyzed. The leukocyte DNA in whole blood was extracted, and a genome-wide association study (GWAS) was conducted to identify genetic variants associated with VO2max response. Non-responders, responders and the highest training responders were defined as the ES<0.2, ES≥0.2 and ES≥0.8 respectively. We generated polygenic predictor score (PPS) using lead variants and constructed predictive model for VO2max response based on the multiple linear stepwise regression analysis.

RESULTS: (1) The VO2max increased significantly after 12 weeks of HIIT on average, but with a high degree of inter-individual differences (4.44±4.38ml/min/kg, range: -7.8~17.9 ml/min/kg). For 27% of participants, the VO2max showed no improvement (ES<0.2). (2) We identified one genetic locus near GABRB3 (rs17116985) associated with VO2max response at the genome-wide significance level (P<5×10-8), and additional nine SNPs at the suggestive significance level(P<1×10-5). SNPs rs474377(P=1.51×10-7), rs9365605(P=4.22×10-6) and rs17116985 (P=3.22×10-8) respectively explained 11%, 9% and

6.2% of variance in VO2max response. Additionally, 13 SNPs at suggestive significance level(P<1×10-5) were found on chromosome 6(Position: 148209316 - 148223568). (3) Individuals with a PPS greater than 1.757 had the highest training response (ES≥0.8), and those with a PPS lower than -3.712 were non-responders (ES<0.2) after 12 weeks HIIT. (4) PPS, baseline VO2max, sex, and body weight could explain 56.4% of the variance in VO2max response, the major predictor was PPS which could explain 39.4% of the variance in VO2max response.

CONCLUSION: VO2max increased 4.44ml/min/kg (range: -7.8~17.9 ml/min/kg) after 12 weeks of HIIT. Ten lead SNPs were associated with VO2max response beyond the suggestive significance level(P<1×10-5). SNP rs474377(P=1.51×10-7), rs9365605(P=4.22×10-6) and rs17116985(P=3.22×10-8) could respectively explain 11%, 9% and 6.2% variance of VO2max response. PPS, baseline VO2max, sex and body weight could explain 56.4% of the variance in VO2max response. The mainly predictor was PPS, which had the highest contribution of 39.4%. Individuals whose PPS were more than 1.757 could have the highest training response, and whose PPS was lower than -3.712 would be non-responders after 12 weeks HIIT.

EFFECTS OF ESTROGEN THERAPY ON METABOLIC FLEXIBILITY IN POSTMENOPAUSAL WOMEN

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INTRODUCTION: Menopause is characterized by an abrupt decrease in estrogen production, resulting in a chronic estrogen deficiency in the postmenopausal period. The hormonal changes are associated with an increased accumulation of metabolic risk factors, such as central obesity, dyslipidemia and insulin resistance [1]. These are, in turn, associated with deteriorating metabolic flexibility [2]. We hypothesized that estrogen treatment in postmenopausal women receiving oral hormonal therapy with estrogens would preserve metabolic flexibility to a greater extent than in non-treated postmenopausal women (control).

METHODS: This ongoing study included 20 healthy postmenopausal women, where ten were in oral hormonal treatment with estrogens, and ten were not (age:55±4 and 55±6 years; BMI: 22±2 and 23±2 kg/m2, respectively). Metabolic flexibility was assessed in the overnight fasting state by measuring the capacity for fat oxidation at rest (ventilated hood) and the maximal fat oxidation (MFO) during an incremental test on a cycle ergometer (breath by breath-measurements of the pulmonary gas exchange) by indirect calorimetry. In addition, data from anthropometric measures, visceral fat mass and total body fat mass (DXA scanning) were obtained. The subjects were matched by VO2max, as training status is closely associated with maximal fat oxidation capacity [3]. Unpaired t-tests were used to compare these parameters between the two groups. Pearson's Product-Moment Correlation was used to assess the correlation between MFO and visceral fat mass. Data are shown as mean±SD.

RESULTS: Estrogen-treated women had significantly higher MFO rates than controls (0.33±0.07 and 0.27±0.07 g/min, respectively; (P= 0.03)). Furthermore, estrogen-treated women had a lower visceral fat mass than controls (226±114 and 510±415 g, respectively; (P= 0.04)). A significant negative correlation was found between MFO and visceral fat mass in the control group (P=0.04), but not in the estrogen-treated group (P=0.5). No significant differences were observed in resting fat oxidation rates (RER: 0.79±0.06 and 0.79±0.09, respectively; (P= 0.66)) or total body fat mass (16.5±5 and 21±6 kg, respectively; (P=0.1)). There was no difference in lean body mass (46±5 and 45±5 kg, respectively; (P=0.27)) or in VO2max (37±5 and 34±6 ml/kg/min, respectively; (P=0.33)) between the two groups.

CONCLUSION: Estrogen replacement may affect parameters of metabolic flexibility, such as MFO capacity. Furthermore, the capacity for fat oxidation may be linked with the accumulation of visceral fat mass in the absence of estrogen treatment, as observed in the control group. MFO is not linked with whole body fat mass in any of the groups.

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UNCOVERING THE PHYSICAL LIMITATIONS AND EXERCISE INTOLERANCE IN POST-COVID PATIENTS

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INTRODUCTION: Post-COVID syndrome poses an unprecedented challenge to modern society, affecting millions of people worldwide. Persistent fatigue, breathlessness and muscle pain are among the most common complaints of these patients. Importantly, such symptoms are worsened following exercise (post-exertional malaise; PEM). As such, healthcare providers are often reluctant to incorporate exercise into the rehabilitation program, which risks exacerbating physical deconditioning. This study aims to conduct a thorough physiological assessment including respiratory, cardiac, vascular, muscular and neurophysiological function in post-COVID patients and age-, sex-matched healthy controls to improve our understanding towards the phenotype and symptoms seen in this patient group.

METHODS: Fourteen post-COVID patients who were experienced PEM ≥3 months after covid infection and had no previous chronic disease (44.2±11.6 yr, 64.2% female, 24.2±2.3 kg/m2) and 10 healthy controls (45.8±13.3 yr, 60% female, 25.5±4.3 kg/m2) were enrolled in the study. Subjects performed cardiopulmonary exercise testing (CPET) to assess exercise capacity, echocardiography (cardiac function) spirometry (lung function), arteriography (vascular function), dynamometry (muscular strength), TILT-test and needle electromyography (EMG) to assess nerve responses. Statistical analysis was performed through SPSS 29 and independent t-test was used to assess difference between the groups (P<0.05).

RESULTS: Post-COVID group showed a trend of lower VO2peak when compared to controls (29.7±8.2 ml/kg/min vs. 37.3±11.2 ml/kg/min; P=0.077). Force vital capacity (4.3±1.1L vs. 4.1±1.0L; P=0.691), forced expiratory volume in 1 second (3.3±0.9L vs. 3.0±0.8L; P=0.691) and single-breath diffusing lung capacity for CO (8.7±2.5 mmol/min*kPa vs. 8.4±2.4 mmol/min*kPa; P=0.778) were similar between post-COVID and controls respectively. Isometric strength assessed in knee extensor (145.5±56.7 Nm vs. 173.6±59.7 Nm; P=0.255) and handgrip (post-COV: 36.4±20.1, Con: 39.4±12.5; P=0.660) were similar between the groups. There was a trend of higher pulse wall velocity in post-COVID patients compared to controls (8.9±1.4 m/s vs. 7.7±1.3 m/s; P=0.07). Post orthostatic tachycardia syndrome was observed in 4 post-COVID patients and none in the control group. Needle EMG showed myopathies in 3 post-COVID patients and none in controls. No abnormalities were observed in echocardiography in none of the subjects and ejection fraction was not different among the groups (post-COV: 57.1%±2.3, Con: 58.2%±1.6; P=0.799).

CONCLUSION: Outcomes suggest a trend of reduced physical capacity in post-COVID individuals experiencing PEM, however cardiac and respiratory functions were relatively preserved. In contrast, signs of dysautonomia and myopathies suggesting nervous system involvement in the pathophysiology of long covid. More subjects are required to draw a definitive conclusion whether there is a predominant mechanism underlying exercise intolerance in post-COVID syndrome.

INFLUENCE OF A PRIOR MAXIMAL FAT OXIDATION TEST ON VO2MAX DETERMINATION IN A SINGLE DAY IN TYPE 2 DIABETES MELLITUS: VALIDITY AND RELIABILITY STUDY

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INTRODUCTION: The determination of maximal fat oxidation (MFO) and maximum oxygen uptake (VO2max) is normally a 2-day laboratory evaluation and there is not a validated one-day MFO and VO2max test. The main aim of this study was to validate VO2max determination in a single-day test including MFO and VO2max. We also aimed to analyze the relationship between the MFO test duration and the VO2max test outcomes.

METHODS: Twenty overweight or obese adults with type 2 diabetes mellitus (10 women; 53.12±8.8 years old) were included. MFO and VO2max were determined by indirect calorimetry on a cycle ergometer. MFO test was performed until respiratory exchange rate (RER) was greater than 1.0, and VO2max was performed until exhaustion. The participants attended the laboratory on two randomized different days in a fasted state of 8-10h, avoiding caffeine, alcohol, and vigorous physical activity in the previous 24hrs. One day, participants were cited in the laboratory for an MFO test (1) before a short VO2max test with five minutes of passive recovery between tests. This short VO2max test consisted of 15W 1-minute steps beginning with the last load of the MFO test. On another day, the participants were called to the laboratory to do a traditional VO2max test to validate these results. In addition, after 15 minutes of passive rest, a VO2max verification protocol was carried out to confirm that the VO2 values were maximum (2). The Bland-Altman method and intraclass correlation coefficient (ICC) were used to determine the validity and reliability of the single-day test for MFO and VO2max measurements. Repeated analysis of variance (ANOVA) with Bonferroni comparisons were used to examine the difference in VO2max between both tests. To examine de relation between the duration of the MFO test (MFOt) and the delta between maximum oxygen uptakes from VO2max-1 and VO2max-2 the Pearson correlation coefficient was used.

RESULTS: There were no significant differences in VO2max between tests (p=1.00) and the ICC for VO2max was excellent (ICC=0.983). There was no relationship between MFOt and the delta of VO2max values in tests (r=0.302, p=0.195).

CONCLUSION: In conclusion, the single-day test for maximal fat oxidation and VO2max measurements is a valid protocol to use in patients with type 2 diabetes mellitus, independently of the duration of the MFO test.

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Oral presentations

OP-PN32 Genetic Associations

NO ASSOCIATION OF ACTN3 AND ACE GENOTYPES WITH STRENGTH QUALITIES IN INDIAN BOXERS

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RAMAKRISHNA MISSION VIVEKANANDA EDUCATIONAL AND RESEARCH INSTITUTE

INTRODUCTION: Boxing is a weight restricted sport. Relative strength is one of the key indicators of boxing performance. The force generated by both the upper and lower limbs is important for punching force (Chaabe`ne et al., 2014). The strength qualities of an individual is determined largely by genetic factors (heritability estimates for power-related phenotypes ranges from approximately 49% to 86%; Ahmetov et al., 2022). ACTN3 R577X and ACE I/D gene polymorphisms are the most studied gene polymorphisms for the association of strength qualities with contradictory findings across different populations (Ahmetov et al., 2022).

The aim of this study was to investigate the differences in strength qualities among Indian boxers based on their ACE I/D and ACTN3 R577X gene polymorphisms.

METHODS: For the purpose of this study, 39 elite Indian boxers were recruited and 2-3 ml saliva sample from participants was used for DNA isolation. PCR-RFLP method was used to observe the gene polymorphisms. The strength qualities of the boxers were measured at National Coaching Camp, Patiala. Maximal strength of the upper body and lower body was measured with 1RM strength test (bench press and back squat, respectively). Lower body upward power was assessed by countermovement jump test. Maximum static strength of both hands was assessed by maximal handgrip strength test. One way ANOVA test was used (after testing assumptions) to analyze the differences in strength qualities of the Boxers.

RESULTS: Elite Indian boxers had relative strength of 1.28 (± 0.09) in their lower body and 1.11 (± 0.04) in their upper body. The participants performed countermovement jump with a height of 48.13 cm (± 3.36). The maximum static strength of their left and right hands was 48.70 kg (± 3.30) and 49.94 kg (± 2.68), respectively. After categorizing Indian boxers based on their genotypes, we observed no significant differences ($p > 0.05$) in their relative strength (upper and lower body), lower body power, and maximum static strength of both hands.

CONCLUSION: On the basis of the findings of this study, we infer that the ACTN3 R577X and ACE I/D gene polymorphisms do not differentiate Indian boxers for their strength qualities.

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GENETIC ASSOCIATION BETWEEN ACTN3 R577X POLYMORPHISM AND ENDURANCE PERFORMANCE IN KOREAN POPULATION

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INTRODUCTION: ACTN3 is a gene that expresses the α-actinin-3 protein. α-actin-3 protein is expressed only in type 2 fiber, and another isoform of α-actinin-2 is expressed ubiquitously in the muscle fiber type. The α-actinin-3 protein expressed in the fast twitch muscle affects the cohesion of the cytoskeleton of the Z-line. α-actinin-3 is inhibited in expression in about 20% of the total population because the single-base polymorphism of the ACTN3 gene(rs1815739) replaces the R577th protein, Arginine, with a stop codon. People of the α-actinin-3 deficient genotype, express more α-actinin-2 to compensate for the deficiency. According to previous studies, the RR genotype has already been well-known for power performance. Conversely, there is no solid evidence yet that X Homozygous is fit for endurance performance. Therefore, this study aims to verify the distribution of ACTN3 genotypes in Korean adults and Korean endurance athletes and to find out the genetic link between ACTN3 genotypes and Korean endurance performance.

METHODS: The distribution of ACTN3 genotypes was investigated and compared, respectively, with data from Koreans with no health problems(n=977, Controls) and athletes in Korean endurance events(n=117). Endurance athletes were selected as athletes using 90~100% aerobic energy based on the energy metabolism ratio of each event. The genotype was divided into RR type and RX+XX type, and the frequency and ratio were calculated by applying the Hardy-Weinberg formula and verified by the Hardy-Weinberg law. The difference verification between groups was conducted through Chai-Square, and the odds ratio was calculated.

RESULTS: The genotype distributions of RR, RX, and XX in healthy Koreans were 30.2%, 50,7%, and 19.1%, respectively. As a result of the analysis, the frequency of XX and RX genotypes in the control group was 69.7%, and that of endurance athletes was 77.8%, which was significantly different at P=0.044. Regarding the RR genotype, the control group showed a distribution of 30.2%, and the endurance athlete showed a distribution of 22.2%. The odds ratio was 1.52 times higher for ordinary people with the RX or XX genotype than for those with the RR genotype.

CONCLUSION: Contrary to our hypothesis that only pure XX type in Koreans will be involved in endurance ability, even if the R allele is reduced by more than half, it is involved in endurance ability. Power is the determination of performance in all dynamic sports events. Therefore, type 2 fibers cannot be completely excluded. RX type is expected to have more impact when making the final spurt for endurance performance. RX is expected to code phenotypes with fast muscle characteristics and endurance characteristics because at least 50% of the α-actin-3 protein is expressed. As far as we know, this is the first finding that Koreans have an advantage in endurance performance when they have the XX and RX genotypes that reinforce the characteristics of slow twitch muscles while leaving the characteristics of fast twitch muscles.

EFFECT OF THE ACTN3 R577X POLYMORPHISM ON THE ASSOCIATION BETWEEN CK LEVELS AND SPRINTING TIMES DURING GAME IN BRAZILIAN PROFESSIONAL SOCCER PLAYERS

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INTRODUCTION: The ACTN3 R577X (rs1815739) polymorphism is associated to sports performance, where the R allele is related to muscle strength and power, and the X allele to muscular endurance. Previous studies also suggested the association of this polymorphism with the risk of sports injury, that can be different depending on populations and modalities. Therefore, this study aimed to evaluate the relationship between post-game Creatine Kinase (CK) levels and the number of sprints performed, and the influence of the ACTN3 genetic polymorphism on this response in Brazilian Professional Soccer Players.

METHODS: A total of 23 professional soccer players (25 ± 3.9 years old; 77 ± 5.6 kg; 180 ± 4.7 cm) belonging to first division of the Brazilian Championship were sampled through blood collection. The DNA was extracted by the Salting out method and the polymorphisms genotyped by Polymerase Chain Reaction (PCR) and Restriction Fragment Length Polymorphism (RFLP) with restriction enzyme. The post-game CK level was measured 48h after official games of Brazilian Championship, and the number of Sprints during each competition was estimated with Global Positioning System (GPS). The data was collected accordingly to the number of times the player participated at official games, average of 10 ± 4.8 measures per player. For each player, the 5 median CK measures were used for analysis together with their respective GPS data (≥60 min/game), totalizing 115 combinations of GPS+CK data analyzed.

RESULTS: From the 23 players, 13 were RR genotype and 10 were X allele carriers (RX and XX genotypes). Athletes ACTN3 RR had significantly higher mean weight (RR 78.8 ± 4.9 kg, X 74.6 ± 5.6 kg, $p<0.001$) and height (RR 181 ± 4.6 cm, X 179 ± 4.6 cm, $p=0.02$), while X athletes were significantly older (RR 24.5 ± 2.3 years old, X 25.8 ± 5.2 years old, $p=0.04$). A significant positive correlation was seen between the number of sprints (>19 km/h) performed during the game and the CK levels ($p=0.009$). When divided by the ACTN3 genotypes, athletes with the RR allele had higher CK levels as more sprints were performed ($p=0.017$). However, X allele carriers did not present significant relationship ($p>0.05$). The RR athletes also had a significantly higher mean of CK levels compared to X individuals (RR=876 ± 598, X=536 ± 211, $p<0.001$). However, there was no significant difference in the number of sprints between the genotypes (RR 24.8 ± 18.3 times, X 20.6 ± 16.8 times, $p>0.05$)

CONCLUSION: Our results suggest that the number of sprints is directly related to the concentration of the extracellular biomarker of muscle damage, where the greater the number of sprints, the greater the levels of CK in the blood, especially in athletes with RR genotype. Hence, RR genotype can be more susceptible to microlesions due to a better physical performance in high intensity activities, requiring a better control of workloads and recovery time in order to prevent the development of chronic severe conditions as a consequence of repeated microinjuries.

THE OLYMPIC MIRNOME: AN ANALYSIS OF THE COMPLETE PLASMA MIRNA PROFILE IN MAXIMAL AEROBIC TESTS DURING THE SAME SEASON IN OLYMPIC MEDALIST KAYAKERS.

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INTRODUCTION: MicroRNAs (miRNAs) are small non-coding RNA molecules, conserved between species. They can be found intracellularly, controlling gene expression, or circulating in biological fluids, as plasma, creating a crosstalk between tissues (1). Several circulating miRNAs have been described to respond to acute exercise and training (2). However, Olympic medalist athletes were not analyzed until now, so the aim of this study was to identify new biomarkers in medalist athletes to define their training response to an aerobic macrocycle and their acute response to maximal tests previous and after that macrocyle.

METHODS: Four plasma samples were collected from 4 kayakers (28.8.2±4.0 y) medalist in Tokyo Olympics. The four sampling points were done before and after two maximal aerobic capacity tests in kayakergometer. These two maximal tests had been done at the starting point of the season (A- pretest 1, and B- posttest 1) and after the macrocyle of aerobic development (C, pretest 2, and D posttest 2). In both tests, VO2max and HRmax were recorded. A 752-miRNA plasma profile was measured by qPCR using miRNome panels (Qiagen). Raw data was pretreated by 2^(-ddct) method using to normalize mean miRNA expression values. One factor ANOVA was carried out to compare between points. Pearson analysis was performed to correlate expression with VO2max and HRmax.

RESULTS: Our results defined a specific response of miR-223-3p at each of the points, an increase in levels between A and D based on training response, and an increase in its expression in acute response in both maximal tests. Specifically in

response to training, miR-19a-3p, miR-320b and miR-425-5p increase their expression. In acute response to the early season maximal test, miR-150-5p and miR-197-3p are overexpressed, while miR-132-3p and miR-192-5p levels are reduced, a response that is for the first time described in this work since all maximal test data so far defined an overexpression of miRNA levels. However, in the maximal aerobic performance phase the reality is different, obtaining only the response of overexpression in two miRNAs: one common to the other maximal test miR-197-3p and one specific to this phase, miR-103a-3p. On physiological response no differences were observed neither in HRmax nor in VO2max.

CONCLUSION: Moreover, as previously described, miR-150-5p was increased in acute response and miR-106b-5p was correlated with aerobic performance (3). However, in these high-performing subjects, new miRNAs emerge as responders not previously considered in the exercise response.

All in all, we have defined a new specific miRNA profile in Olympic medallists in both acute and training response, which is also related to maximal aerobic performance. This opens the door to possible functional analyses of epigenetic differences on high-performance athletes.

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ASSOCIATION BETWEEN CYP1A2 RS762551 C/A POLYMORPHISM AND ENDURANCE RUNNING PERFORMANCE

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INTRODUCTION: Caffeine is widely used by athletes because of its ergogenic effect on athletic performance. However, the ergogenic effect of caffeine has been found to vary considerably between individuals and is influenced by a genetic polymorphism (rs762551 C/A) in the gene encoding cytochrome p450 1A2 (CYP1A2), a caffeine metabolising enzyme. A previous study reported that pre-exercise caffeine intake reduced 10km cycling time by 6.8% in individuals with the AA genotype, but increased it by 13.6% in those with the CC genotype. Therefore, this study aimed to examine the association between the CYP1A2 rs762551 C/A polymorphism and long-distance running performance in Japanese athletes who regularly consume caffeinated beverages, such as Japanese tea, coffee, and others.

METHODS: In total, 283 Japanese long-distance runners (227 men and 56 women) were included in the study. Total DNA was isolated from the saliva of the participants using the Oragene DNA Extraction Kit. CYP1A2 rs762551 C/A polymorphism was analysed using the TaqMan SNP Genotyping Assay. The International Association of Athletics Federations (IAAF) score for each athlete was calculated from the 2017 edition of the IAAF Scoring Tables based on their personal best records in 5,000 and 10,000 m runs, half-marathons, and marathons.

RESULTS: There existed a significant difference between the IAAF scores of athletes with AA + AC genotype and those with the CC genotype in men but not in women. Male athletes with AA + AC genotype had significantly higher IAAF scores than those with the CC genotype (1041 ± 122 vs. 991 ± 214, $p < 0.05$).

CONCLUSION: Our findings showed that the CYP1A2 rs762551 C/A polymorphism was associated with the physical performance of long-distance male runners. Caffeine ingestion prior to exercise has been attributed to increased serum free fatty acid (FFA) levels, which increase lipid metabolism, decrease muscle glycogen utilisation, and consequently potentiate endurance performance. The CYP1A2 rs762551 C/A polymorphism alters CYP1A2 enzyme activity. Based on the CYP1A2 enzyme activity, individuals can be categorised as fast or slow caffeine metabolisers. Fast metabolisers (i.e., individuals with the AA genotype) have higher levels of paraxanthine (caffeine metabolite) than slow metabolisers (i.e., individuals with the CC genotype). Paraxanthine exhibits higher binding potency for the adenosine receptor than caffeine and may lead to higher FFA blood levels. Moreover, our data showed gender differences. A previous study reported consistently higher caffeine intake during competitions by male athletes than by female athletes. This may be explained by the results of the present study which suggest that there is no association between the CYP1A2 rs762551 C/A polymorphism and endurance performance in female athletes. In conclusion, the CYP1A2 rs762551 C/A polymorphism is associated with endurance performance in men.

Oral presentations

OP-SH19 Teacher and teaching education

PEDAGOGICAL CONTENT KNOWLEDGE IN MOVEMENT AND PHYSICAL ACTIVITY AMONG EDUCATORS IN EARLY CHILDHOOD EDUCATION AND CARE.

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Introduction

Movement and physical activity (MoPA) are critical to children's health and development. Most children aged 1-5 years are enrolled in Early Childhood Education and Care (ECEC) in Sweden, and high expectations are placed on educators to deliver education of sufficient quality to support children's development.

Methods

The aim of the 18-month-long action-based study was to investigate how 88 ECEC educators in five preschools perceived and experienced the priority and teaching of MoPA. The educators planned and implemented MoPA sessions among children in a trial-and-error manner. They filmed sequences from the sessions, which later were shown in the focus groups. The filmed sequences were the starting point for the collegial discussions with the researcher as a moderator. Content analyses of the transcribed focus group discussions were conducted.

Results

The content analyses revealed three themes with associated subthemes (in brackets): Teaching aspects (Competence; Role modeling); Educational aspects (Children's development; Children's health and wellbeing); Structural aspects (Curriculum; Environment).

Discussion

During the project with the trial-and-error MoPA teaching, the educators detected insufficient pedagogical content knowledge to teach MoPA and the teaching was often replaced with free play. By the end of the project, they had completely run out of exercises and activities and the lack of pedagogical content knowledge became tangible. The increased metacognition made the educators aware of children's different MoPA levels and that free play did not always increase all children's skills. The perceived insufficient pedagogical content knowledge to teach MoPA was perceived as a troublesome barrier for promoting MoPA. The educators' metacognition about MoPA increased and they became more observant on children's MoPA. They also became aware of children's different MoPA levels and that free play did not always increase all children's skills. Despite of increased metacognition about MoPA and its importance for children's development and health, most of the educators were not ready to leave their comfort zones and were not open to extra work or effort when it came to plan and implement more MoPA in the daily rutines. Organizational barriers such as group size of children, lack of available facilities, vague formulations in the curriculum were highlighted, but also personal barriers such as attitudes and fitness levels. The educators demonstrated the need for improved education in MoPA in early childhood teacher education, as well as the need for continuous education for working educators in ECEC to enhance the pedagogic content knowledge for adequate teaching in MoPA, which is important for children's present development and future health.

ACCURACY OF PRIMARY TEACHER JUDGMENTS ON BASIC MOTOR COMPETENCIES

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Introduction: Assuming that students' motor competence development is a goal of physical education, pedagogical diagnostics (in the sense of teacher's perception and interpretation in an diagnostic situation) as well as teachers' decisions (in the sense of teachers' judgement and instructional decisions) should be particularly proficient in context of students' motor competence status. Generally, one should trust teachers' instructional decisions, but various studies suggest (eg. Seyda, 2018), that physical education teachers show difficulties in assessing students specific learning levels. This shows that the quality of teachers diagnose can be doubted, too. Therefore, this study was conducted to assess the accuracy of primary teacher judgements of basic motor competencies (BMC) in 2nd and 4th grade. Methods: 16 teachers (age 39.5 ± 12.43 years, 87% female) were asked to judge the BMC of 2nd (n = 151, age 7.9 ± 0.8 years) and 4th graders (n = 103, age 9.6 ± 0.6 years). In addition, students BMC were assessed using the MOBAK-1-2 for 2nd graders and MOBAK-3-4 test for 4th graders (Herrmann, 2018). The tests inform about the status of students self-movement (SM) and object-movement competence (OM). Three judgment components were calculated according to Schrader (1989): the skill to judge students level of BMC (level), the skill to judge students competence rank within the class (rank) and the skill to judge the heterogeneity of motor performance. Results: The calculations showed an overestimation of BMC level, an accurate assessment of BMC heterogeneity in OM as well as its underestimation in SM, and a medium judgment accuracy for the BMCs ranking. Discussion: Except the accurate assessment of BMC heterogeneity in OM, the results confirm previous studies that found difficulties in teachers' judgement of students' specific learning levels. Nevertheless, these findings suggest a promotion of primary teachers diagnostic competence.

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DIAGNOSTIC COMPETENCE OF P.E. TEACHERS - HOW IS IT LINKED TO INSTRUCTIONAL AND DIAGNOSTIC ACTION?

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Introduction

Successful teaching requires pedagogical content knowledge (PCK) in order to make subject content understandable (Blömeke et al., 2020). This includes, among other things, diagnostic competence, i.e. the ability to accurately assess students and performance-relevant facts (Schrader, 1989). Research on diagnostic competence show that assessing their students is a challenging task for teachers (Südkamp et al., 2012). It is examined how physical education (PE) teachers deal with this task and if different level of diagnostic competences are linked to divergent instructional and diagnostic action in PE.

Methods

A mixed-method approach was used. In the quantitative part of the study, 43 PE teachers (70% women) rated the physical performance of 742 third/fourth grade students (48% girls) on a likert-scale of 1 to 5. Parallel the physical performance of the students was determined using a standardized motor test (also via a likert-scale of 1 to 5). The quality of the assessment was measured using the Schrader-components (1989), that focus on rank, level and differentiation of the teacher judgements. For the qualitative part of this study ten of the 43 PE teachers with different levels of diagnostic competences were identified and interviewed concerning their instructional and diagnostic activities in PE. Three groups of different level (high, medium, low) were formed and the interviews were qualitatively compared.

Results

The quantitative results showed that PE teachers have difficulties in correctly assessing the physical performance: They overestimate the level and heterogeneity and they struggle to correctly asses how their students compare to each other in terms of performance. In the qualitative group comparisons, it is shown that predominantly PE teachers with high diagnostic competence try to assess each child individually. In addition, they create time for diagnosing through their didactic actions in class. In contrast, PE teachers with medium and low diagnostic competence assess the learning requirements of the entire class. Their diagnostic and didactic activities often interfere, so that they cannot concentrate on the assessment.

Discussion

Overall, differences in the quality of diagnostic competence and linked activities are recognizable. The findings show approaches on how diagnostic competence can be improved.

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16:30 - 17:45

Invited symposia

IS-BM07 How to sprint fast and safe? Segment and muscle coordination in sprint-based sports

INTER-SEGMENTAL COORDINATION STRATEGIES DURING INITIAL SPRINT ACCELERATION

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Proficient sprint acceleration requires a combination of large mass-specific force applied against the ground with a horizontally orientated force vector, short ground contact times and high step frequencies. To achieve this, athletes must produce kinematic solutions to position their limbs in such a way that enables optimal muscle forces to be generated across joints and to translate the centre of mass forwards and upwards. This combination of kinetic and kinematic parameters establishes 'sprint acceleration technique', which is of interest to anyone looking to enhance performance of this task.

The body is a complex system with numerous redundant degrees of freedom. Coordination patterns in the execution of motor skills (such as sprint acceleration) emerge by self-organisation through interaction with a set of constraints imposed by the nature of the task, the environment and the individual. In research and practice, sprint acceleration technique is typically studied by analysing the configuration of specific body segments and joints at key events during the stride. However, the measurement of isolated kinematic variables at discrete points in time fails to capture the coordination pattern

that occurs between these events and does not directly assess the relative motion of multiple segments. Recent studies have provided the first description of inter-segmental coordination during initial sprint acceleration in highly trained athletes and revealed some characteristic features that indicate strong task constraints. However, between-athlete variation is also evident due to individual constraints and there are potentially important performance implications of these coordination pattern variations. Once these are understood, it would be beneficial for practitioners to have a framework for identifying movement strategies to guide any technical or physical interventions.

This presentation will, firstly, summarise the typical features of inter-segmental coordination and the implications for understanding the demands of initial sprint acceleration. Secondly, novel findings of coordination pattern sub-groups and the association with sprint acceleration performance will be presented. Finally, a practical framework for assessing athletes coordination pattern will be proposed.

The target audience would include researchers with an interest in sprinting or the biomechanics and motor control of movement tasks, in particular during running. Furthermore, coaches and sport scientists who are interested in understanding the technical demands of sprint acceleration would also be addressed. The topic is of relevance to provide a more holistic understanding of sprint acceleration technique and is directly related to the growing area of coaching interest in this field, supporting the integration of research and practice.

INTERMUSCULAR COORDINATION STRATEGIES DURING SPRINT ACCELERATION

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UNIVERSITY OF NANTES

Effective sprint propulsion is a result of heterogeneous contribution of muscles to the force applied to the ground. This heterogeneity is partly due to the distinct force-velocity and force-length properties of different muscles. For example, the semitendinosus can produce relatively large force at fast velocities, therefore is believed to contribute to high step frequency in sprint running. This may be related to higher muscle volume of the semitendinosus and gluteus maximus as compared to other hip extensors in sprinters compared to non-sprinters. However, to exploit the maximum capacity of these muscles to produce force, they should be highly excited. Not only the magnitude of excitation but also the timing seems to be crucial for optimising intermuscular coordination. Additionally, intermuscular coordination is likely altered when external resistance is increased, such as during certain methods of sprint acceleration training.

Muscle excitation is frequently examined using electromyography (EMG). The EMG signal provides information about the magnitude and timing of muscle activation with high temporal resolution. However, studies relating the magnitude and timing of EMG activity to kinematics and force-velocity properties of sprint acceleration are scarce. Additionally, recent technological advances allow for data acquisition with improved signal quality in field settings.

This presentation will show novel results from the FULGUR project, which includes high-level athletes from sprint-based sports (track & field, bobsleigh, rugby). In the first part of the presentation, a comprehensive analysis of EMG patterns from 16 muscles of the lower body will be linked to performance variables such as sprint force-velocity profile, step length, and step frequency. Secondly, the magnitude, timing, and distribution of muscle excitation in resisted sprints will be presented. EMG activity will be interpreted in the context of segment kinematics, which we acquired using state-of-the-art markerless pose estimation. Finally, future directions in the assessment of muscle excitation in highly dynamic movements will be presented.

This presentation will be relevant to those interested in understanding muscle activation strategies in resisted and non-resisted sprint acceleration. A broader audience interested in how to acquire and process EMG signals in dynamic movements will also benefit.

IMPORTANCE OF SEGMENT AND MUSCLE COORDINATION IN SPRINTING FOR HAMSTRING INJURY RISK MANAGEMENT

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Hamstring strain injuries are highly common in explosive field sports demanding repeated sprinting and acceleration efforts. In particular, the long head of the biceps femoris presents a high vulnerability to strain and rupture in the sprinting-related injury mechanism. Sprinting is a complex motor task, necessitating precisely fine-tuned interplay between different parts and entities of the kinetic chain. Therefore, athletes presenting neuromuscular coordination deficits might be at increased risk of sprinting-related injuries. These deficits potentially impact muscle loading via two mechanisms: (i) neural guiding alterations might negatively influence muscle contraction patterns and (ii) associated kinematic deviations might introduce excessive strain and strength production demands on the muscle-tendon system.

The extent to which sprinting induces strain and the exact timing of maximum excitation of each hamstring muscle belly during the gait cycle in high speed running have repeatedly been investigated before. However, the effect of neuromuscular coordination and associated kinematic variations on hamstring injury risk during high speed running has not been investigated so thoroughly.

This presentation will first summarize a case-control study with prospective follow-up that aimed to examine the causative importance of muscle activation, intermuscular coordination, and lower limb and trunk kinematics in the running-related hamstring strain injury vulnerability in male football players. Muscle functional magnetic resonance imaging (mfMRI) scans were taken before and after strenuous eccentric hamstring exercise to assess intermuscular coordination patterns

and amount of metabolic hamstring muscle activation comparing the three bi-articular hamstring muscle bellies. Then, surface electromyography (EMG) activity of the trunk, pelvis and lower limb muscles as well as lower limb and trunk kinematics were collected during repeated overground sprint acceleration. Our results indicate that muscle and segment coordination are essential in hamstring injury risk management. The second part of this presentation will provide practical recommendations on which coordination patterns to examine in sprint-based sports to minimize hamstring injury risk.

The target audience includes researchers and practitioners interested in the preventive value of assessing segment and muscle coordination in sprint-based sports.

Oral presentations

OP-AP17 Resistance Training Methods

THE EFFECTS OF TWO DIFFERENT STRENGTH TRAINING SESSIONS (PULL UPS VERSUS DIPS) ON HAND GRIP STRENGTH.

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INTRODUCTION: Over the last years bodyweight exercises regained popularity. Both professional and recreational athletes are using them. Calisthenics is a type of training that uses bodyweight to improve muscle strength, endurance, and control. Elite calisthenics athletes often use external weights to further load their training sessions. Such activities are linked with the strength of the hand grip. Pulls ups and Dips are widely used exercises both highly depended on the stabilization of the grip. However, grip has a totally different role in these to exercises. The purpose of the present study was to investigate possible effects on grip strength measured at two different elbow angles after a training session for maximal strength in Pull ups and Dips with additional weights.

METHODS: Six healthy, young male adults performed Hand Grip Strength (HGS) measurements. Two wireless Hand grip Dynamometers (K-grip @Kinvent) were used (one at each hand) pre-post the training sessions on Pull ups and Dips. The training sessions were randomized and had 7-day difference between them. Participants followed a maximal strength training protocol designed to reach their Repetition Maximum. Strength measurements included six 4sec isometric trials (3 with elbow at 180o and 3 at 90o) with 30s rest time. Participants performed the grip strength measurements with both hands simultaneously. From each trial a time series of force was extracted, and four variables were calculated for analysis as the average of both hands (Max Force, Average Force, Maximum Rate of force development (RFD) until maximum force and Time until maximum force). A Shapiro–Wilk test was used to validate the normality of the distribution. For the assessment of the hypothesis, a repeated (within subjects) measures analysis of variance was used with 3 factors (time, type of training, angle of test) of 2 levels each.

RESULTS: Significant interaction was noticed between the type of training and angle factors in the Time to max variable which was significant lower in the 180 degrees angle only in Pull session. In addition, marginal interaction was noticed between the time and type of training factors for the RFD to max variable. Although not significant, the values were lower in Pull session compared to Dip post training. Regarding significant main effects both max and average force were significantly lower in 90o - compared to 180o.

CONCLUSION: The type of exercise has an effect on HGS. An explanation could be involved by the grip position in each exercise considering that the vertical reaction forces act more favorable for the dip instead of the pull facilitating less active role for the grip at the dip exercise. The lower values in 90o flexed elbow compared to the 180o position verify the theory of the length-tension relationship. Forearm bi-articular grip flexor muscles such as Palmaris Longus and Flexor Digitorum Superficialis are in optimal length when the elbow is at 180o, leading to higher grip strength.

EFFECTS OF DIFFERENT ARM-SPECIFIC TRAINING ON THE PULL-UP PERFORMANCE OF CLIMBERS

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AIX-MARSEILLE UNIV

INTRODUCTION: Sport climbing performance is known to be highly related to strength and endurance in upper limb. Trainers and climbers therefore focus on developing the ability of the fingers to hang on holds and the arms to pull up from one position to another. Although finger-specific assessment and training methods are widely analysed in the literature, no study has yet quantified the effects of arm-specific training. These programs usually consist of different muscle contraction regimes (isometric, eccentric…). The aim of this study is then to compare the effects of these different types of training on climbers pull-up capabilities.

METHODS: 35 advanced to high-elite climbers (23±7y/o; 176±8cm; 62±8kg) performed 5 weeks of training (twice a week) based on pull-ups on hangboard, and were randomly divided into 4 different groups: eccentric (ECC; n=9), stato-dynamic (SD; n=9), plyometric (PLYO; n=9) and no specific trainings (CTRL; n=8). Before and after training, they were tested on a force-sensing hangboard (SmartBoard, France). Force, velocity, muscle power and muscle work were analysed during 3 various pull-up exercises: pull-ups at body weight ("jump tests" with or without coordination, or preceded by a descending phase), incremental weighted pull-ups and maximal number of pull-ups ("exhaustion test"). These tests were used to characterize the climber's abilities (body coordination skills, concentric capabilities of arm muscles, force-velocity profile

and capacity to resist fatigue). The comparison between groups before and after training were assessed by ANOVAs with post-hoc tests and principal component analysis (PCA).

RESULTS: Performance between the pre- and post-tests was similar in the CTRL group, but significantly improved after training in the SD, PLYO and ECC groups. Significant interaction effects were found, showing that improvements varied according to the training programs. Especially, the training programs differed in their effects on the velocity parameters during jump tests (+27±11% with PLYO) which led to a greater muscle power, on a higher maximum load during weighted pull-ups (+5±2% with ECC) and on the maximum number of pull-ups (+21±19% with PLYO) and muscle work (+34±17% with PLYO) during the exhaustion test. To summarize, the evolution of each participant on a 2-factor PCA was quantified and showed that the effects of training depended both on the training type (either PLYO, ECC or SD) and on the individual characteristics prior to the training.

CONCLUSION: This study pointed out that the muscle contraction regimes used during the arm training programs affected the benefits. It seemed that ECC improved force variables, PLYO enhanced velocity and endurance parameters whereas SD had lower effects. Overall, all program effects were dependent on the individual initial characteristics. This study provided new quantification and knowledge that is available to trainers and climbers to help them optimise their improvements.

COMPARATIVE STUDY OF LOWER STRENGTH AND ANAEROBIC CAPACITY IN JUVENILE ATHLETES USING BLOOD FLOW RESTRICTION AND MUSCLE ELECTRICAL STIMULATION COMBINED WITH LOW-INTENSITY RESISTANCE TRAINING

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INTRODUCTION: The purpose of this experiment is to explore the adaptive differences between BFRT and EMS combined with low-intensity resistance training on the maximum strength, explosive power and anaerobic capacity of lower limb muscles of juvenile athletes, and provide reference for athletes and coaches to select appropriate training methods at relevant stages to improve juvenile athletes ability.

METHODS: This experiment Recruited a total of 24 running juvenile athletes (ages between 15-18y) ,were randomly divided into three groups, eight in each group. Besides daily running training, take 6 weeks, three times a week fitness training. BFRT group and EMS group were combined with 30% 1RM resistance training, while CON group only took 30% 1RM resistance training. The isokinetic peak moment of knee joint flexion and extension at 60 °/s, the height of counter movement jump (CMJ), and the root mean square amplitude (RMS) of surface electromyography during CMJ were measured before and after training. They were recorded as lateral femoral muscle: RMSVM, rectus femoris: RMSRF, medial femoral muscle: RMSVL, and biceps femoris: RMSBF, 30 s Wingate anaerobic test peak power (PP), relative PP, mean power (MP), relative MP.

RESULTS: There was a significant increase in the isokinetic peak moment of bilateral knee flexion compared with that before training in the group, The left knee isokinetic peak torque of EMS group after training was significantly higher than that before training. The muscle strength ratio of the right knee joint in the EMS group after training was significantly higher than that before training. The CMJ height of EMS group afte training was significantly higher than that before training. And the difference before and after intervention after training was significantly different from that of BFRT group. After training in the EMS group, there was a significant improvement in the group. PP and relative PP in the EMS group decreased significantly after training. MP and relative MP after training were significantly lower. After training, there was a significant difference between the EMS group and the BFRT group in the relative PP and relative MP difference before and after intervention.

CONCLUSION: 6-weeks BFRT combined with low-intensity resistance training increased the maximum strength of knee flexion of juvenile athletes to a certain extent, and the explosive power level did not significantly improve, nor did it affect the anaerobic capacity of juvenile athletes; 6-week EMS combined with low-intensity resistance training enhanced the maximum strength of the vulnerable limb of the young athletes through the interaction effect, which made the maximum strength of the knee flexor muscle without electrical stimulation enhanced, and the explosive power level significantly improved, but the 6-week training weakened the ability of the anaerobic energy supply system of the juvenile athletes.

PERSONALIZING RESISTANCE TRAINING MITIGATES NEUROMUSCULAR AND PERCEIVED FATIGUE: THE AUTOREGULATION CLUSTER TRAINING METHOD

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INTRODUCTION: Traditionally, resistance training is prescribed in the form of rigid, non-personalized training programs. To illustrate, fixed structures of sets, repetitions, and rest intervals are prescribed alongside percentages of the maximal load a person can lift for a single repetition (1RM) in an exercise. Although this approach is promoted at group level, it fails to account for the variability of day-to-day performance. In fact, prescribing resistance training based upon rigid training variables may lead to an overloading stimulus in some days and an underloading in others due to the acute fatigue accumulating within the ongoing session. A strategy to mitigate fatigue within a session is the cluster-set training approach, which consists in splitting up the total number of repetitions performed into clusters (e.g., 4–16) of fewer repetitions (e.g., 2–6) interspersed by brief rest intervals (e.g., 10–60 s) . However, all cluster-training variants are designed like the traditional-set approach by using predetermined and fixed configurations of clusters, repetitions per cluster and between-

cluster rest intervals. Therefore, we conceptualized the Autoregulation Cluster Training (ACT) method, which personalizes cluster-set configurations by accommodating changes to cluster-set structures in a dynamic manner during the ongoing training session based upon an autoregulation target. The aim of this study was to compare the effects of predetermined and ACT resistance training sessions on neuromuscular and perceived fatigue.

METHODS: Twenty-six resistance-trained men completed three sessions including the back squat and bench press exercises matched for load (75% of 1 repetition maximum), volume (24 repetitions) and total rest (240 s). Sessions were randomly performed as: traditional-set (TRA), 3 sets of 8 repetitions with 120 s inter-set rest; cluster inter-set rest redistribution (IRR), 6 clusters of 4 repetitions with 48 s inter-cluster rest; ACT, a personalized combination of clusters, repetitions per cluster and between-cluster rest regulated upon a velocity loss threshold. The comparative effects were evaluated on velocity loss outputs measured with a linear encoder and perceived fatigue responses reported using a single-item scale.

RESULTS: IRR and ACT induced less velocity loss compared to TRA ($b = -2.09$, $P < 0.001$). ACT also mitigated velocity loss more than IRR ($b = -2.31$, $P < 0.001$). The back squat resulted in greater velocity loss compared to the bench press ($b = 1.83$, $P < 0.001$). Perceived fatigue responses mirrored the pattern observed for the velocity loss outputs (IRR and ACT vs. TRA: $b = -0.64$, $P < 0.001$; ACT vs. IRR: $b = -1.05$, $P < 0.001$; back squat vs. bench press: $b = 0.46$, $P = 0.005$).

CONCLUSION: IRR and ACT reduced neuromuscular and perceived fatigue likely due to their cluster-set structures embedding frequent windows of inter-set rest. However, the ACT was overall more effective, presumably given its personalized structure.

TRADITIONAL RESISTANCE TRAINING MAY NOT BE ENOUGH. IS ACCENTUATED ECCENTRIC LOADING THE ANSWER?

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INTRODUCTION: During traditional resistance training (TRAD), the same absolute external loads are used during the concentric (CON) & eccentric (ECC) phase of an exercise. However, greater forces can be produced during ECC contractions than CON contractions [1]. Despite this, the ECC joint moments during TRAD squatting are significantly smaller than CON joint moments [2]. It has however been demonstrated that ECC joint moments can be enhanced with accentuated eccentric loading (AEL) [2]. Therefore, the aim of this study was to investigate if training with AEL leads to greater strength & hypertrophy adaptations than TRAD

METHODS: 22 strength trained males (squat 1RM >1.5x body mass) were split into a TRAD or 1 of 2 AEL groups (work matched or repetition matched). The TRAD group performed squats with 80% of 1RM during the CON & ECC phases. Both AEL group performed squats with 80% during the CON phase & 120% in the ECC phase. All groups trained for 6 weeks with progressive overload each session. RPE & muscle soreness was collected throughout the intervention. Pre/post testing assessed; CON, ECC & isometric knee extensor joint moment (accompanied by vastus lateralis EMG), jump performance & squat 1RM. Vastus lateralis muscle architecture was assessed at the distal, mid-belly, & proximal site to identify muscle hypertrophy. ANOVA was used to assess the effects of the intervention & between groups differences. Effect size was calculated as omega-squared values. Significance was set at $P<0.05$

RESULTS: There was a significant effect of training on knee extensor joint moments ($P=0.007$), ECC EMG ($P=0.019$), & squat 1RM ($P<0.001$). There was no effect of the intervention for any of the groups on muscle architecture, jump performance or CON EMG ($P>0.005$). Between group differences identified that only the AEL groups improved their ECC knee extensor joint moments ($P=0.004$, $ES = 0.378$). All groups improved their CON & isometric joint moments, with no difference between groups ($P=0.133$). Only the AEL groups displayed an increase in ECC EMG ($P=0.010$, $ES = 0.40$). At the start of the intervention, muscle soreness & RPE was significantly higher in the AEL groups than TRAD, however by session 8, no differences existed between groups. No differences were found between the work matched or repetition matched AEL groups for any outcome measure

CONCLUSION: This study has shown AEL training, but not TRAD, resulted in improvements in ECC strength. These adaptations may be driven by neural mechanisms rather than changes in muscle architecture, at least in the short term. The perceived negative effects of AEL training appear to be overcome after 4 weeks of training & thus we recommend that AEL training should be prescribed in blocks exceeding this time frame. AEL training did not negatively impact on any other adaptations compared to TRAD, & therefore may be a valuable training method in sports that require high levels of ECC force production such as changes of direction

1. Alcazar et al (2019) 2. Armstrong et al (2022)

Oral presentations

OP-PN18 Endurance

COMPARISONS OF VISCERAL ADIPOSE TISSUE AND LIVER FAT CONTENT BETWEEN HIGHLY TRAINED AND RECREATIONALLY ACTIVE OLDER MEN AND THE EFFECTS OF REPEATED PROLONGED EXERCISE

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INTRODUCTION: Visceral adipose tissue (VAT) and liver fat (LF) content is increased with age (1) and is associated with the development of cardiometabolic disease (2). Exercise is effective in reducing fat content in both areas, however, VAT and LF content has not been measured in trained older males. We therefore measured VAT and LF content in trained older men, before and after 16 days of repeated prolonged cycling around the Baltic Sea. Baseline values were compared with values obtained from recreationally active older men matched for age and BMI. We hypothesized that both VAT and LF content would be lower in the group of trained older men, and that repeated prolonged exercise would result in unchanged VAT and LF content, proposedly due to low amounts at baseline.

METHODS: Five trained older men (66.3±6.7yrs, BMI 23.9±0.63) and eight recreationally active older men (69.9±3.7yrs, BMI 24.3±1.76) performed identical tests. A graded bicycle ergometer test with collection of respiratory gasses was performed to determine maximal fat oxidation (MFO), the relative workload at which MFO occurred (FatMax) and maximal oxygen uptake (VO2max). Heart rate (HR) was monitored to determine HRmax. Anthropometrics including VAT content was determined by DXA. The fraction of liver fat relative to water content (FLF) was quantified using MRI. HR during cycling was measured, for estimation of workload relative to HRmax. Baseline and post cycling values were compared using paired t-tests. Baseline measurements were compared between groups using unpaired t-tests.

RESULTS: The trained older men had lower VAT content ($p=0.02$), and a tendency towards lower FLF ($p=0.06$) compared with the recreationally active older men. The trained older men had a higher VO2max ($p<0.01$) and MFO ($p<0.01$) but similar FatMax ($p=0.2$). The trained older men cycled an average daily distance of 170±25km/d at 67% of HRmax, which resulted in a 9.2% decrease in FLF ($p=0.02$), despite unaltered VAT content ($p=0.79$), weight, fat mass and lean mass. VO2max, MFO and FatMax was not affected by repeated prolonged exercise either.

CONCLUSION: VAT but not LF content was lower in trained older men, compared with recreationally active older men. However, repeated prolonged exercise reduced LF, but not VAT content, proposedly due to a low VAT content at baseline.

The study indicates, that physical activity does not protect from increases in LF content to same degree as VAT content, with increasing age, which is also reflected in different responses to repeated prolonged exercise. We propose that a lower limit for VAT content is present. Further research with higher statistical power is however needed to confirm these findings.

1. Neerland et al. (2019) 2. Thomas et al (2012)

MODERATE-INTENSITY CONTINUOUS TRAINING VERSUS HIGH-INTENSITY INTERVAL TRAINING ON INSULIN SENSITIVITY AND MAXIMAL FAT OXIDATION IN ADULTS WITH TYPE 2 DIABETES.

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UNIVERSITY OF CADIZ

INTRODUCTION: Type 2 diabetes (T2D) is a disease associated with distinctive features such as reduced insulin sensitivity and impaired ability to oxidize lipids at rest and during exercise (1). Recent studies have shown that physical exercise has beneficial effects on insulin sensitivity (2). Both high-intensity interval training (HIIT) and moderate-intensity continuous training (MICT) induce similar acute improvements in peripheral insulin sensitivity 24h after exercise and similar long-term metabolic adaptations in skeletal muscle in adults (3). Thus, this study aims to compare the impact of HIIT and MICT on insulin sensitivity and maximal fat oxidation (MFO) in adults with T2D, and whether these changes are related to each other.

METHODS: This is a preliminary analysis of EDUGUTION/APETEX/LIPIDOX randomized controlled studies with 46 subjects with T2D (55.70 ± 6.97 years). Participants were allocated to MICT (n=20, 8 women), HIIT (n=15, 4 women) and control group (CG) (n=11, 4 women). HIIT consisted of 10×1 intervals pedalling at 90% of peak power output, MICT consisted of continuous pedalling at 10% above the first ventilatory threshold for 50 minutes, and the CG remained inactive. The program consisted of 12 weeks of training of three sessions per week on non-consecutive days. The measurements consisted of two days assessed before and after the intervention. On day 1, blood glucose was measured at fasting basal as well as at 90 minutes in an oral glucose tolerance test. On the second day, MFO was evaluated through an incremental test on a cycle ergometer (15-W/3-min) with indirect calorimetry. A mixed factorial ANOVA with Bonferroni post hoc comparisons were applied. Pearsons correlation was performed with MFO and insulin sensitivity changes. Significance was set at $p<0.05$.

RESULTS: Basal and 90 min glucose levels significantly decreased in HIIT (p=0.046; p=0.019) and MICT (p=0.021; p=0.008). No significant results were found between groups or the time by group interactions. The MFO was significantly higher after 12 weeks of training (HIIT and MICT) compared to the CG, with a significant time by group interaction (p=0.010). In the MICT group, there is a significant correlation between MFO and insulin sensitivity (p=0.002).

CONCLUSION: Both training programs improved insulin sensitivity and MFO in adults with T2D, being the HIIT a time-efficient exercise strategy in the management of T2D.

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2. Borghouts LB, Keizer HA. Exercise and insulin sensitivity: a review. Int J Sports Med. 2000;21(1):1–12.

3. Ryan BJ, Schleh MW, Ahn C, Ludzki AC, Gillen JB, Varshney P, et al. Moderate-Intensity Exercise and High-Intensity Interval Training Affect Insulin Sensitivity Similarly in Obese Adults. J Clin Endocrinol Metab. 2020;105(8):E2941–59.

REPEATED HIGH-INTENSITY INTERVAL TRAINING INTERVENTIONS AFFECT HUMAN SKELETAL MUSCLE EPIGENETICS AND PROMOTE MUSCLE MEMORY

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UNIVERSITY OF PAVIA

INTRODUCTION: Skeletal muscle epigenetic memory of hypertrophy has been identified in humans. Resistance training promotes retention of DNA modifications and related gene transcription which lead to enhanced hypertrophic response when the anabolic stimulus is later experienced (Seaborne et al., 2018). Repeated single-leg moderate-intensity endurance training does not induce differences in transcriptomic alterations and results in similar skeletal muscle adaptations (Lindholm et al., 2016). However, training at higher intensity seems to promote epigenetic modifications and consequently altering gene expression of mitochondrial biomarkers (Barrès et al., 2012). This study explored whether repeated high-intensity endurance training interventions could evoke an epigenetic muscle memory facilitating enhanced metabolic gene expression and oxidative muscle adaptations. We hypothesized the higher exercise intensity would positively modulate methylome and transcriptome responses.

METHODS: Eleven healthy subjects (25±5 yrs) performed two repeated interventions of high-intensity interval training (training and retraining) separated by 12 weeks of detraining where exercise was completely suspended. Intervention consisted of 8 weeks of combined high-intensity and sprint interval cycling exercises performed 3 days per week. At baseline and after training, detraining and retraining, vastus lateralis muscle samples were collected and genome-wide DNA methylation, gene expression and mitochondrial respiration (O2 flux by high-resolution respirometry) were analyzed.

RESULTS: Training induced hypomethylation in 14,516 differentially methylated positions (DMPs). Epigenetic memory profiles were identified in at least 1,190 DMPs showing a retained hypomethylated state even after detraining and retraining. Six genes: ADAM19, INPP5a, MTHFD1L, PDGFB, CAPN2 and SLC16A3 were identified as epigenetic memory genes with increased expression after training, retained expression after detraining and enhanced expression after retraining. Mitochondrial O2 flux in maximal uncoupled respiration rate through complexes I+II combined improved in both training and retraining (+13.1±17.8 and +24.1±16.0 pmol·s−1·mg−1 respectively, both $p<0.05$). Importantly, O2 flux changes observed after retraining were greater than after training ($p<0.05$).

CONCLUSION: Across repeated interventions, memory profiles were highlighted at epigenetic level characterized by retention of hypomethylation after training into long-term detraining and retraining periods. At transcriptional level, memory of earlier training was observed in genes involving calcium signaling, lactate and pyruvate transport and mitochondrial enzymes, suggesting epigenetic memory not only provides the mechanistic basis for the positive effect on mitochondrial function but is also relevant for muscle contractile function. Human skeletal muscle possesses a molecular and functional memory from repeated aerobic training interventions when exercise intensity is kept above a critical value.

DO EXERCISE AND ENERGY METABOLISM EXERT A SELECTIVE PRESSURE ON GUT MICROBIOME? LESSONS LEARNED FROM THE EXOMIC PILOT CLINICAL STUDY

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INTRODUCTION: Microorganisms living in the gastrointestinal tract provide a variety of benefits to its host. Our research team identified a direct link between gut microbiota, skeletal muscle and endurance performance (Nay and al. 2019). Over the last decade, substantial studies observed that microbial α-diversity and fecal short-chain fatty acids (SCFA) concentrations were higher in elite athletes than sedentary population supporting the hypothesis that highly trained individuals would possess an optimized microbiome extracting more energy from food. However, all of these studies present some important limitations, including the lack of control for dietary habits, which are clearly known to significantly affect the composition and function of the gut microbiome.

METHODS: In this context, we conducted a clinical study (NCT05220657) to characterize the gut microbiome of male participants ranging from sedentary individuals to elite athletes with high (i.e. elite soccer players) or even very high energy requirements (i.e. elite cyclists). All volunteers (n=50) performed an incremental exercise test and a fasting submaximal exercise test. Measured metabolic parameters (e.g. VO2max, carbohydrate and fat oxidation) were then linked to the metagenomic shotgun and metabolomic data from fecal samples. Participants also completed a Food Frequency Questionary (FFQ) to quantify habitual dietary intakes.

RESULTS: As expected, we recruited a heterogeneous population on VO2 max (i.e. from 38.7 to 85.6 ml/min/kg) and maximal fat oxidation (i.e. from 0.5 kcal/min to 13.30 kcal/min). On contrary to our expectations, α-diversity showed an inverse U-shaped relationship with VO2max. Two groups of participants can be distinguished (using Bray Curtis Distance): one (n = 21) with an overrepresentation of bacteria from the Prevotellaceae (P) family, and another (n = 29) exhibiting a majority of Bacterodaceae (B). The majority of cyclists had a P enterotype (n = 12/14; 86%), whereas almost all sedentary participants had a B enterotype (n = 18/21; 85%). Participants exhibiting a P enterotype were related to the higher fat oxidation values during exercise ($p < 0.01$). Although P enterotype participants displayed lower gut microbiome α-diversity ($p < 0.01$), fecal concentrations of SCFAs (i.e. propionate and valerate, $p < 0.01$) were higher compared to B enterotype. Neither dietary intake of carbohydrates, fat, fibers nor proteins explained the enterotype shift.

CONCLUSION: From this population matched for dietary habits and BMI, cyclists with a majority of Prevotellaceae appear to produce more SCFA, probably conferring an advantage for endurance performance. These changes in gut microbiome are not related to diet habits, but rather to fat oxidation and thus energy metabolism. Further experiments including fecal transplantations in mice will determine if a causal relationship really exists between gut microbiome and energy metabolism during submaximal exercise.

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Oral presentations

OP-AP41 Running Technology

MOVEMENT VARIABILITY IN SIX RUNNING CONDITIONS: A COMPLEX SYSTEMS APPROACH

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INTRODUCTION: Variability is an essential trait to describe all movements either from a performance or from a health perspective. The analysis of variability requires the usage of analytical methods to describe the complexity of the system, such as sample entropy (sampEn) [1]. The aim of this study was to compare the variability in acceleration during six different running conditions.

METHODS: Fifteen healthy adults were tested (age=31.43±9.39 yrs). After a familiarisation session, the participants performed the following six running variations in random order: high-knees (90° knee angle), tethered, shoulder-wide, shoulder-wide coreboard, treadmill (10.9 m/s at 0% of slope), and slope treadmill (10.9 m/s at 6% of slope). All conditions had a pre-defined cadence (130 or 150 bpm), over 90sec with 5-min rest interval between them. Perceived exertion (RPE) was assessed using the Borg scale (6-20), and inertial measurement units (Blue Trident, Vicon, NZ) placed on both ankles to capture accelerations. Matlab® routines were employed to calculate sampEn and the complexity index of acceleration (CI). The coefficient of variation (CV) was also determined. A Friedman-test was used for analysis ($p \leq 0.05$). Data are expressed as median (25th-75th percentiles).

RESULTS: The sampEn was higher ($p<0.001$) in slope treadmill and coreboard in right (Mdn 0.45; IQR 0.40-0.53) and left ankles (Mdn 0.53; IQR 0.37-0.66). Differences were also identified for the CI [right ankle, $X2(5) = 36.49$, $W=0.52$; left ankle, $X2(5) = 38.78$, $W=0.55$; $p<0.001$], with the coreboard showing higher CI values when compared to the other variations (right ankle, Mdn 12.25; IQR 11.43-12.64; left ankle, Mdn 13.82; IQR 11.36-15.28). Running with high knees exhibited higher CV (right ankle, CV= Mdn 2.04; IQR 1.89-2.20; left ankle, CV= Mdn 2.08; IQR 1.09-2.26), in comparison to the other variations ($p \leq 0.05$). The high knees also showed higher values in RPE (Mdn 16.71; IQR 15-18).

CONCLUSION: Coreboard and slope running resulted in higher CI and sampEn values, suggesting that irregular surfaces lead to more complex and irregular movement patterns, which might require greater neuromuscular control, coordination, and adaptability. Also, high knees resulted in higher variability, possibly due to the increased intensity and muscular demands, coordination, and joint flexibility required to perform this movement.

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NOVEL APPROACH FOR A HYBRID CUSHIONING SYSTEM IN RUNNING SHOES BASED ON HALBACH ARRAYS

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INTRODUCTION: Based on a novel magnetic spring construction (Halbach arrays), an innovative midsole cushioning concept for running shoes has been developed (patent granted). Laboratory tests of hybrid material samples showed higher stiffness (more progressive behaviour) with faster rebound compared to conventional midsoles [1]. A pilot study has been conducted to investigate possible effects on selected biomechanical parameters when used in a conventional running shoe. The primary goal of this study was to identify possible changes in EMG [2,3] and force characteristics during gait and running.

METHODS: Four male subjects (26.5±5.4 yrs, 184.8±5.6 cm, 78.8±3.3 kg) wearing two different types of the same running shoe were investigated. The first shoe was original (unmodified) while the second shoe (modified) had the magnetic module installed in the longitudinal arch between the heel bone and the metatarsus. Subjects were asked to perform 10 trials walking and 10 trials running over force measuring plates (Kistler 9281EA) mounted into the ground. In addition to the ground reaction forces, we recorded surface EMG data (Delsys Trigno) of vastus medialis, biceps femoris, tibialis anterior and gastrocnemius medialis muscles. The force and EMG data of the left and right leg were time and amplitude normalized and the mean time courses were calculated to analyze differences between the two running shoes.

RESULTS: Two subjects showed markable changes in the breaking impulse of the anterior-posterior (AP) ground reaction force (GRF) impulses (subject 2: -35.7 %, subject 4: -12.9 %) when running with the modified shoe. Also a reduction in the amplitude of the passive peak (running) of the vertical ground reaction force could be observed (subject 2: -15.6 %, subject 4: -8.2 %). The same subjects showed slightly increased muscle activity in the m. tibialis anterior just before foot strike with the integrated magnetic spring in the shoe. In contrast, no noticeable difference in the observed parameters could be found in subjects 1 and 3, neither during walking nor during running.

CONCLUSION: The observed effects in ground reaction forces are likely related to muscular pre-activation of the lower leg leg muscles. It is possible that the magnetic spring generates some kind of mechanical stimulus in the longitudinal arch (foot reflex zone), which causes an interaction effect and slightly varies the movement pattern. The intraindividual differences indicate that both responders and non-responders were included in the subject group and further investigation will be needed.

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CASE STUDY OF RECORD-BREAKING IRONMAN ATHLETE IN RESPONSE TO CUSHIONED FOOTWEAR AND FATIGUE STATES

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INTRODUCTION: Technological advancements in footwear have gained increasing attention due to their performance benefits particularly on the road racing marathon distance [1]. Focusing on the cushioning element of these shoes, previous research has found that softer midsoles improve running economy [2]. Other than road runners, Ironman athletes also use such footwear during the marathon leg of a race but start in a more fatigued state. Previous research has found that alterations in running kinematics with worse running economy have been linked to fatigue in prolonged running [3]. Interestingly it has also been found that despite being in a muscle damaged state, highly cushioned shoes continue to improve running performance [4]. Knowing this, the aim of this study was to investigate if fatigue levels alter the running economy response in a world-class Ironman athlete to different shoe conditions.

METHODS: This case study included one world-class Ironman athlete (age: 36 years; weight: 65.8 kg; height: 178 cm) who 3 weeks prior had broken the Ironman run course record with the fastest marathon time of 2:30:32 (h:min:sec) during an Ironman competition. We conducted submaximal laboratory-based assessments during two different sessions. The first testing session included steady state running economy trials at the average marathon pace (17 km/h) of his most recent Ironman race in two different shoe conditions in a randomized counterbalanced repetitive order. The second session consisted of a similar protocol but was conducted with each steady-state trial following a 15-minute race level (260 W) biking leg. The shoe conditions included an advanced footwear technology shoe consisting of a curved stiff element in the forefoot and a 40 mm high stack height of a lightweight resilient foam, as well as a maximal shoe, with matching technology but with an even higher stack height of 50 mm. These shoes differ particularly in terms of their cushioning properties with the maximal shoe having 9.0% (1.6 mm) more maximal deformation under 2000 N of force as measured on a material testing machine.

RESULTS: At average marathon speed, in a non-fatigued state, the advanced footwear technology condition (55.6 mL/kg/min) was more efficient than the maximal shoe (56.3 mL/kg/min). Testing in a fatigued state revealed an opposing trend with the maximal shoe (55.1 mL/kg/min) being more efficient than the advanced technology condition (56.9 mL/kg/min).

CONCLUSION: While this is a single case study example, for this Ironman triathlete, when adding the fatigue from the bike leg, the increased deformation of the maximal shoe benefits the efficiency of this runner by 3.2% whereas in a non-fatigued state this athlete does not appear to benefit from the additional stack height.

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HIGH MIDSOLE RESILIENCY AND LOW SHOE MASS DO NOT CONSISTENTLY ALIGN WITH BEST RUNNING ECONOMY MEASURES

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INTRODUCTION: Innovations in running shoes have demonstrated promising preliminary results for enhancing performance [1,2]. New lightweight midsole material allows for increased height without added weight. The added height provides space for carbon fiber plate additives and, along the material composition, enhances the cushioning system of the shoe. The critical parameter that enhances running performance via improvement in running economy remains unclear [3]. Existing studies vary in findings, in part, because of methodological inconsistencies with respect to footwear testing and feature control [4-8]. To advance footwear recommendation and design, a better understanding of how specific features influence performance is needed. Our study purpose was to determine the influence of changes in midsole cushioning and shoe mass on running economy in shoes with and without carbon fiber plates.

METHODS: We conducted two separate experiments to achieve our study purpose. In experiment 1, we had 10 recreational runners use three different shoes (Nike Vaporfly [NV], Nike Pegasus [NP] and Diadora Volo [DV]) and four insole conditions resulting in 8 conditions that varied in the amount of midsole resilience while shoe mass was controlled at 282g. In experiment 2, we had 10 recreational runners use the same shoes and native insoles resulting in 7 different conditions with varied mass: native shoes, NV 178g, NV 258g, NV 282g, NP 258g, NP 282g, and DV 282g. In both experiments, participants ran at 14 km/h on a treadmill for 5-minutes while breath-by-breath gas exchange was collected (CosMed, Fitmate, Rome, IT). Caloric cost unit (kcal/kg/km) was our primary outcome. For experiment 1, we expected the order of most to least economical trials to follow most to least resilient shoes (NV, NP, DV). For experiment 2, we expected the order of most to least economical trials to follow lightest to heaviest shoe mass condition within each shoe group (NV and NP).

RESULTS: Ten percent (1/10) of runners responded with the expected economical order in experimental set 1 and zero percent (0/9) in experimental set 2. Neither shoe (p=0.99) nor insole (0.99) had a significant effect on running economy in set 1. Neither shoe (p=0.31) nor mass (p=0.85) had a significant effect on running economy in set 2. No interactions were observed.

CONCLUSION: No consistent or predictable relation was found between running economy and footwear conditions with varying shoe mass and resiliency. The subject-specific response indicates we are missing a key parameter from running biomechanics that is likely mediating the interaction of the shoe and the runner. Future work should be directed at understanding the interplay between the shoe and the runner to develop better recommendation and design guidelines.

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Oral presentations

OP-BM25 Muscle and tendon function

ACTIVE AND PASSIVE RIGIDITY OF HAMSTRING MUSCLES DEPENDS ON HIP ANGLE

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INTRODUCTION: Intramuscular passive structures seem to play an underestimated role in numerous aspects of sport practice (1) but there has been a growing interest for their interaction with muscle active structures in the last decades (2). Shear wave elastography (SWE) has been proved reliable to estimate muscle rigidity at rest and during submaximal voluntary contractions, the latter being linked to individual muscle force (3). The aim of this study was to determine the impact of hip angle on the active and passive contributions to hamstring muscles rigidity during submaximal voluntary contractions.

METHODS: The Shear Wave Speed (SWS) was assessed using SWE in the biceps femoris (BF), semitendinosus (ST) and semimembranosus (SM) at rest and during submaximal isometric knee flexions (at 25%, 50% and 75% of the maximal voluntary contraction [MVC] torque) for a knee angle of 90° and two hip angles (90° and 70°) in 22 women. Surface electromyographic (sEMG) signals from the hamstring muscles were acquired during the experiment. The active SWS (aSWS) was defined as the difference between the SWE measurement realized during submaximal contraction and at rest (pSWS). Both aSWS and pSWS were expressed in percent of the SWS measured during the submaximal contractions. A three-way ANOVA was used to investigate the effect of hip angle on the aSWS, SWS and sEMG root mean square (RMS) in each muscle and for each contraction intensity. A two-way ANOVA was used to examine the effect of hip angle on the pSWS in

each muscle. Post-hoc analysis was conducted using Tukey HSD test. A Student t-test was performed to evaluate the impact of hip angle on MVC torque.

RESULTS: Regardless of the muscle studied and the intensity of submaximal contractions, a change in hip angle had no significant effect on SWS (P=0.26), while pSWS and aSWS significantly changed between 90° and 70° of hip flexion ($P < 0.001$ and $P < 0.01$, respectively). Post-hoc tests showed that pSWS increased with hip flexion while aSWS decreased. The mean sEMG RMS over the three muscles and contraction intensities also decreased with hip flexion ($P < 0.05$). No difference in MVC torque was observed between the two hip angles ($P = 0.29$).

CONCLUSION: The three hamstring muscles presented a greater resting rigidity for a hip angle of 70° than at 90°, which did not lead to a difference in SWS during contraction because of the smaller aSWS and activation observed at 70°. Such an effect of muscle length on the hamstring muscles pSWS and sEMG RMS had already been reported (4,5). However, muscle activation strategies dependent on the passive mechanical properties of the muscles had never been reported before and still warrant further examinations.

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EFFECTS OF HIP EXTENSION TRAINING PERFORMED WITH FULL VERSUS PARTIAL RANGE OF MOTION AT LONG MUSCLE LENGTHS ON MUSCLE HYPERTROPHY AND SPRINT PERFORMANCE

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INTRODUCTION: The hip extensors appear to play an important role in sprint running performance (Miller et al., 2021; 2022). However, it is unknown whether hip extension training improves sprint performance. Growing evidence suggests that training at long muscle lengths produces greater hypertrophy than training at short muscle lengths (Maeo et al., 2021; 2022). Although resistance training guidelines generally recommend wide or full range of motion (ROM) (ACSM, 2011; Schoenfeld & Grgic, 2020), training with partial ROM at long muscle lengths may be superior for muscle hypertrophy and consequently also sprint performance. Thus, we examined the effects of hip extension training performed with either full ROM versus partial ROM at long muscle lengths, on muscle hypertrophy and sprint performance.

METHODS: Thirty-four healthy young adults were allocated to a full (FULL: n = 18) or partial (PART: n = 16) group, and they completed the study. The participants conducted unilateral hip extension training in a standing position either with full ROM (hip 90°-flexed to 0°) or partial ROM at long muscle lengths (hip 90°-flexed to 45°-flexed), as allocated, with the knee kept straight. Each leg performed 5 sets of 10 repetitions (2 s for each of the concentric/eccentric phases) at 70% of one repetition maximum (specific to FULL/PART) during each training session, and 2 sessions/week for 12 weeks. Before and after the intervention, T1-weighted axial 3-T MRI scans (FOV: 200*200 mm, slice thickness & gap: 5 mm) were obtained to assess muscle volume of the hip extensors (the gluteus maximus and hamstrings), and 60-m sprint time was also assessed.

RESULTS: After the intervention, muscle volume significantly increased in all hip extensors for both groups ($P \leq 0.006$). The changes in muscle volume were greater for PART than FULL in the gluteus maximus (+6.1 vs +2.4%, $P = 0.038$, Cohens'd = 0.90) and biceps femoris long head (+9.4% vs +4.2%, $P = 0.014$, Cohens'd = 1.04), but statistically not different between groups in the semitendinosus (+7.3 vs +4.6%, $P = 0.891$, Cohens'd = 0.37) and semimembranosus (+7.2% vs +3.9%, $P = 0.109$, Cohens'd = 0.75). Consequently, the change in muscle volume of the whole hip extensors was greater for PART than FULL (+6.8 vs +3.1%, $P = 0.025$, Cohens'd = 0.96). 60-m sprint performance significantly increased (i.e. shorter/faster time) in both PART and FULL without a significant difference between groups (-2.5% vs -1.1%, $P = 0.108$, Cohens'd = 0.79).

CONCLUSION: Hip extensor hypertrophy was greater after hip extension training performed with partial ROM at long muscle lengths compared to full ROM, while both types of training improved sprint performance similarly.

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TRAINING AND CONTRALATERAL EFFECTS OF 6 WEEKS ISOKINETIC ECCENTRIC EXERCISE ON PLANTARFLEXOR MUSCLE-TENDON MECHANICS

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INTRODUCTION: Large increases in joint range of motion (ROM) have been reported after eccentric resistance training [1], however limited data exist on the potential mechanisms associated with these changes. Furthermore, while the contralateral effects of eccentric training are well documented for strength [2], no data exist for ROM. Therefore, the present study examined the training and contralateral effects of a 6-week isokinetic eccentric plantarflexor training programme on muscle-tendon mechanics.

METHODS: Before and after the 6-week programme, dorsiflexion ROM, stretch tolerance, elastic energy, plantarflexor muscle-tendon stiffness, gastrocnemius medialis (GM) architecture, and maximal isometric plantarflexor torque were measured using dynamometry and sonography in both lower limbs of 13 participants (5 males, 8 females, age [mean ± SD] = 22.1±2.4 y, height = 1.7±0.1 m, mass = 71.3±16.2 kg). Training was performed twice-weekly on the right limb, consisting of 5 sets of 12 maximal isokinetic eccentric plantarflexor contractions performed at a 10°·s-1 velocity through a 30° ROM, with each contraction terminating at full passive dorsiflexion ROM.

RESULTS: Significant (P<0.05) increases in dorsiflexion ROM (trained = 9.5±5.4°, d=1.75; contralateral = 4.0±4.1°, d=0.98), stretch tolerance (trained = 95.9±40.8%, d=1.48; contralateral = 46.2±23.9%, d=1.48), elastic energy (trained = 161.3±49.6%, d=1.70; contralateral = 51.7±37.3%, d=1.34), and isometric strength (trained = 38.0±40.2%, d=1.09; contralateral = 44.2±33.4%, d=1.75) were detected in the trained and contralateral limbs, respectively. Within the trained limb, significant increases were also observed in GM thickness (6.1±8.1%, d=0.79), fascicle length (7.6±8.5%, d=0.94), and plantarflexor muscle-tendon stiffness (28.5±37.0%, d=0.67). Significant correlations were detected between the changes in trained and contralateral limb dorsiflexion ROM (r=0.59), stretch tolerance (r=0.70), elastic energy (r=0.66), and isometric strength (r=0.69).

CONCLUSION: The large increase in ROM after eccentric resistance training was associated with changes in neurological, mechanical, and structural adaptations in the trained limb, with evidence of a contralateral effect primarily being associated with a neurological (stretch tolerance) adaptation. The substantial and similar increases in isometric strength in both the trained and contralateral limbs are consistent with a previous review [2] confirming a stronger contralateral effect following eccentric resistance training than other contraction modes. The large changes in structural and functional measures combined with substantial changes in the contralateral limb have important implications for exercise prescription in healthy and clinical (e.g. injured, diseased, aged) populations where periods of inactivity may negatively influence these outcome measures.

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MILD DAMAGE IN KNEE EXTENSOR MUSCLES ACCUMULATES AFTER TWO BOUTS OF MAXIMAL ECCENTRIC CONTRACTIONS

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INTRODUCTION: Most of sport activities involve repeated eccentric contractions that is a major cause of cytoskeletal disruptions, commonly referred as muscle damage. Muscle damage trigger a cascade of symptoms such as long-lasting strength loss, muscle soreness, and inflammatory response. While many authors considered that muscle damage could accumulate with the repetition of intense efforts, the current literature still lacks of robust experimental evidences to draw definitive and practical conclusions. This study aimed to determine whether mild muscle damage accumulates on the knee extensors after two bouts of maximal eccentric contractions performed over two consecutive days.

METHODS: Thirty participants performed an initial bout of maximal eccentric contractions of knee extensors during the first day of the protocol (ECC1). Then, they were splitted in two groups. The experimental group (EXP, n = 15; 6 females; age: 21 ± 2 years; height: 175.5 ± 9.6 cm; weight: 66.8 ± 10.2 kg) repeated the eccentric bout 24h later (ECC2) while the control group (CON, n = 15; 6 females; age: 21 ± 1 years; height: 171.1 ± 11.7 cm; weight: 64.9 ± 11.1 kg) did not. Indirect markers of muscle damage (i.e., strength loss, muscle soreness, and shear modulus) were measured to quantify the amount of muscle damage and their time course

RESULTS: We reported a significant time × group interaction on strength loss and muscle soreness (both $P < 0.01$). Two days after the initial eccentric session, participants from EXP had a higher strength deficit (-14.5 ± 10.6 %) than CON (-6.7 ± 8.7 %) ($P = 0.017$, $d = 0.9$). Similar observations were found on muscle soreness. Although both groups exhibited a similar increase in knee extensors shear modulus after ECC1, we found a second significant increase in muscle shear modulus (+13.3 ± 22.7 %; $P < 0.01$; $d = 0.5$) after ECC2 for the EXP group, despite the presence of initial mild muscle damage (i.e., strength loss about -16.2 ± 7.4%).

CONCLUSION: The current protocol induced mild damage on the knee extensors after one (CON) or two (EXP) work-matched bouts of maximal eccentric contractions performed one day apart. Both the concomitant alteration of the time

course of the strength loss and muscle soreness, combined with an increase in shear modulus after the second bout of eccentric contractions provide evidence that EXP group exhibited an accumulation of muscle damage.

THE IN VIVO PASSIVE STRETCHING RESPONSE OF THE PECTORALIS MAJOR DIFFERS BETWEEN MUSCLE REGIONS

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INTRODUCTION: The stretching response of skeletal muscle has been investigated in vivo for individual muscles (1), muscles belonging to a muscle group (2) and regions within the same muscle (3). However, the examined muscles have a strap-like shape and most have pennate architecture. The stretching response of broad, fan-shaped muscles like the pectoralis major (PM) has not been investigated. The purpose of this study was to investigate the stretching response of the clavicular, sternocostal and abdominal PM regions during shoulder abduction.

METHODS: Passive stretching response of the PM regions during shoulder abduction was determined for 20 healthy males (age 29.1 ± 8.8 years, height 172.3 ± 25.0 cm, body mass 80.3 ± 27.7 kg). Ultrasound shear wave elastography (SWE) was used to assess stiffness of the clavicular, sternocostal and abdominal regions at rest as the shoulder was abducted in intervals of 0.1 rad. Shear wave velocities (SWV) were extracted from the resulting SWE images as a measure of muscle stiffness. We used a repeated-measures ANOVA with joint angle as within-subjects factor and muscle region as between-subjects factor to test whether SWVs differ between the PM regions. A piece-wise exponential model was fitted to SWV-joint angle data to extract slack angle, SWV at slack and elasticity constant of the SWV increase for each PM muscle region. Differences in these parameters between the PM regions were determined using a linear mixed model with muscle region as fixed factor and participant as random intercept.

RESULTS: SWVs increased for all PM regions as the shoulder abduction joint angle increased ($p < 0.001$), with significant differences in SWVs between the clavicular, sternocostal and abdominal regions ($p < 0.001$). The measured SWV-joint angle data for the clavicular region rarely followed the exponential model, so data was only fitted for the sternocostal and abdominal regions. Slack angle was smaller for the sternocostal region (47.5 ± 19.6°) than for the abdominal region (62.3 ± 23.7°), trending towards significance ($p = 0.08$). SWV at slack was significantly greater ($p = 0.005$) for the sternocostal region (2.42 ± 0.37 m/s) compared to the abdominal region (2.15 ± 0.28 m/s). The difference between the elasticity constants of the two regions trended towards significance ($p = 0.08$; sternocostal: 0.0058 ± 0.0018, abdominal: 0.0075 ± 0.0037).

CONCLUSION: The difference in SWV at slack between PM regions indicates differences in material properties. Specifically, the sternocostal region appears to be stiffer than the abdominal region. Differences in slack angle and elasticity constant trended towards significance and require further investigation with a larger sample size. These results provide the first insights into differences in stretching response between muscle regions within a fan-shaped muscle with a broad origin.

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Oral presentations

OP-BM09 Balance and posture II

OPTIMAL MERGING OF KINEMATIC AND KINETIC INFORMATION TO DETERMINE THE POSITION OF THE WHOLE BODY CENTER OF MASS

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INTRODUCTION: Stability analyses of standing and walking rely on accurate measurements of the position of the center of mass (CoM). Unfortunately, this cannot be directly measured, and is typically estimated using kinematic markers placed on the body. Various kinematic models of the CoM have been proposed, ranging from very simple (a single marker on the sacrum) to very detailed (38 markers). The accuracy of these models is however unknown. The aim of this study is: first, to evaluate the accuracy of state-of-the-art kinematic models of the CoM; and second, to improve this accuracy by combining kinematic and forceplate measurements.

METHODS: Data from a publicly available database were analyzed. Two subjects performed treadmill running for one minute at 3 m/s and 4 m/s. Marker positions were used to calculate the CoM position according to three kinematic models: 1. the state-of-the-art model, requiring 38 markers, 2. a simplified version requiring 13 markers, 3. the hip mid-point. To determine the error in acceleration, the CoM position was differentiated twice to obtain acceleration, and only the flight phases of running were analyzed. To determine the error in position, the step-triggered average CoM position was obtained as the double integral of the step-triggered average acceleration obtained from the force plates, corrected to remove drift.

A Kalman filter structure was adapted to optimally combine the measurement of CoM position from kinematics and the measurement of CoM acceleration from forceplates.

RESULTS: During the flight phase of running, the acceleration of the CoM is equal to gravity, i.e. null in the horizontal plane and downwards of amplitude 9.81 m/s2. However, the mean acceleration calculated from all three kinematic models had a bias both in the vertical direction and in the horizontal plane. Altogether the mean error in acceleration was largest for the hip markers (32 % of gravity), followed by the simplified model (15 %) and the full model (9 %). Likewise, the mean error in position was largest for the hip markers (11.6 mm), followed by the simplified model (4.9 mm) and the full model (3.5 mm).

The proposed Kalman filter merges high-frequency force plate information and low-frequency kinematic information. The cutoff frequency is automatically determined from the ratio of kinematic noise to force noise. When using this novel filter, the error was drastically reduced for both acceleration and position.

CONCLUSION: State-of-the-art kinematic models of the CoM were found to have very low accuracy. On the other hand, estimating the position of the CoM from force plates alone requires high-pass filtering the force plate signal at an arbitrary frequency. The proposed Kalman filter optimally combines kinematic and forceplate information to improve the accuracy of CoM measurements. The code for calculating the CoM position from kinematics alone and from combining kinematic and force plate measurements will be made available online.

DOES MINI-TRAMPOLINE TRAINING REDUCE LOWER LIMB ASYMMETRIES?

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INTRODUCTION: Inter-limb asymmetry is defined as the performance imbalance (i.e. strength, balance) of a limb with respect to the other. Asymmetries between limbs are influenced by several factors as lateral dominance (left vs right), injuries and sports. In particular, team-sports athletes exhibit significantly greater inter-limb asymmetries with respect to non-athletes, due to the large number of unilateral actions such as jumping and changes of direction. Studies widely demonstrated how plyometric and balance trainings could minimize inter-limb imbalance by reducing asymmetries and the relative risk of sport-related injuries. Among the different plyometric training modalities, an effective method is represented by mini-trampoline training, such as SuperJump (SJ). Therefore, this study aimed to evaluate the acute effects of SJ on dynamic balance Unilateral Asymmetry Index (UA).

METHODS: 37 healthy subjects were randomly allocated in SJ group (SJG n=20) and Control group (CON n=17). SJG participated in SJ session, whereas CON did not receive any workout. SJ included a 30-min workout with a warm-up including mobility exercises, a central phase with jumping exercises alternating movements of upper and lower limbs and a cool-down. Before (PRE) and after (POST) SJ subjects performed Wobble Board (WB) balance test consisting of 3-min of free familiarization with the board followed by 1 test trial of 30s per limb with 1-min of rest in between. Subjects stood barefoot on the board in a single leg stance by adopting a comfortable and central foot position, knee slightly bended and hands on the hips. To visualize real time balance performances on a monitor, subjects were asked to focus on a motion marker (MM) and try to minimize its displacement with the aim of keeping it inside the target zone (TZ) as long as they could. WB performance was represented by the time the MM spent in the TZ. To evaluate the magnitude of UA Index, the formula [(100/high·low)·-1]+100 was used, where high and low correspond to the greater and lower limb values for WB test.

RESULTS: The linear repeated measures mixed model analysis showed significant differences ($F(3,35) = 3.29$; $p=0.005$) for UA Index between PRE (36.9±27.7%) and POST (17.9±13.6%) in the SJG. No differences were found PRE (32.2±19.3%) and POST (30.5±15.0) for the CON group.

CONCLUSION: Results suggested that SJ training played a key role in reducing UA. Structured training programs aiming at eliminating or limiting the asymmetries, should not only focus on the execution of exercises for the less performing limb. In fact, monopodalic training could lead to a change in the direction of asymmetry, from the dominant limb to the non-dominant one or conversely, by not getting improvements in UA. Therefore, bipodalic exercises, such as repetitive vertical jumps on SJ, could represent an important method in improving UA in healthy young and athlete population.

UPPER EXTREMITY MUSCLE ACTIVITY DURING M-CKCUEST

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INTRODUCTION: The Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST) was proposed to assess the upper extremity closed kinetic chain function (1). In a push-up position with hands spaced at a half arm span (m-CKCUEST, 2), the participant alternatively touches, as fast as possible, the floor outside the stance hand with the other hand (phase 1) and returns in starting position (phase 2) during three 15-s bouts. The stance limb supports about 65% of the body weight (3) and superior mediolateral peak force was reported for the nondominant limb than for the other side (4), suggesting effect of dominance on loads and muscular activation. This study aimed to assess the influence of dominance, phase and muscle on stance-limb muscle activity during m-CKCUEST.

METHODS: Electromyography activities of lower, middle and upper trapezius, triceps brachii, posterior, lateral and anterior deltoid, and serratus anterior were recorded bilaterally for 14 male athletes (22.3±2.1 yrs, 1.66±0.06 m, 66.5±6.6 kg) per-

forming m-CKCUEST. The effects of dominance, phase and muscle on the stance-limb muscle activity (% of a maximal voluntary isometric contraction) were analyzed with linear mixed model.

RESULTS: For 26±2 touches per athlete, only a significant effect of phase*muscle interaction ($p<0.001$) on muscle activity was found. During phase 1, serratus anterior (31±13%), posterior deltoid (30±13%) and triceps brachii (27±14%) were more activated ($p<0.05$) than lower (18±8%), middle (17±10%) and upper trapezius (21±10%), lateral (19±6%) and anterior (19±8%) deltoid. During phase 2, the serratus anterior (33±11%), anterior deltoid (29±12%) and triceps brachii (25±11%) were more activated ($p<0.05$) than lower (15±5%), middle (15±6%) and upper (9±4%) trapezius, posterior (21±16%) and lateral (16±6%) deltoid. All muscles presented similar activity during both the phases, excepted the anterior deltoid, which was significantly more activated ($p=0.04$) during the phase 2 (29±12% vs. 19±8%).

CONCLUSION: Our findings showed muscular activities were similar for dominant and nondominant stance limbs, and confirmed m-CKCUEST challenges the upper limb stability (3). During both the phases, serratus anterior may resist to trapezius action by rotating internally and upwardly the scapula, and triceps activated to maintain elbow in full extension. When the moving hand reached out the stance hand, posterior deltoid may counteract humeral flexion, while, when the moving hand returned to starting position, anterior deltoid may counteract humeral extension, hence limiting body anteroposterior displacement. The upper extremity muscle activities may thus be coordinated to maintain the glenohumeral joint above the stance hand during the m-CKCUEST.

FUNDINGS:

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THE IMMEDIATE EFFECTS OF PLANTAR FASCIA ROLLING ON POSTURAL CONTROL IN HEALTHY SUBJECTS AND PATIENTS WITH NECK PAIN

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INTRODUCTION: The fascial system is organized in chains along the body and is thought to have proprioceptive and nociceptive function (Adstrum 2017). One such chain, the superficial backline, connects the plantar fascia of the foot with the head (Myers 2013). The foot and the head are also crucial players in providing sensory information for maintaining postural control (Henry 2019) and patients with neck pain display decreased postural control (Peng 20219). To test whether manipulation of the plantar fascia improves postural control, we were interested in the immediate effects of plantar fascia rolling on postural control and pain in healthy individuals and patients with neck pain.

METHODS: 45 individuals participated in this study. 15 patients with neck pain and 30 healthy controls were tested by blinded outcome assessors regarding Y-balance test performance, cervical joint position sense acuity and pressure pain threshold of neck muscles. Patients with neck pain received plantar fascia rolling. Healthy subjects were randomly allocated to plantar fascia rolling or placebo. Patients with neck pain and healthy individuals rolled their plantar fascia with about 25% of their bodyweight for one minute on the right and then for one minute on the left side. Both sides were alternately rolled twice. In total, the therapy consisted of 2 x 1 min rolling on the left and 2x1 min rolling on the right side. The placebo group received sham-ultrasound to the plantar fascia. Post-test measurements were performed immediately after the intervention, in a standardized sequence.

RESULTS: A significant time effect ($F1, 42=42.84$; $\eta 2=0.503$; $p<0.001$) but no time*group effect was observed for the Y-Balance test. Cervical joint position sense revealed no time and no time*group effect. Pressure pain threshold showed a trend ($F1, 42=3.1$; $\eta 2=0.07$; $p=0.084$) for time but no time*group interaction.

Comparing healthy individuals, a significant time ($F1, 28=7.96$; $\eta 2=0.500$; $p<0.001$) and time*group interaction ($F1, 28=5.42$; $\eta 2=0.162$; $p=0.027$) was found for Y-Balance performance. Pressure pain threshold demonstrated a significant time ($F1, 28=7.96$; $\eta 2=0.221$; $p<0.009$) and time*group interaction ($F1, 28=5.42$; $\eta 2=0.162$; $p<0.027$). No significant results were observed for cervical joint position sense.

Comparing patients with neck pain and healthy subjects regarding their Y-Balance performance, a significant time effect ($F1, 28=44.38$; $\eta 2=0.613$; $p<0.001$) was observed, but no time*group interaction was found. Pressure pain thresholds demonstrated a significant time ($F1, 28=27.36$; $\eta 2=0.494$; $p<0.001$) effect, but no time*group interaction. No effects were observed for cervical joint position sense.

CONCLUSION: A single session of plantar fascia rolling improved Y-balance performance in healthy subjects and patients with neck pain but did not affect cervical joint position sense. How long this effect maintains is unclear. For patients with neck pain, other therapies such as balance training, neck muscle vibration or mental training seem

"NEURO SOCKS": ACUTE AND LONG-TERM EFFECTS ON BALANCE

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INTRODUCTION: Deterioration of balance in old age is a significant predictor of fall risk. Wearing special socks or insoles would be a relatively simple and inexpensive option to improve balance. The company VoxxLife claims that wearing their socks with a special tactile pattern (Human Performance Technology) triggers a neural response in the brainstem that leads to numerous improvements in a wide variety of areas, including enhanced balance. The aim of the present study was to examine whether wearing these "Neuro Socks" has acute and/or long-term effects on balance ability compared to standard socks.

METHODS: In a randomized controlled trial, 60 subjects (20-63 yrs of age; 31 females) were allocated to wear either Neuro Socks or standard socks for 5-6 weeks. Pre and post static balance performance with Neuro Socks and standard socks were measured using a multiaxial-unstable balance board (MFT Challenge Disc®). To evaluate acute and long-term effects, frequentist and Bayesian 3-way ANOVA with Time (pre, post) and Socks (Neuro, standard) as within-subject factors and Group (intervention, control) as between-subject factor was calculated using JASP 0.16 (with default prior). Separated 2-way ANOVAs and t tests were employed for post-hoc comparisons.

RESULTS: Changes in the balance performance from pre- to post-test were similar between groups (Group X Time: $p=.546$) with trivial effects ($eta^2p=0.006$) and moderate evidence in favour of H0 ($BF01=3.33$). In the pre-test, wearing Neuro Socks during balance testing did not significantly differ from wearing standard socks ($p=.246$; $d=0.151$) with moderate evidence in favour of H0 ($BF01=3.69$). In the post-test, a significant interaction of Group X Socks was found ($p=.031$; $eta^2p=0.078$; $BF10=1.99$) with the Neuro Socks intervention group showing worse balance abilities when tested with Neuro Socks ($p=.004$; $d=0.572$; $BF10=9.98$).

CONCLUSION: The findings of our intervention study contradict the notion that wearing Neuro Socks improves the static balance ability in young to middle-aged healthy subjects. This applies to both short-term and long-term effects. For any balance improvements, it seems rational that there must be a change in the foot-ground interface. In order to do this, the socks would need to be able to generate a certain threshold of intense afferents. The Neuro Socks with a relatively small HPT pattern, however, seem to be insufficient to stimulate the sensorimotor system in this manner. Whether they have positive effects on other areas such as pain, strength or speed must be verified in further studies.

Oral presentations

OP-AP40 Technology for Performance Analytics

OPTIMAL ARROW GROUPING BASED ON ARROW MECHANICAL PROPERTIES AND VANES POSITIONNING

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INTRODUCTION: The material used by an archer affect the score, alongside the shooting technique and conditions [1]. Since different arrows are shots during an event, selecting a set of similar arrows based on their properties is crucial [2]. To obtain optimal grouping on the target, which leads to better score, matching characteristics have been identified: diameter [2], straightness [3], mass [4] or stiffness [4]. In addition, stiffness around the arrow shaft is variable [5] but never considered in those studies, nor the vanes positions with respect to the stiffness pattern. This work aims to investigate if these two aspects influence arrow grouping.

METHODS: Sixty arrow shafts were analyzed using a test bench to obtain their diameter, straightness, and stiffness. Every shaft started on a standardized position (S) according to their labels, then rotated four times around its longitudinal axis, with eight measures per rotation. A sine wave was used to characterize the stiffness. The mean, amplitude, frequency, and phase were found by a Fourier transform and nonlinear fitting. Each shaft was associated with an arrow point and fletched so that out of three vanes, one was placed on S. The angular position of the maximum and minimum of the stiffness, relative to S and therefore one of the vanes was computed. The mass of the shaft, point and assembled arrow were also considered. Five sessions were made with a shooting machine, using the same bow, at the Olympic distance of 70 meters, indoor. The average coordinates of a given arrow across the five shots were collected with graph paper.

The normalized Cartesian distance between every existing pair of arrows ($n = 1770$) on the target was computed. Likewise, the normalized mechanical distance for the pairs were evaluated for every existing combination of the eleven parameters ($n = 2047$). Finally, to assess which parameters to consider for arrow grouping, the RMSE between the two distances were computed.

RESULTS: For each arrow, the standard deviation of the positions was 2.2 ± 1.1 cm on the horizontal axis and 2.0 ± 1.0 cm on the vertical axis. The minimum for the RMSE between target and mechanical distances was found for a combination of three parameters: mean stiffness, frequency and assembled arrow mass.

CONCLUSION: This work provides three parameters to consider for arrow selection, from the eleven parameters that were considered initially. As expected, arrows that had similar stiffness and total mass were closer to each other on the target. The third parameter was the sinusoidal frequency of the stiffness, which suggest that the stiffness pattern variation around

the shaft has also to be considered for optimal arrow grouping. Shaft diameter, straightness and vanes positions with respect to stiffness extrema were found to be less relevant in arrow grouping.

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KINEMATIC AND NEUROMUSCULAR PATTERNS OF UPPER LIMBS DURING ROWING ERGOMETER: DESCRIPTION AND IMPACT OF AN ERGONOMIC HANDLE.

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INTRODUCTION: In rowing, arms transfer all the power produced to the handle and generate 22% of the whole power (1). Therefore, a large articular stress might be applied to the upper limbs. However, no study has evaluated their kinematics and neuromuscular activities to further understand these constraints. In addition, the use of an ergonomic handle might reduce the injury risk (2) and increase comfort (3). Therefore, the aim of this study was to describe neuromuscular and kinematics patterns of the upper limb during rowing ergometer and evaluate the impact of an ergonomic handle.

METHODS: 29 experimented rowers performed two randomized bouts at a competitive rate on a rowing ergometer (RP3®, Care RowPerfect BV, The Netherlands): one with a standard handle (Concept II Inc., USA), and another with a new ergonomic handle (Caremosim™, France) having six faces, with a round placed at the thenar eminence and a plane at the hypothenar eminence, and a 1:1.25 adapted size ratio (2) based on the average hand length of the subjects (194±9mm). Left shoulder, elbow and wrist kinematics were measured with 4 IMU (iSen, STT Systems, Spain) and neuromuscular activity of Triceps Brachii Longus (TBL), Flexor Carpi Ulnaris (FCU), Deltoideus posterior (DP), Brachioradialis (BR), and Biceps Brachii (BB) with surface EMG sensors (Trigno™, Delsys, USA). A comfort scale evaluated separately the perceived grip, size, and shape of handles (4). Handle effect on upper limb joint range of motion, averaged EMG RMS and rower's comfort was investigated with paired Student's t-test.

RESULTS: Upper limb kinematics and EMG were not significantly different during the drive phase between standard and ergonomic handles. However, the ergonomic handle was significantly more comfortable in terms of grip ($p<0.01$) and shape ($p<0.001$). The shoulder yielded a 80° retropulsion with a 30° abduction (20° to 50°) occurring during the last quarter of the drive. The elbow did a 60° flexion (20° to 80°) during the last quarter. The wrist ulnar deviation reached 15° along the drive phase with a 25° flexion at the end. TBL was active only during the first half of drive phase, followed by FCU at middle drive and then DP, BR, and BB during the second half.

CONCLUSION: This study described upper limb kinematics and neuromuscular activity in rowing ergometer. TBL, BR and FCU are important to transfer power at the handle by stabilizing upper limb mainly during the first half of drive phase with isometric contractions. DP, BR and BB allowed arms power production during the second half with concentric contractions. Ergonomic handle increase rower's comfort. Individualization of this ergonomic handle would need to be investigated.

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HOW TO MEASURE INTENSITY DURING ON-WATER SPRINT KAYAKING?

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INTRODUCTION: In cycling the use of power meters is the most used way to assess the intensity of the athlete. It is an objective measure of intensity, and it is not dependent of the slope and/or weather conditions. The measurement of power is relatively easy and mechanically transparent. However, the measurement of power in on-water sprint kayaking is actually very complicated. The reason is that for measuring power you need a force and a velocity. The force one could get from an instrumented paddle, but the question remains which velocity to take and at the same time make sure that the calculated power output is independent from for example wind conditions.

In this work, we present therefore an alternative method to calculate the intensity of a kayaking athlete using impulse based on measured paddle forces.

METHODS: One male national athlete (Age: 20; Body mass: 91.5 kg; Height: 179.5 cm) participated in a test. The athlete did an all-out effort on a 500m on-water kayak sprint. Paddle forces, footrest forces, and velocity were obtained with a sample rate of 100 Hz using the E-kayak system (APlab, Rome, Italy). Bonaiuto et al. (1) has described this system in more de-

tail. The impulse was calculated as a moving integral of the absolute paddle force values over a window of 5 seconds and is expressed in N·s.

RESULTS: The time over the 500 meter was done in 115 s. The moving impulse over 5 seconds peaked already at 10 seconds with a value of 1500 N·s after which the produced impulse decreased over time. The velocity shows the same development as the 5-second impulse indicating that the intensity goes down because of fatigue.

CONCLUSION: The advantage of using impulse is that the calculation is straightforward, transparent, and mechanically sound. The calculation of impulse is based on the forces delivered by the athlete and is, therefore, independent of environmental conditions. Therefore, with headwind the same athlete would produce the same kind of impulse, but the speed would be lower. There is great potential that in the kayak community, impulse could be used as an intensity measure like power output is used in the cycling community using wearable devices. However, the expectation is that the interpretation and acceptance of impulse as an intensity measure will need time and more athlete data before kayak athletes and coaches will use it.

ACKNOWLEDGEMENTS

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A NEW JIG FOR VALIDATION OF INSTRUMENTED PADDLE SHAFTS IN SPRINT KAYAKING

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INTRODUCTION: The interest to use new technologies to record paddle stroke forces and power in kayaking has increased over the last decade as a tool for performance development in elite athletes. However, a comprehensive validation of this new technology is needed. For this purpose, a jig is required to handle the physical inconsistencies and characteristics of the paddles, as well as differences in measurement principles. The aim was to further develop a previously described calibration jig (Aitken and Neal 1992) concerning calibration and evaluation of sensors attached to paddle shafts to record stroke forces.

METHODS: A jig was developed by means of modifying a strength training weight stack and adding commercially available aluminum profiles (40x40mm) with open grooves that permit versatile fastening of various panel elements such as shaft and blade support and rotation devices. A force transducer was positioned beneath each support position to record the blade and top hand forces in the vertical plane. To record the bottom hand force a sling was placed around the shaft at the bottom hand position and connected to a force transducer attached to the weight stack. A linear motion path recorder enabled vertical and horizontal displacement was attached to the jig frame to calculate shaft stiffness and measure positions. Two strain gauge based counter-levered moveable sensors (MS) measuring force in one plane were mounted on a GUT-wing blade elite-paddle and sensor responses were recorded with stepwise vertical loading from 5 to 50kg and the paddle rotated stepwise from ±15º to ±45º from the initial vertical force direction. In addition, the response of embedded force sensors (EFS) in four paddle shafts (Gen 2.1, One Giant Leap, Port Nelson, NZ) with Jantex and Bracá blades were recorded at stepwise vertical loading (10, 20, 30 and 40kg) without rotation.

RESULTS: The recorded responses of all force sensors showed correlation coefficients indicating a highly linear response in the vertical force direction. The r-values for MS were 0,9945 (left) and 0,9979 (right) while for EFS the range was from 0,9992 to 0,9998 (n=8). A lowered response of the MS sensors was significant in stepwise rotation of the paddles from the initial vertical force direction on both left (L) and right (R) sides. At +45º L 69%, R 63%; +30º L 83%, R 75%; +15º L 95%, R 85%; -15º L 94%, R 90%; -30º L 86%, R 81% and at -45º L 68%, R 67%.

CONCLUSION: Performance of sensors based on different measuring methods to measure stroke forces during sprint kayaking can be feasibly evaluated during static conditions with the versatile jig. In addition, the present study shows decreased responses in one plane sensors with rotation out of force plane.

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STRUCTURAL OPTIMISATION OF A BICYCLE USING A MULTI-INSTRUMENT EXPERIMENTAL DESIGN

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INTRODUCTION: Optimising the structure of the bike is a key element in increasing rider performance. Studies show that parameters such as saddle height modify the mechanical work of the lower limb joints and alters the pedalling efficiency (1)

A multifactorial experiment was developed to optimise the bike structure according to the settings and therefore the position of the rider. The objective of this study is to optimise certain parts of the bike such as the bottom bracket, the headset and the saddle tube/frame junction by studying the effects of the parameters on the structure using inertial measurement units on the rider and deformation gauges on the test bench.

METHODS: The study was performed by 6 non-professional riders (3 males 3 females). 4 IMUs (COMETA WaveTrack) were placed on the subjects. One in the lower back, one on the upper right thigh, one under the right knee and the last one on the right foot (2). Strain gauges have been placed on the handlebars (left and right) and on the saddle and calibrated before each test (3). These datas are collected through an ARDUINO board. The pedals are instrumented to obtain the cyclists cadence and pedalling power (GARMIN Vector 3).

The full factorial experiments have as parameters and levels: the saddle height (distance from the ground to the crotch *0.883 or -5% of this value), the position of the handlebars on the axis of the bicycle, and the pedalling rate (60 or 80 rpm (4)).

The test session consisted in a 10 min warm-up and 8 trials of 30 seconds duration where the pedal rate is stabilized, each with a different parameters combination.

IMU data was processed with a quaternion based Kalman Filter. The data sets were implemented in a Matlab 2022 code to obtain the associated rotation matrices and therefore the Euler angles.

RESULTS: Several results were obtained in this study showing the influence of some major parameters. As example, results show that there is a 100% increase between the 2 extremes positions of the experiment on pedalling power. On the other hand, the saddle height has little influence.

CONCLUSION: The results obtained from this multi-instrument experimental design have shown that the parameters of the test bench settings, and therefore of the riders position, influence the forces applied to the structure. An optimization model is proposed to improve a specific structure for each rider.

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Invited symposia

IS-MH08 In-hospital precision-based exercise in children, adolescents and young adults with cancer as the new frontier of "exercise is medicine" paradigm

EXERCISE TOLERANCE IN CHILDREN, ADOLESCENTS AND YOUNG ADULTS WITH CANCER: NON-INVASIVE ASSESSMENT IN COMPLEX CLINICAL SETTINGS

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A meticulous approach to Precision-based exercise programs (PEx) includes a sensible functional evaluation of every CAYA-C to set the right amount of training, in quality and quantity provisions, exactly as pharmacological treatments are typically prescribed. This is a big challenge for clinical exercise physiologists and pediatricians; however, the reward could be enormous, and the CAYA-C disability conversation flaws lessened. Collection of accurate data regarding the follow-up of CAYA-H's exercise tolerance is not trite: due to the pharmacological toxicity related to life-saving treatments and bedridden consequences, they experience a roller coaster of symptoms that vary from days where PEx are fully affordable to others where severe fatigue is prevalent. The fatigue also affects a patient's motivation to be evaluated and trained. Phenotyping correctly a population before starting PEx is mandatory in order to facilitate personalized risk assessment and the development of targeted exercise prescriptions to optimally prevent or manage systems toxicity after a cancer diagnosis. Following this rationale and because the efficiency of our systems is really understood when the oxidative metabolism pathway is under stress (during an augmented metabolic request), the researchers of the FORTEe research program (EU Horizon 2020 fund) would like to introduce performance tests in hospital for CAYA-C undergoing PEx. The study participants will be randomly assigned to one of two groups: the experimental group (exercise group) receiving a PEx and a control group which receives usual care.

Customizing PEx requires a battery of functional evaluation tests such as those used amongst athletes, including the evaluation of endurance, resistance, balance, and flexibility capacities. An exhaustion test for example can contribute to the correct allocation into a specific phenogroup with a correspondent training protocol. The complication is that functional evaluation tests have to be performed in restrictive clinical settings and require a daily consultation between sport medicine experts and pediatricians. Evaluating the individual maximal exercise tolerance is the most accurate way to define PEx and to assess longitudinally their impact in CAYA-C. By using a careful evaluation of the impact of exercise on physiological and social outcomes is possible to adapt the intervention that can be modulated on a daily basis. The use of technology to motivate training in CAYA-C can make a difference in the adherence to evaluation and training sessions.

For the purposes of the FORTEe project, evaluation protocols have therefore been written and are used by the exercise professionals of the 8 clinical centres across Europe that are recruiting 450 CAYA-C over 30 months. These evaluation protocols, once tested and proved to be useful, could become international guidelines.

PRECISION-BASED TRAINING PROGRAMS IN CHILDREN, ADOLESCENTS AND YOUNG ADULTS WITH CANCER: QUANTITY AND QUALITY MATTER WHEN WORKOUTS ARE IN COMPLEX CLINICAL SETTINGS

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Exercise programmes based on precision-adapted exercise (PEx) are an emerging therapeutic option in paediatric oncology and fully encompass the indications provided by the WHO Global Disability Action Plan. The exercise as medicine paradigm is fulfilled by PEx, especially when they start from the earliest days of neoplasia onset and include the most medically fragile CAYA-C, with the inclusion of organ transplant recipients. This is a great challenge for clinical exercise physiologists and paediatricians; however, the rewards could be enormous and the shortcomings of the CAYA-C disability conversation reduced. PEx can also be useful in order to demonstrate sub-clinical impairment of oxidative metabolism systems, compared with what clinicians could diagnose after a medical visit during bed-rest. The body systems are critically challenged during exercise, which triggers structural weaknesses or damages as well as a reduced cardio-respiratory reserve.

The use of generic exercise prescriptions may actually mask the full therapeutic potential of exercise treatment in oncology. In essence, the manipulation of training variables such as volume, intensity, frequency and recovery is an attempt to systematically structure training through phases to optimize physiological and psychological adaptations in an athlete who is also a cancer patient. Finally, recovery and rest are crucial in restoring the availability of nutrients and energy substrates to replace necessary system components (protein in muscle). The researchers of the FORTEe research program (EU Horizon 2020 fund) would like to introduce PEx in hospital adapted to the intensity of the cancer treatment: the most adapted PEx are intended for the most medically fragile children, who usually require long hospital stays; CAYA-C under very intensive and moderately intensive cancer treatments can afford more intensive workouts and they usually are trained in the hospital, but outside the wards. Combined training will be available for CAYA-C of the FORTEe program: cardiorespiratory, resistance, neuromotor and flexibility are considered as part of the PEx. Training sessions are adapted each day in accordance with the clinical condition of the individual participant and after discussing with the treating paediatrician the types of exercise that may be risky for CAYA-C, a precision-based training approach.

For the purposes of the FORTEe project, PEx have therefore been written and are used by the exercise professionals of the 8 clinical centres across Europe that are recruiting 450 CAYA-C over 30 months. These training protocols, once tested and proved to be useful, could become international guidelines.

The impact of this intervention seems to demonstrate, according to the first results of FORTEe project, that PEx are safe and really inclusive also of the frailest CAYA-C.

DEVELOPMENT OF NOVEL TECHNOLOGY APPLICATIONS IN PRECISION-BASED EXERCISE PROGRAM IN CHILDREN, ADOLESCENTS AND YOUNG ADULTS WITH CANCER: MOTIVATION IS A MUST

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An important innovation in the precision-based exercise programs (PEx) and sports in children, adolescents and young adults with cancer (CAYA-C), is the use of technology to motivate training as well as to maintain a high adherence to evaluation and training sessions. Another common challenge faced by families and CAYA-C during several periods of cancer treatment is that the patients immune system is compromised. Thus, CAYA-C are advised to keep their physical distance and stay at home instead of going to kindergarten, school or work. In order to face these specific challenges, all participants in the FORTEe research program (EU Horizon 2020 fund) will receive additional training at home during periods of recovery from cancer treatment. Within the FORTEe research project there are several technologies:

1) a FORTEe app for exercise (on a dedicated tablet provided by the exercise professional team), will help exercise professionals to personalise training. The application will also include a visualisation adapted for children, with the aim of increasing their motivation to participate in the process of personalising training. The tool will also contain a catalogue with different exercises with graphics adapted to children and young people;

2) An augmented reality app (on a dedicated smartphone provided by the exercise professional team), will try to improve training adherence and increase the flexibility of the training site.

3) A virtual personal trainer (on a dedicated TV screen in the gym in the hospital) will allow PEx where CAYA-C can imitate the movements and perform exercises settled by the exercise professionals after a consultation with the pediatricians. The screen captures over 30 points of the body and provides children with feedback on correct posture. This helps to avoid incorrectly performed movements. The tool allows exercise professionals supervising the intervention to integrate exercises that are customised to the individual patient. This will eventually increase the CAYA-C compliance.

Another essential part of the use of technology is the possibility of creating databases dedicated to collecting data that may emerge from multi-centred clinical trials and simultaneously monitoring the recruitment process and evaluating the impact of PEx on this population.

Oral presentations

OP-BM19 Team Sports

SEX-SPECIFIC KINETIC AND KINEMATIC CHARACTERISTICS UNDERPINNING CHANGE OF DIRECTION PERFORMANCE IN BASKETBALL PLAYERS

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INTRODUCTION: In basketball, change of direction (COD) activity comprises ~20.7% of the speed demands, being determinant during both offensive and defensive moments of the game (1). Although there is a great deal of literature investigating COD performance related factors (2), sex-specific information is still limited (3). Consequently, training for women basketball players is often informed from men data. Interestingly, the recent inclusion of microtechnology allow basketball coaches to monitor reliable kinetic and kinematic measures during sport-specific tasks (4,5), which might help to provide a precise sex-specific characterization of different CODs. Therefore, the aims of this study were to (I) evaluate the sex-specific kinetic and kinematic outcomes underpinning COD performance, (II) compare the kinetic and kinematic outcomes across three different COD tasks, and (III) examine the sex- and test-specific outcome most strongly related to COD performance in basketball players.

METHODS: Thirty young basketball players (17 men and 13 women) competing at the national level were assessed for the modified 505 test, modified T-test and V-cut test. The maximum values of acceleration (ACCmax), deceleration (DECmax), velocity (VELmax), and centripetal force (CentFmax) were measured using Local Positioning System technology (WIMU PRO, Realtrack Systems S.L., Almería, Spain).

RESULTS: Men players displayed greater ACCmax, VELmax, DECmax, and CentFmax outputs for each section of the 505 test, T-test, and V-cut test (all, $p < 0.05$), resulting in a faster COD performance than women players across tests (all, ES > -1.42; 95% CI = -3.45 to -0.57). The 505 test demanded significantly greater kinematic outputs than T-test, and V-cut test for men ($p < 0.001$) and women players ($p < 0.01$), respectively. In addition, ACCmax explained ~26-58% of the variability in COD time for men players, while DECmax and VELmax explained 38% and 53% of the variability in T-test and V-cut test time, respectively.

CONCLUSION: These findings suggest that using men and women COD data as interchangeable information may lead to important errors of interpretation when testing and training. The test-specific kinematic profile should be considered to regulate COD intensity, especially to progress in the ACCmax and DECmax demands, which require an optimal player's physical capacity to tolerate the associated loading. Men and women basketball players present different COD determinants, which may help coaches to prescribe individualized training programs.

ANALYSIS OF THE BIOMECHANICAL RESPONSE TO UNANTICIPATED IMPACTS IN PROFESSIONAL RUGBY UNION

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ENSAM PARISTECH

INTRODUCTION: The concussion study is of growing interest in professional rugby union, in particular due to the increase of its incidence in last decades. Concussion prevention requires a better understanding of the biomechanical parameters involved in risky play phase. Tackle is identified as the main cause of concussion and certain factors are likely to increase this risk. During unanticipated tackle, the players attention is focused on ball possession or teammates movement, and therefore, the player is more vulnerable to collision. The aim of this study is to analyze the biomechanical response of professional rugby players to unanticipated impacts.

METHODS: 17 professional rugby players participated in this study. They were categorized into two position groups: forwards and backs. An impact simulation device has been developed to reproduce unanticipated tackles under safe and reproducible conditions. Each participant experienced a total of 12 impacts, on the right and left lateral faces, during a motor dual task situation. To evaluated the kinematics response to the impact, players were equipped with 4 inertial units (Vicon, 1200 Hz), positioned on the head, the C7 cervical vertebra, the sternum and the sacroiliac line. The influence of position on player kinematic response was identified using a one-way analysis of variance.

RESULTS: The maximum values of linear and angular accelerations were calculated for each segment. The variance analysis revealed a significant influence of the position on the linear and angular head accelerations: the acceleration peaks are higher for the backs than for the forwards ($p<0.001$). Two head injury criteria were included in this study: the Severity Index and the GAMBIT. For these two parameters, the mean values are higher for the backs than for the forwards ($p<0.001$).

CONCLUSION: We propose an original experimental device for studying unanticipated impacts in a controlled environment. Results showed that the backs experienced higher head acceleration peaks and higher injury criteria than the forwards. These results indicate that when faced with the same impact, backs are characterized by a wider head kinematic response, exposing them to a greater concussion risk. These findings can be explained by the morphological characteristics, weaker for backs than for forward. Indeed, analysis revealed the existence of a negative correlation between the morphological characteristics and the head kinematic parameters associated with concussion risk. Another explanatory factor concerns the higher level of cervical strength in the forwards than in the backs, due to their greater involvement

in combat actions. It is possible that these adaptations also participate in limiting the concussion risk by reducing the magnitude of the head kinematics after the impact. This study improves our understanding of the biomechanical mechanisms involved in unanticipated tackle and provides intervention perspectives for sports staff to implement concussion risk prevention strategies.

THE EFFECT OF LEG DOMINANCE ON THE FREQUENCY AND 3D KINEMATICS OF SOCCER PASSING IN FEMALE ACADEMY PLAYERS

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INTRODUCTION: The execution of sub-maximal passes using both feet is fundamental in football as it underpins possession retention and goal scoring. Biomechanical research has focussed on maximal kicks performed by male players. Limited analyses of female players have generally examined gender differences in adult populations. There is a need for female specific research especially within the youth development phase where skill acquisition occurs most easily (1). The aim of this study was to examine the effect of leg dominance on the frequency and 3D kinematics of sub-maximal passes in female academy players.

METHODS: Twelve, female footballers (age: 13.7 ± 0.5 years) from an FA National League academy participated. The frequency and success rate of sub-maximal passes performed in a league game were established via live-match coding (SportsCode). 3D data were collected using a 12-camera Vicon motion capture system sampling at 240 Hz. 16 markers were attached to the lower body then using a 2-step run-up, participants completed ten sub-maximal passes, 5 on each leg towards a target (1.2m by 0.8m) 7m away. Temporal characteristics and kicking leg kinematics were calculated using Vicon Nexus, Pro-Calc and Matlab. Asymmetry was examined using paired-samples t-tests.

RESULTS: Players completed more passes ($p = 0.000$) with a higher level of accuracy ($p = 0.028$) with their dominant leg. In dominant leg passes, the pelvis was consistently in a significantly more closed position relative to the target with the difference ($p = 0.020$) being largest at ball contact (Dom = -34.1 ± 96.6°; Non-Dom = -43.1 ± 6.5°). Increased pelvis obliquity with an elevated kicking side was also observed at maximum kicking leg knee flexion (Dom = -10.0 ± 4.5°; Non-Dom = -7.0 ± 2.7°). Other differences included a significantly shorter leg cocking phase ($p = 0.011$), significantly less ankle dorsiflexion at ball contact ($p = 0.039$) and the standing foot being positioned significantly closer to the ball ($p = 0.018$) when the dominant leg was used.

CONCLUSION: The increased frequency and accuracy of sub-maximal dominant foot passes suggests that players only used their non-dominant foot when the match allowed for a lower level of accuracy (2). Superior accuracy with the dominant leg appears to be caused by increased technical proficiency. Less pelvis rotation away from the target and positioning the standing foot closer to the ball potentially created a smaller foot arc and encouraged players to strike through rather than across the ball (3). The increased pelvic obliquity during the leg acceleration phase could also have caused a rapid pelvis drop before ball contact which has been associated with improved foot speed and control. These findings provide important coaching cues for adolescent female footballers and highlight the need for further biomechanical research within this demographic.

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Oral presentations

OP-AP24 Team Sports Training

DEVELOPMENT IN PHYSICAL FITNESS DURING YOUTH YEARS IN TEAM SPORT ATHLETES: A SYSTEMATIC REVIEW.

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INTRODUCTION: During youth, large improvements in physical performance occur due to growth and maturation. The timing and tempo in development vary considerably, and earlier maturing athletes are found to outperform their later matured counterparts in several physical performance tests (Malina, 2004). Whether training load have any additional effect is somewhat uncertain, with limited research addressing this matter. Physical development also varies between sexes, with girls tending to plateau their development at an earlier stage compared to boys, as observed in the general population (Malina, 2004). The aim of this systematic review was to investigate the development of physical fitness throughout youth years among team sport athletes.

METHODS: A systematic search of various electronic databases was conducted combining keywords related to physical fitness, youth athletes, team sport and study design. The included articles studied various physical characteristics tests

such as sprint, change of direction ability, endurance, and strength, as well as training load and maturation. Results were normalized and weighted relative to sample size to have a larger database for comparisons.

RESULTS: Hundred and seventy-four eligible articles were identified, but due to large diversity in testing methodology, data from 114 were included in the analysis. In general, the data showed a steady annual improvement in most physical characteristics over time for both boys (lower body strength 12.5 % (-6-27 %); specific endurance 13.5 % (10-16 %); CMJ 7.9 % (4-10 %); 30-m sprint -3.7 % (-6-1 %)) and girls (lower body strength 5.7 % (-1-9) %; specific endurance 10 % (-2-25 %); CMJ 5.1 % (2-7 %); 30-m sprint -1.9 % (-4-0 %)). Only 17 studies included measures of training load.

CONCLUSION: Findings shows a progressive improvement in most physical characteristics throughout the youth years, in both girls and boys. However, girls tend to have a less pronounced development compared to boys, likely due to less increase in lean mass (Malina, 2004). Comparable findings were observed in comparison to the general population, raising doubt regarding the potential additive effects of participating in team sports on this development. There is also a large diversity in testing methodologies for different physical qualities, limiting the effectiveness of comparisons with the literature for researchers and practitioners. Future research should include measures of training load data to better understand the effect training has during this period.

THE PREVALENCE AND APPLICATION OF 'OFF-FEET' TRAINING PRACTICES WITH PROFESSIONAL TEAM SPORT ATHLETES

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INTRODUCTION: Metabolic conditioning of team sport athletes typically involves a combination of field-based high-intensity interval and game-specific training [1]. There has been recent interest in the effectiveness of 'off-feet' training (i.e., cycling, rowing, upper body ergometry), which has been advocated for athletes who might require careful load management. However, the prevalence and application of this form of training are not yet known. Therefore, the aim of this study was to explore off-feet training use in professional team sports.

METHODS: A snowball sampling approach was used, where those responsible for the delivery of strength and conditioning and rehabilitation of professional team sport players were targeted and then asked to forward an electronic survey. The survey comprised 27 questions in four sections (demographics, pre-season use of off-feet conditioning, in-season use of off-feet conditioning, and use of hypoxic training with off-feet conditioning). Fifty-nine respondents were included in the final analysis. Participants were sport scientists (28.8%), strength and conditioning coaches (49.2%), physiotherapists (8.5%) and 'other' (13.6%). The sports represented were rugby union (25.4%), rugby league (18.6%), soccer (40.7%), hockey (8.5%), netball (1.7%), cricket (1.7%), basketball (1.7%) and 'other' (6.8%). Respondents worked with males most often (89.8%).

RESULTS: Of the 59 respondents, only three reported not using off-feet training methods at any time. Cycling was used by more practitioners than other forms of training ($X2 = 93.6$, $P < 0.0001$). Thirty-seven (62.7%) of the respondents used more than one type of off-feet training, whilst 15 (12.7%) used only cycling. Season stage normally had no effect on whether off-feet conditioning was adopted. Practitioners typically prescribed 1-2 off-feet sessions per week (67.9%), but load managed players were likely to complete off-feet training more frequently than uninjured players ($X2 = 41.786$, $P < 0.001$). Load managed players were also more likely to undertake off-feet conditioning as a main training stimulus ($X2 = 30.42$, $P < 0.001$). Short intervals (< 60 s) were the most used forms of off-feet training ($X2 = 148.601$, $P < 0.0001$), and heart rate (50.8%), rating of perceived exertion (54.2%) and power output (37.3%) were the most frequent prescription methods ($X2 = 36.525$, $P < 0.001$). Eighteen (30.5%) participants reported using hypoxic training in conjunction with off-feet conditioning, with lack of facilities (50.8%) being cited as the most common reason for not using this approach.

CONCLUSION: Off-feet training is a prevalent approach to metabolic conditioning in professional team sport players, despite limited research on its efficacy. This research provides a basis for researchers to examine this training method and ensure best practice with athletes.

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EFFECTS OF ROBOTIC SPRINT RESISTANCE TRAINING ON ACCELERATION AND SPRINTING PERFORMANCE OF FIELD HOCKEY PLAYERS

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INTRODUCTION: Athletic abilities such as acceleration and maximum speed have gained overwhelming importance in recent years. Sprints in field field hockey are very short with an average distance of 8-13 m (Vanwanseele & Aeles, 2016). The majority of duels are decided in the first few meters and rule changes by the International Hockey Federation of 2015 (playing time 4x15 min) further increased the average intensity of the game. Morin et al. (2016) reported that in team sports with short sprints the relationship between sprint performance and horizontal force increases. Studies with individualized training are necessary to determine the appropriate loading parameters to improve athletic performance.

METHODS: For the study, 9 athletes each were recruited for the intervention group (IG) and for the control group (CG). The IG completed individualized resistance training using the 1080 Sprint, whereas the CG continued conventional sprint resistance training. The intervention included two training periods of 5 weeks (2 sessions) each (3x4x20-m sprint). Unfortunately, it was not possible to measure a CG during the first project stage. Therefore, the following are the results of the second training stage (April to May 2022) exclusively. In the first training session, a load-velocity profile (LVP) was created

for all athletes. Starting from the second week of training, the individual LVP was applied to achieve a targeted speed loss of 10 % to a maximum of 20 %. The sprint distance of the second training period was reduced to 3x4x10-m due to the high training and competition load.

RESULTS: There was a significant improvement in the IG of sprint time over 20 m of 0.07 s (3.22 s vs. 3.15 s). The CG values also showed a significant improvement of 0.06 s (3.18 s vs. 3.12 s) in the 20-m sprint. Sex-disaggregated data showed no marked differences between IG and CG. Despite better baseline performance, the IG showed higher performance improvements in the 20-m sprint than the CG.

CONCLUSION: It has been shown that individualized sprint resistance training with the 1080 Sprint improves sprint acceleration and maximal velocity of a 20 m sprint from a standing position. This supports scientific studies that have shown lower or comparable positive effects on acceleration in team sport athletes (soccer and rugby) with resistance training (Rakovic et al., 2018; Cross et al., 2018). However, this study did not demonstrate a superior effect of individualized resistance training over established training on sprint performance. Separated by gender, the performance level of both female and male players in the IG was higher than in the CG before and also after the intervention. In that circumstance, the increase in IG sprint performance after the second training period is all the more remarkable. In summary, individualized sprint training using the 1080 Sprint was shown to be a suitable and promising training tool to realize targeted performance progress in relatively short periods of time.

EFFECTS OF RESISTED SLED PUSH AND SLED PULL TRAINING ON SPRINT VELOCITY IN FIELD HOCKEY PLAYERS

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INTRODUCTION: During competition, field hockey players rarely reach their maximum velocity (Vmax); therefore, the ability to accelerate becomes very important on short distances inferior to 15m (West et al., 2013). To improve the acceleration abilities, one training method is to add resistance while sprinting and commonly referred to as "resisted sprint" (Cahill, al., 2019). This resistance can be added by sled pulling (SPull) or sled pushing (SPush). Both training modalities leads to different technical adaptations. SPull and SPush positions are similar to the start and acceleration phases of a sprint, but SPush does not allow to use trunk and arms that have a great importance in the forward propulsion (Slawinski et al., 2022). The aim of this study is to compare the effect of SPull and SPush training methods on sprint times and individual force-velocity (F-v) profile's factors.

METHODS: Fifteen young national field hockey were split into two groups: SPull (8) and SPush (7) training. Each group performed 12 resisted sprint training session twice a week. Training protocol was divided into 3 phases: power, strength and velocity. Pre and post tests were composed of a F-v test (Fornasier-Santos et al., 2022) to measure the theoretical force (F0), velocity (V0) and maximal power (Pmax). A 15m sprint with ball and cross test was also perform to measure field performance (P15m). To compare effect of training, data were analyzed using a repeated measures ANOVA in complement of a post-hoc test when necessary.

RESULTS: The results demonstrated that there was no interaction effect ($p>0.05$), just a training effect for V0 and F0. V0 decrease following training (8.48±0.48 vs 8.28±0.47 m.s-1; $p\leq0.001$) and F0 increase (7.3±0.5 vs 7.7±0.9 N.kg-1; $p\leq0.01$). Other parameters remained constant ($p\geq0.05$).

CONCLUSION: Both SPull and SPush allowed to improve F0 and to break down V0. Contrary to our hypothesis the use of the arms and the trunk during sprint training seems to have no effect in the modification of the F-v profile. To conclude, SPull either SPush can be used to improve the acceleration phase in sprint running.

CHANGES IN PEAK FAT OXIDATION FROM PRESEASON TO COMPETITIVE SEASON IN PROFESSIONAL MALE FOOTBALL PLAYERS

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INTRODUCTION: Football is an intermittent sport with high aerobic and anaerobic energy turnover demands, and high-intensity running bouts during matches are considered decisive. Interestingly, recent studies found that peak fat oxidation rates (PFO) are high in professional football players compared to other athlete types. It remains unexplored whether PFO varies during a season and if PFO has implications for physical performance in football. This ongoing study aims to investigate if PFO increases from the early preseason period to competitive season and if PFO is related to the physical performance in match-play for professional male football players.

METHODS: 36 professional male football players from the Danish Superliga undergo laboratory testing during the first week of winter preseason and 11 weeks later during the competitive season (in-season). Testing is conducted during season 2021/22 and 2022/23 and consists of a whole-body dual-energy x-ray absorptiometry scan (body mass: 79.4±2.5 kg, fat-free mass: 65.2±1.9 kg, fat percentage: 13.1±0.9%, (mean±95% confidence interval) and a graded exercise test on a treadmill determining PFO, the intensity eliciting PFO (Fatmax) and peak oxygen consumption (VO2peak) (0.63±0.07 g/min, 40 ± 3%VO2peak and 57.0±1.6 ml/min/kg, respectively).

Furthermore, the players' physical performance is assessed by in-match measurements of running speed and heart rate, but these data are yet to be collected and analysed.

RESULTS: At the current stage, nine players have completed in-season testing (season 2021/22) and compared with preseason levels (paired t test) no changes were observed for PFO (mean change: 0.03±0.11 g/min, p=0.494) and Fatmax (2±11%VO2peak, p=0.690). VO2peak did not increase significantly from preseason to in-season testing (1.6±1.7 ml/min/kg, p=0.064). The fat percentage decreased by 1.2±0.9%-points, p = 0.015, due to a 1.0±0.7 kg, p=0.014, decrease in fat mass and a numerical increase in fat-free mass (0.8±1.1 kg, p=0.126).

CONCLUSION: The preliminary results suggest that PFO and Fatmax are not increased in-season compared with early preseason, whereas VO2peak tends to increase and the body composition becomes leaner during the same period in professional male football players. This implies that football preseason training does not improve PFO in highly adapted players, however it remains to be seen whether PFO is associated with physical performance in match play for professional male football players.

Oral presentations

OP-MH17 Health and fitness in children

SLEEPING VARIABILITY AND PHYSICAL ACTIVITY OF 17-YEAR-OLD ICELANDIC UPPER SECONDARY STUDENTS.

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INTRODUCTION: Adolescence is a period characterized by immense physical changes and neurological development [1]. Therefore, adolescents are especially sensitive to variations in their sleeping pattern and physical activity (PA) levels. Studies have shown that adolescents' sleep duration is both short and varied [2]. Similarly, adolescents live a sedentary lifestyle; over 80% of 11–17-year-olds are not fulfilling PA recommendations [3]. The aim of this study was to compare variability in sleep and PA between students with traditional (TSS) and college-style school schedules (CSS).

METHODS: Data was gathered in March-May of 2021. Free-living sleep and PA were measured via Actigraph accelerometry (ActiGraph Inc., Pensacola, Florida, USA) in 75 students at age 17 (28 male). Of those participants, 67% had CSS. Difference in sleep and activity between TSS and CSS were assessed with independent t-tests, ANOVA, and linear regression models, and adjusted for height, weight, BMI, total sleep time and sleep onset.

RESULTS: Difference in mean sleep duration was not significant between school systems; average sleep duration was 6.5 ± 0.8 hours. Intra-individual sleep variability was significant between school systems; mean variability was 0.8 ± 0.4 hours/night and 1.4 ± 0.8 hours/night in students with TSS and CSS, respectively ($p < .001$). Difference in sleep midpoint was also significant; mean midpoint of sleep was 04:01am ± 0.7 hours for students with TSS and 05:02am ± 1.2 hours for students with CSS ($p < .001$). Difference in PA was not significant between school systems; students with TSS had a mean of 20238 ± 7607 counts/day while students with CSS had a mean of 20054 ± 7662 counts/day.

CONCLUSION: Icelandic secondary students have both short and variable sleep schedules [4]. Our results indicate that students with CSS have greater variability in their mean- and midpoint of sleep compared to students with TSS. Difference in PA between school systems was not significant. This indicates that the more intermittent nature of CSS exacerbates students' already poor sleep compared to more structured school start times in TSS. Future studies should explore ways to reduce students' sleep variance via streamlining school schedules

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IS CHILDREN'S SPORTS PARTICIPATION ASSOCIATED WITH THEIR HEALTH-RELATED PHYSICAL FITNESS?

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INTRODUCTION: The involvement of children in sports has been linked to health markers during adolescence and adulthood [1]. Also, health-related physical fitness (HRPF) is a marker of health [2]. Therefore, we investigated the relationship between sports participation (SP) and HRPF components.

METHODS: The sample comprised 821 Portuguese children (436 girls), aged 6-10 years, from 29 schools. Cross-sectional data were collected from January 2022 to June 2022 (after the COVID-19 pandemic). Several HRPF components were assessed: morphological (body mass index (BMI) and waist circumference (WC)), muscular (standing long jump and handgrip strength), motor (shuttle-run and 50 yards dash) and cardiorespiratory (PACER) [3,4]. Children's SP was obtained from parents via questionnaire. Given the hierarchical structure of the data (children nested within schools), multilevel modelling was used, with sex and age as covariates. All calculations were done in STATA 14.

RESULTS: Although girls (53%) tend to participate less in sports than boys (65%) (Chi-square=12.413, p<0.001); yet, no age-differences were found in SP for either sex (p>0.05). Multilevel results showed that in the morphological component, SP was not related to BMI (b=-0.26, SE=0.2, p=0.291) nor to WC (b=-0.77, SE=0.60, p=0.195). In the muscular component, SP was unrelated to handgrip strength (b=-0.46, SE=0.29, p=0.116) but was significantly linked to standing long jump (b=3.59, SE=1.38, p=0.010). In the motor component, SP was significantly associated with the shuttle-run (b=-0.25, SE=0.08, p=0.002) but not with the 50 yard-dash (b=-0.12, SE=0.08, p=0.146). Children more involved in SP had better cardiorespiratory fitness (b=2.56, SE=0.65, p<0.001). Further, and on average, boys tended to be fitter than girls in almost components (p<0.05), except the morphological one. Finally, as children grew, from 6 to 10 years of age, they were systematically fitter in all components (p<0.05).

CONCLUSION: Although boys were fitter than girls, SP proved to be an important asset to significantly associate with children HRPF. Yet, no such link was found for the morphological component.

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DETERMINANTS OF FIVE YEAR IMPROVEMENTS IN MOTOR PERFORMANCE AND FITNESS AMONGST PRIMARY SCHOOL CHILDREN

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EXERCISE AND MOVEMENT SCIENCES

INTRODUCTION: Motor performance is a cornerstone of being able to participate in organised sports and for establishing and maintaining an active lifestyle throughout the lifespan. Cardiovascular fitness during childhood is a good predictor of health in adult life. The development of those aspects during childhood is influenced by education, environment, nutrition and family habits. Identifying factors that negatively affect motor performance and fitness development could allow to target disadvantaged children to improve their activity and health outcomes in adulthood. The aim of this study is to identify determinants of motor performance and fitness development during primary school.

METHODS: In the first and fifth grade motor performance, fitness, and body composition were assessed in all children in the municipality. Parents were asked to indicate their monthly household income to assess socioeconomic status in seven categories. Motor performance tests included 20-meter sprint, balancing backwards and side hopping, while fitness was assessed by a 20-meter shuttle run. Linear mixed effects regression models were used to identify associations with developmental trajectories. Mean and standard deviations are presented for descriptive data and effect sizes (cohen's d) and p-values for regression results.

RESULTS: 1564 children were assessed in both grades and 418 questionnaires were returned. Children were 50% female, 7.4 (±0.4) years of age in first grade, BMI was 16.3 (±2.4) kg/m2, and SES was 5.4 (±1.8). There was no credible influence of socioeconomic status on developmental trajectories of any performance test (p>0.1). A higher initial BMI (+1kg/m2) was associated with slightly reduced improvements in jumping (d=-0.04, p=0.02), sprinting (d=-0.07, p<0.01), and shuttle-run (d=-0.12, p<0.01) performance but was not credibly associated with balance performance improvements (d=-0.03, p=0.86). Girls showed reduced improvements in jumping (d=-0.14, p<0.01) and shuttle-run (d=-0.44, p<0.01) performance but increased improvements in sprinting performance (d=0.22, p<0.01), while no credible difference was observed for balance improvements between the sexes (d=-0.02, p=0.78). Relatively (-1 year) younger children in the first grade developed stronger in jumping (d=0.33, p<0.01), balance (d=0.46, p<0.01), sprinting (d=0.49, p<0.01) and shuttle-run (d=0.53, p<0.01) performance.

CONCLUSION: Allocating resources to boost motor performance development of children with a higher BMI might be advised to improve their abilities required for participating in organised sports and maintaining an active lifestyle. This data can serve to curb expectations when it comes to motor development in older children of the same grade and girls, as their improvements are potentially reduced in some tests. In this cohort, economically disadvantaged children's development was fortunately not hampered.

EFFECTS OF A 12-WEEK SCHOOL-BASED EXERGAMING INTERVENTION ON STUDENTS' PHYSICAL FITNESS, PHYSICAL SELF-CONCEPT, AND ENJOYMENT- A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Exergames are interactive video games that stimulate an active, whole-body gaming experience. By combining electronic entertainment with physical exercise, exergames may offer novel opportunities to expand physical activity in different age groups and settings. This study aimed to investigate the effects of a school-based exergame intervention on anthropometric parameters, physical fitness, and physical self-concept (PSC). Furthermore, possible changes in enjoyment over time were assessed.

METHODS: Fifty-eight students (10.4±0.8 years; 48% girls) were randomized into an intervention (IG) and a control (CG) group. Both groups participated in regular physical education classes during the three-month intervention period. The IG additionally received a 20-minute exergame intervention twice per week in the ExerCube. At baseline and following the intervention period, body mass index (BMI) and waist-to-height ratio (WHtR) were assessed. Furthermore, a sprint test (ST), a countermovement jump test (CMJ), and a shuttle run test (SRT) were performed. PSC was assessed using the PSC scales for children (1), and enjoyment was measured using the Physical Activity Enjoyment Scale (PACES) (2).

RESULTS: A significant time × group interaction was determined in CMJ performance ($p<.001$; $\eta2=.403$), with a significant increase ($p<.001$; $\eta2=.315$) in the IG and a significant decrease ($p=.009$; $\eta2=.190$) in the CG. Furthermore, ST performance significantly improved in the IG ($p=.012$; $\eta2=.180$) but not in the CG, revealing significant interaction effects ($p=.02$; $\eta2=.157$). Significant time × group interaction was observed for the SRT ($p=.046$; $\eta2=.122$), with a significant increase ($p=.028$; $\eta2=.147$) in the IG and no changes in the CG. No significant interaction effects were detected in BMI ($p=.157$; $\eta2=.063$) and WHtR ($p=.063$; $\eta2=.114$). Significant time × group interaction effects were found for "PSC total" ($p=.015$; $\eta2=.178$), and the subscales "flexibility" ($p=.017$; $\eta2=.169$), "coordination" ($p=.045$; $\eta2=.124$), "strength" ($p>.001$; $\eta2=.388$), and "speed" ($p=.029$; $\eta2=.145$). The IG revealed significant improvements over time in "PSC total" ($p=.042$; $\eta2=.249$), "flexibility" ($p=.051$; $\eta2=.230$), and "strength" ($p<.001$; $\eta2=.551$). In the CG, no significant differences could be determined. The PACES reveal no significant changes in enjoyment ($p=.164$, $\eta2=.073$) over time in the IG.

CONCLUSION: The findings indicated that integrating regular exergaming sessions into a school setting increased physical fitness and PSC in elementary school children. These findings supported the implementation of exergames as innovative and enjoyable PA programs in school settings.

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Oral presentations

OP-BM05 Motor control: Fatigue

EFFECTS OF RUNNING-INDUCED FATIGUE ON THE STRUCTURE OF MOVEMENT VARIABILITY IN NOVICE RUNNERS

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INTRODUCTION: Fatigue is a major issue in sports science, especially for endurance sports. Running is one of the most popular endurance sports worldwide. Consequently, there is a high number of people that start running without prior experience. On the other hand, novice runners were shown to be prone to injury, possibly because they lack an adequate running style or strength to deal with the loads acting on the body. On this basis, understanding the effects of fatigue in novice runners is crucial since fatigue may associate with injuries as well as with running economy. Nevertheless, studies analyzing the effects of fatigue in novice runners are rare. Previously, it was shown that running-induced fatigue does not affect spatiotemporal parameters in novice runners but influenced the center of mass (CoM) movement (1). Therefore, the aim of this study was to investigate how the movement variability structure stabilizing the CoM trajectory changes under running-induced fatigue in novice runners.

METHODS: Fourteen healthy male novice runners participated in the study. The experiment was conducted on a motorized treadmill (h/p/cosmos). After a treadmill familiarization protocol, the participants had two minutes to recover before running at a fixed speed of 13 km/h until subjective exhaustion. Kinematic data were recorded at 200 Hz using 16 Vicon cameras (Vicon Motion Systems, Oxford Metrics Group, Oxford, UK). The uncontrolled manifold (UCM) approach was applied to a 3D whole-body model using the joint angles as elementary variables, and the CoM as the result variable (2). The portion of variability that does not affect the CoM is referred to as UCM_par, whereas the portion that has effects on the CoM as UCM_ort. The ratio of UCM_par and UCM_ort (UCM_ratio) is used to operationalize the degree of stabilization (3). By using statistical parametric mapping (SPM), the differences between the PRE and POST fatigue conditions for three UCM parameters (UCM_par, UCM_ort and UCM_ratio) were analyzed.

RESULTS: The participants continued to run at 13 km/h for 6.18 ± 2.45 min. Their exhaustion was confirmed by a Borg-scale rating of 18.7 ± 1.0 ("very very hard" (4)). The SPM results revealed significant increases in the UCM_ort but no significant effects on the UCM_par or UCM_ratio.

CONCLUSION: The increases in the UCM_ort after running-induced fatigue can be interpreted as decreased control concerning the CoM (5). However, based on the unchanged UCM_ratio, it can be suggested that the stability of the CoM was not affected by fatigue. To sum up, the running-induced fatigue increased the step-to-step movement variability in novice runners and decreased the level of control of their CoM.

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SEX DIFFERENCES IN FORCE STEADINESS AND MUSCLE ACTIVATION DURING AN INTERMITTENT ISOMETRIC EXERCISE TO TASK FAILURE

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INTRODUCTION: Previous studies have reported sex differences in the amplitude of isometric force fluctuations during submaximal isometric fatiguing contractions of elbow flexors with women (W) showing less steadiness than men (M) [1]. Similar results were observed during submaximal sustained knee-extensor (KE) contractions [2]. However, the relationship between fatigue and force steadiness of KE during intermittent isometric exercise protocols in W and M remains uninvestigated. Since exercise protocols that include intermittent rest periods may elicit considerably different responses at the muscle level in W and M compared to sustained steady-state contractions [3], this study aimed to evaluate sex differences in force steadiness and muscle activation during a fatiguing KE intermittent isometric task.

METHODS: Twenty-six young volunteers (13 W, age: 24±3yrs and 13 M, age: 26±2yrs) performed a fatiguing intermittent submaximal KE isometric exercise (3s on, 2s off) at 110% of the Critical Torque (CT) to task failure. CT was determined from the 5 minutes intermittent (3s on, 2s off) maximal voluntary isometric contraction (MVIC) test [4]. Performance fatigability was assessed as the loss in MVIC force from MVIC performed before (PRE), during (every 3 minutes) and immediately after (POST) task failure. Force steadiness was determined as the coefficient of force variation (CV) during each set of submaximal contractions. Muscle activation was calculated as root mean squared (RMS) of the EMG signal from vastus lateralis (VL) and rectus femoris (RF) normalized to RMS EMG of MVIC (PRE). All measures were extracted from a 2-second epoch in the middle of the force trace [5].

RESULTS: CT was similar between W and M (38.4 vs 36.9% of MVIC, $P>0.05$). W exhibited a longer time to task failure than M (1511±506 vs 1017±499 s, $P<0.05$). At POST, force loss was similar between W and M (-53.4 vs -55.6%, $P>0.05$). At PRE, CV was similar between W and M (3.2±1.1 vs 2.8±0.4%, $P>0.05$). During the fatiguing task, CV showed a time effect (+8.8% at half of task failure and +26.9% at POST, both $P<0.05$) with no sex effect or time x sex interaction. RMS amplitude throughout the task showed a time effect for both VL (+24.3% at half of task failure and +43.2% at POST, both $P<0.05$) and RF (+28.0% and +40.1% at half of task failure and POST, respectively, both $P<0.05$).

CONCLUSION: During the fatiguing KE intermittent isometric task, W were more fatigue-resistant than M. Force steadiness decreased comparably for W and M. Muscle activation in both VL and RF increased throughout the exercise without difference between sexes. These findings may suggest that sex-differences in force steadiness are task- and muscle-dependent.

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POSTURAL ADJUSTMENTS OF A FATIGUING FINGER HANGING TASK IN CLIMBERS: JOINT COORDINATION AND MUSCLE SYNERGIES

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INTRODUCTION: So far, the neuromechanical strategies during sustained finger hangings – a common posture to be maintained while climbing – remain unclear. Therefore, the aim of this study was to assess changes in coordination patterns and muscle synergies during sustained isometric finger hangings in climbers.

METHODS: Eleven climbers (26±5 yrs) performed a hang on a 20 mm-depth edge until failure. Fingers were maintained at open crimp gripping and arms were fully extended. Upper body kinematics was obtained with a 12-camera 3D motion capture system (Vicon, UK). Coordination strategies adopted during the task were calculated by vector coding [1], which quantifies the variability in joint relative motion, among wrist, elbow, and shoulder angles in the sagittal plane. Surface EMG from 6 muscles per limb (flexor digitorium superficialis, extensor digitorium, brachioradialis, biceps, pectoralis major,

trapezius) were measured (Cometa, IT) and processed. We analyzed the first 20% (START) and last 20% (END) of the task. Mean activation over consecutive 100ms bouts were connected for START and END. After scaling to unit variance, muscle synergies were extracted via non-negative matrix factorization, initialized by non-negative-single-value-decompensation with low-rank-correction outputs. The number of synergies was determined by the knee point of the total-variance-accounted for curve, averaged over all participants [2]. For both needed synergies the activation coefficients (AC) were averaged for START and END individually.

RESULTS: Results (mean±std) showed the coordinative patterns (degrees) in START and END between wrist/elbow (START: 201.4±42.5; END: 108.3±40.6), wrist/shoulder (158.1±237.4; 36.7±75.4), and elbow/shoulder (169.1±241.8; 30.7±50.8) couplings to be significantly different ($p<0.05$). At START, wrist/elbow coupling showed dominance of the wrist extension over the elbow, which towards the failure point, progressed to an anti-phase relationship so the elbow tended to flex as the wrist maintained or increased extension. Wrist/shoulder and elbow/shoulder couplings showed similar behaviour. Wrist and elbow changed from an anti-phase coupling with the shoulder at START, where joints were extended while the shoulder was flexing, to a shoulder flexion domination at END. Synergies also differed its contributions across the task ($p<0.001$). Namely, Synergy 1, (mainly formed by finger flexor/extensor) was less activated in END (-0.08±0.07), while Synergy 2 (mainly formed by trapezius and pectorialis) had higher participation at END (0.24±0.08) due to the differences of mean AC.

CONCLUSION: Thus, postural adjustments of climbers while sustaining open crimp hangs demand changes in coordinative patterns of the upper body joint kinematics and muscle synergies in a proximal-to-distal fashion. This allows for a balanced body position and efficient gripping, thus compensating for the neuromechanical impairments caused by fatigue.

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NEUROMUSCULAR FATIGUE ACCORDING TO INJURY HISTORY IN THE ACCELERATION PHASE OF A REPEAT SPRINT ABILITY TEST: PRELIMINARY RESULTS

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INTRODUCTION: Sprinting is a fundamental component of the professional soccer player's ability to achieve the highest performance in the sport (1) and the hamstrings muscles are crucial in sprint acceleration performance and maximal sprinting (2). The aim of this preliminary study was to analyze the influence of hamstring injury history on the neuromuscular fatigue in the acceleration phase produced by an RSA test in elite female football players.

METHODS: Ten female elite soccer players of the Second Spanish Soccer Division participated in the study. The participants were divided into: (1) a Control group who have not suffered previous muscular injuries and (2) a Hamstring group with previous hamstring injury at least one season prior to the protocol. The players performed a protocol consisting of a Repeat Sprint Ability Test (RSA) (6 × 40 m; 30 s rest). The different variables of the study were compared between groups with a two-way ANOVA for repeated measures.

RESULTS: The main findings from the present study were that, in subjects with previous hamstring injury, the performance was impaired compared with the control group in the initial meters of the sprint during an RSA, there was a higher percentage difference between SplitTT and ideal Split in 0–10 m compared to 0–20 m in the hamstring group ($p = 0.04$; ES = 0.48).

CONCLUSION: It seems that in elite female soccer players with previous hamstring injury, RSA-induced fatigue produces a greater decrease in the performance in the first 10 m of the sprint compared to the control uninjured players.

ETIOLOGY OF NEUROMUSCULAR FATIGUE IN HAMSTRING AND QUADRICEPS MUSCLES FOLLOWING SIMULATED SOCCER MATCH-PLAY

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INTRODUCTION: Our previous study demonstrated greater fatigue resistance in hamstring compared to quadriceps muscles during isolated muscle exercise (1). However, the mechanisms of fatigue and recovery in hamstring vs quadriceps muscles during whole-body soccer match-play is currently unknown.

METHODS: Eleven male soccer players (18.7±1.6 years) from an elite French academy took part in this study and performed a simulated soccer match-play (2x45 min). Maximal isometric voluntary contraction (MVC) was used to assess neuromuscular fatigue before, during and immediately after exercise on quadriceps and hamstring muscles. Central and peripheral fatigue levels were quantified via changes in preexercise to postexercise voluntary activation (VA) and potentiated twitch force (Ptw), respectively, as evoked by supramaximal nerve (quadriceps) or direct muscle (hamstring) electrical stimulation. External load during the match was documented using GPS in order to estimate fatigue (2).

RESULTS: During the match, MVC decreased in a non-linear fashion. After 15 min of exercise, MVC already decreased ($P<0.01$) by 10±7% and 11±11% in quadriceps and hamstring muscles respectively. At the end of the match, MVC was reduced by 20±10% and -25±10% in quadriceps and hamstring muscles, respectively, compared to preexercise values ($P<0.001$). Specifically, peripheral fatigue was greater in hamstring (-28±23%) compared to quadriceps (16±8%, $P<0.01$).

Conversely, central fatigue was greater in quadriceps muscles (-20±12% vs -10±16%) compared to hamstring, P<0.01). No correlation was observed between neuromuscular fatigue (ΔMVC) and 'fatigue' metrics derived from GPS such as the Dynamic Stress Load (quadriceps: r^2=0.10, P=0.31; hamstring: r^2=0.06, P=0.48) or the Fatigue Index (quadriceps: r^2=0.09; P=0.38; hamstring: r^2=0.07, P=0.43) during the soccer match-play.

CONCLUSION: The present study documented substantial differences in neuromuscular fatigue etiology between quadriceps and hamstring muscles during a soccer match-play. Indeed, hamstring developed more peripheral fatigue, and less central fatigue, compared to quadriceps muscles. Moreover, 'fatigue' metrics provided by GPS were not correlated with our direct measurements of neuromuscular fatigue, which shows their irrelevance to estimate neuromuscular fatigue. These results might be relevant for practitioners involved in training prescription and muscle injury prevention in soccer.

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Oral presentations

OP-SH10 Cognition III

QUIET EYE SUPPORTS WINNER SHOTS IN A SIMULATED TABLE TENNIS COMPETITION

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Quiet Eye supports winner shots in a simulated table tennis competition

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Background

QE is defined as the final fixation on a specific location or object in the visuomotor workspace, for a minimum of 100 ms, that enables the athletes to gather relevant information before a critical movement. Several lines of research indicate that QE contributes to sports performance. However, its contribution to performance is derived mainly from research investigating isolated motor tasks. Therefore, little is known about its contribution in realistic competitional settings.

Methods

The present study determined whether QE contributes to table tennis performance obtained from matches played in a simulated competition. Athletes (N = 10) performed two matches, one against a difficult and one against an accessible opponent. Gaze behavior was captured using Tobii Glasses 2.

Results

We found that athletes made longer QE before winner balls (i.e., balls that scored a point), compared to forced and unforced errors (pBonferroni = 0.005, t = −4.45; pBonferroni <0.001, t = −6.45). Confirming that QE contributes to performance in a real match even in a competitional setting. We found no significant effect for the difficulty of the match, nor an interaction between the difficulty of the match and the type of shots Fs (1, 9) < 2.26, ps >0.16 0.70, η2ps < 0.20.

Conclusions

The present study provides evidence for QEs contribution to sports performance investigated in a "gold standard" ecological environment. More specifically, it provides evidence that QE gradually increases with the quality of the shot. Identical patterns were found regardless of the difficulty of the match.

THE EFFECTS OF PRESENTATION MODE ON GAZE BEHAVIOR BETWEEN 360VR AND 2D-VIDEO BROADCAST IN A BOXING SPECIFIC TASK.

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Two-dimensional video broadcasts displayed on computer screens have been widely used and studied for perceptual-cognitive evaluation and training in sports. However, they have been criticized for their lack of representativeness compared to life-sized scenarios. With the development of new technologies, virtual reality (VR) is being introduced into the sporting environment because it is assumed to provide more ecological conditions, particularly due to its immersive effect, as well as stimulus and action correspondence. Specifically, immersive 360° VR (360VR) is a form of VR which is made from 360° videos and allows an advanced realism of the footage (e.g., 360° scanning of the environment). It has been

proposed as an enhancement of 2D-video broadcasts for perceptual-cognitive applications in sports. While some evidence has started to show an advantage of using 360VR over video broadcasts to assess and train anticipation and decision-making, it is still unclear how to explain the behavioral differences produced by both 360VR and 2D video broadcasts. One possible contributing factor is how both displays affect visual strategies. Therefore, the objective of this study was to compare the effects of the mode of presentation on gaze behavior between 3D-360VR and 2D-video broadcasts in a boxing specific task.

Fifteen novice participants were recruited for this study (including 5 women). The experimental design consisted of randomly presenting 24 single-punch sequences in a standalone VR headset (Pico Neo 3 Pro Eye), according to two randomly-presented viewing modes: 3D-360VR and on a 2D screen. Instructions for participants were to avoid unpredictable punches as accurately as possible by providing an appropriate motor response to the presented action. The action was voluntary not occluded to maintain ecological conditions. Four categories of punches were randomly presented (jab, direct, uppercut and hook) and were prerecorded from four different elite boxers (2 men and 2 women) using a 3D-360° VR camera (Insta360 Pro II). Gaze behavior was recorded using a Tobii eyetracker embedded in the VR headset. Fixation duration, number of fixations, saccades, and search rate were analyzed.

Results showed fewer fixations, fewer saccades and a lower search rate in the 2D-video broadcasts compared to 3D-360VR. There was no significant difference in gaze duration between presentation modes.

This study shows that the presentation mode had an impact on gaze behavior and offers new insights about the effect of 360VR and 2D-video broadcast on perceptual-cognitive behaviors in novices during a sport-specific task. Future studies should evaluate these behaviors during real-world conditions in both novices and experts to better understand the benefits of VR for perceptual-cognitive assessment and training.

Keywords: virtual reality, eye-tracker, visual search, boxing, novice.

BEHIND THE FENCING MASK: ATTENTIONAL AND EMOTIONAL PROCESSES OF ELITE LEVEL FENCERS

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Introduction

Fencing is a combat sport requiring a high attentional demand. According to Roi and Bianchedi (2008, p.474), fencers "must analyse and select the visual information provided by the opponent" in order to perform their own actions. Furthermore, as in any discipline, emotions are an integral part of the competitive experience, and the need for coping strategies is predominant in order to deal with stressful situations (Jones, 2003; Lazarus, 2000). This study aimed to identify attentional foci and coping strategies of elite fencers during bouts.

Methods

Twenty-two elite epee fencers (11 males and 11 females) from a senior national team took part in a simulated tournament. Retrospective video-recall interviews were held after their matches in order to ask fencers about their attentional foci and coping strategies. Inductive and deductive qualitative analyses were conducted on athletes' verbatims.

Results

Qualitative analysis of athlete's verbatims revealed three categories of attentional foci: (a) cues (i.e. focus on oneself and focus on the environment), (b) strategy and tactics (e.g. having one or more strategies, automatic performance, absence of planning effort) and (c) extraneous attention. In order to manage their emotions, fencers used different types of coping strategies: (a) task-oriented strategies (e.g. concentration effort, seeking solutions) and (b) disengagement strategies (e.g. mental or physical disengagement). They also mentioned, in a lesser proportion (d) deliberate absence of regulation effort and (e) automatic regulation.

Discussion

Results highlighted the value of an ecological approach to explore athletes' cognitions. The results expand those of previous naturalistic studies, which showed that experts' attentional foci were diverse in content as in characteristics, and dynamic along the different performance phases. In line with previous research, athletes could also combine several coping strategies in order to manage their emotional state. To conclude, fencers called upon numerous attentional foci and coping strategies during points, breaks, and across the bout as a whole, providing insights on how these athletes deal with competitive situations.

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VISUAL SEARCH STRATEGIES OF ELITE FENCERS : AN EXPLORATORY STUDY IN ECOLOGICAL COMPETITIVE SITUATION

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Introduction

Visual search strategies (VSS) have been widely studied in sports (for a review, see Klostermann et al., 2020). Experts exhibit fewer fixations of longer duration and are superior at extracting perceptual cues than novice athletes (Martínez de Quel & Bennett, 2019). Fencing experts "must assess and select the visual information provided by the opponent" to perform their own action (Roi and Bianchedi, 2008), and focus particularly on their opponents upper torso to do so (Witkowski et al., 2018). Previous studies were conducted in laboratories or with predetermined outcomes, so we studied VSS during a real fencing bout. We hypothesised that expert fencers use different gaze behaviours and focus on their opponents upper torso to assess their situation in real-world duels.

Method

We monitored the gaze of 10 world-class French fencers (6 men and 4 women, epee, sabre, and foil) with an eye tracker during a bout. Frame-by-frame analysis specified VSS with gaze location, number of fixations, and fixation duration.

Results

Expert fencers, regardless of arm or gender, used visual pivot, to gather information from the central vision, and gaze anchor, to gather information from the peripheral vision. They focused on an area between the opponents elbow, lower torso, and hip joint. Experts use these VSS to gather information from nearby but distinct areas of interest (AOI).

Discussion

This study confirms that expert fencers VSS are mostly visual pivot and gaze anchor. This study is one of the first to show expert fencers real-world visual activity. However, we should proceed with caution because we can not be sure that attention was directed on the object the fencers were looking at. Hence, we advocate merging objective and subjective data with self-confronted interviews to analyse expert behaviour.

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EFFECTS OF ACUTE COORDINATIVE AND AEROBIC EXERCISE ON DYNAMIC ELECTROPHYSIOLOGICAL MODULATION IN RESTING STATE: AN EEG STUDY WITH HOLO-HILBERT SPECTRAL ANALYSIS

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Introduction

Recent research has suggested that the acute effect of exercise on cognitive function can be influenced by the complexity of motor movements involved, however, its underlying neural mechanism is yet to be fully understood. This study aims to examine the difference in the acute effect of coordinative and aerobic exercise on resting state electroencephalography (EEG). Specifically, we employed the Holo-Hilbert Spectral Analysis (HHSA) to reveal the dynamic patterns of neural activity, which may reveal the role of interareal communication for contributing the exercise effects.

Methods

Thirty college students were recruited and randomly divided into a coordinative exercise group (n=15, age=20.9 ± 1.5) and an aerobic exercise group (n=15, age=21.1 ± 1.8). Before and after the exercise intervention, the participants resting state EEG were recorded for 6 minutes with both eyes closed and open to evaluate the acute changes in electrical activity. Holo-Hilbert spectral analysis was used to analyze the EEG signals, which quantifies nonlinear and nonstationary signal characteristics to reveal full-dimension electrophysiological information. Specifically, the amplitude modulation is quantified and sheds light on the underlying mechanisms of specific exercise-induced changes.

Results

Prior to the intervention, the coordinative exercise group exhibited significantly greater frontocentral alpha (8-16 Hz) and beta (16-32 Hz) band power compared to the aerobic exercise group. However, no significant difference was observed between the groups after the intervention, indicating that these exercise types may affect neural dynamics during the resting brain state differently. Moreover, the coordinative exercise group showed a significant decrease in alpha (8-16 Hz)

amplitude modulated by slow waves of 0.5-4 Hz following the intervention, whereas the aerobic exercise group did not exhibit any significant changes.

Discussion

Using Holo-Hilbert spectral analysis of EEG, this study uncover differential patterns of non-linear brain modulation following different types of exercise interventions, as evidenced by the difference in delta AM modulating alpha/beta power. The results suggest that exercise interventions with higher levels of motor complexity may be more effective in activating the interareal communications associated with executive function, sensory perception, or motor triggering events. This emphasizes the advantages of including motor coordination in exercise regimes to improve brain function.

Oral presentations

OP-SH29 Youth pedagogy and sociology

HIGH SCHOOL GIRLS' EXPERIENCES WITH BODY PRESSURE IN A PE CONTEXT

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ABSTRACT ECSS, PARIS JULY 2023

Title: Junior high school girls' experiences with body pressure in a Physical Educational (PE) context and possible effect on participation

Trine Thoresen

In this paper, young girls' experiences with body pressure in different PE contexts is looked at. Girls in 9th and 10th grade give different explanations for their interest-, or lack of interest in participating in physical education (PE). Some young girls express concern about body appearances and physical performance in the subject and are of this same reason hesitant to both participate and use the changing rooms. Previous research has questioned to what extend PE teachers should take into consideration students activity requests, as they sometimes may contribute to increased body pressure. PE teachers and fellow students' choices of communication about the body and performances in different PE contexts, such as the gym, the swimming pool or the changing rooms and content of the subject, all seem to affect both participation and experiences of body pressure differently. The purpose of the study is to shed light on possible challenges that can be seen in connection with changes in the subject, especially when it comes to topics about the body and body ideals and performances. The following question is asked;

Do junior high school girls' experience body pressure in and around a physical education context?

The results are based on two focus group interviews, one in 9th grade, where 8 girls participated and one in 10th grade, where 7 girls participated. The interviews were followed up with individual interviews with three girls in 9th grade and two girls in 10th grade. Results show that the context does affect experiences of body pressure differently. The swimming pool is an example of a context where body pressure was felt strongly. Also, the changing room and showering was experienced by more students to be challenging. They did not participate or chose not to shower as they were concerned about pictures being taken. They also experienced comments about their bodies from other school students and did feel pressure both on performances and body appearances and the way they dressed. The discussion focuses on school students' experiences with body pressure and if they take an active approach to avoid uncomfortable situations or not.

In conclusion, the purpose of this study was to investigate if a group of girls in 9th and 10th grade in junior high school experienced body pressure in connection with a physical education context. Some did not at all have this experience, whereas most of the girls expressed concern about their bodies, to dress and look in a specific way and that participation could be affected by the way the either looked or performed. Some chose to not participate as they felt strongly about bad performances.

THE ROLE AND IMPORTANCE OF PHYSICAL EDUCATION CLASSES FOR UNIVERSITY STUDENTS

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INTRODUCTION: Mental and physical wellbeing is an integral part of a health-conscious life, the importance of which has been proven by numerous national and international studies. In Hungary, after the completion of public education, the last formal stage of health awareness education for young people can be realized within the framework of university education. Increasing prevalence of physical inactivity and health risk behaviours in higher education (Martinez et al., 2020). This is a time of separation from their parents, a period of searching for their own way, which is full of challenges and stress. This developmental psychological phase, when young people no longer feel like adolescents but not yet adults, is referred to in the literature as the emerging adulthood phase (Arnett 2000).

METHODS: The study examined the mental and psychological well-being of some 435 first-year non-athletic students at Eszterházy Károly Catholic University (Hungary), asking them about their life goals (Purpose in Life Test), life satisfaction (Staisfaction with Life Scale), well-being (Well-being Index) and stress (Perceived Stress Scale), as well as their eating habits, attitude to exercise and satisfaction with their bodies. The intervention took place over one semester, with students attending one physical education class per week. The questionnaires were evaluated using the IBM SPSS Statistics 21 software.

RESULTS: At the end of the semester, a feedback survey with a minority of students (N=78) found that 67% of students had a positive change in their quality of life, feeling more active when they wake up and feeling more engaged and full of interesting things to do in their days. In this research, in terms of life satisfaction, almost a third of students feel that they dont always get everything they want and have moved somewhat away from fully agreeing that their lives are close to ideal in most respects. They pay less attention to their eating habits, but 17% have started a diet.Their physical activity has increased, largely due to transport between home and university and between university buildings.In the subjective assessment of posture, fitness and body awareness, the results are contradictory, with 24% of respondents experiencing a deterioration in this area, while 39% feel an improvement. There is a clear increase in the number of sedentary hours, which is also attributed to the writing of final papers, homework and the upcoming exam period, according to the responses.

CONCLUSION: The more important benefit of university physical education, with more than half (52.5%) of students feeling more responsible for their own health. The research also asked a number of other questions, for example, to what extent this was due to the physical education provided in the university setting. It would also be interesting to measure how intrinsic motivation develops and how well they are able to maintain and adapt it throughout their lives.

SPORT AND PARENTHOOD: PARENTAL ROLES IN HORSE RIDING ACTIVITIES FOR TODDLERS

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Sport and Parenthood: Parental Roles in Horse Riding Activities for Toddlers

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Introduction

Parents play important and varying roles in sport activities for children. They provide transport, act as leaders, trainers and audience, work in cafeterias and offer care. To partake in children's leisure activities is even a middle-class norm for parenthood (Lareau 2011; Wheeler & Green 2014; Stefansen et al 2018). Research on parenthood in sports has primarily covered team sports (ball sports), and several studies have a psychological perspective including issues related parental pressure (or support) (Augustsson 2007, Woodcock et al 2011). There are few studies on parental roles in sport activities for young children. In this study, equestrian sports for toddlers are focused. The aim is to describe and analyze parental roles in horse riding activities for toddlers. Studies have shown that parental pressure is stronger in expensive sports (such as equestrian sports) (Idrottens pris 2015), whether this is true for activities for the very young is questioned. The theoretical framework is inspired by Goffman's dramaturgical theory (2020) and Skegg's concept respectability (1997). Goffman uses the metaphor theater to explain human behavior and in this study questions of how parents perform (front stage) in the stable, the indoor and outdoor arenas is analyzed.

Methods

Data consists of 10 participating observations at 6 different riding schools and 21 semi-structured interviews with riding school managers and parents of riding toddlers in Sweden and Norway. Interviews and observations are analyzed using a thematic content analysis.

Results and discussion

Parents play an essential role in horse riding activities for toddlers. They take care of the horses before and after the riding activities, they equipe the horse and during the lesson they side walk the horse and are constantly transferring/translating the commands of the riding instructor to the children. In difference from what previous research has showed for other sports and for parents to older children, where the concepts pressure and support have been used to explore the relationship between parents and children, parents and children form a team (cf., Goffman's concept collaborative teamwork) in the riding school activities. In addition, parenthood need to be understood through gender lenses as mothers and fathers perform and are expected to perform different roles. Mothers are respectable (to speak with Skeggs) when they perform as competent horse people, whereas fathers are expected to be incompetent. The incompetent mother provides an 'unacceptable other'. Parents act on a stage, the riding school, that has, since long been feminized, however providing femininities including strong and capable women (cf., Thorell et al 2015).

PHYSICAL ACTIVITY LEVEL OF CHINESE MIGRANT CHILDREN AND ITS ASSOCIATION WITH ENVIRONMENTAL FACTORS IN SCHOOL, FAMILY AND NEIGHBORHOOD SETTINGS

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Objective: There are 20 million rural migrant children 14 years old or under in China, comprising 13% of the total student population for compulsory education. Chinese children and adolescents have shown the alarmingly low rate of engage-

ment in sufficient physical activity (PA). Environmental supports are important for creating changes in PA. However, there is scarcity of related research in migrant children due to the difficulty of accessibility. This study is of the first to examine the PA levels in Chinese migrant children in Beijing and to explore its association with environmental factors in three common settings for students- school, family, and neighborhood.

Methods: A cross-sectional study was conducted in 503 Chinese children and adolescent (51.3% males) aged 8-13 years from four primary and secondary schools. Children's PA was assessed by Children's Leisure Activities Study Survey (CLASS) Questionnaire. Three environmental settings related to PA were measured both with subjective and objective methods including the home, neighborhood and school. Subjective measures on environmental factors were collected by the questionnaires and reported by students themselves on presence, accessibility and utilization of sport facilities, traffic safety and others in different settings. Objective measure on neighborhood environmental correlates was assessed by ArcGIS V10.0. Proxy reports by parents and school Physical Education Teacher on environmental factors were considered as the objective measures in home and school setting.

Results: Moderate PA (MPA), vigorous PA (VPA), and moderate-to-vigorous PA (MVPA) in weekday were 59.3, 28.1, 39.0 mins, respectively. Students were more active in weekend than weekdays with MPA, VPA, and MVPA at 80.9, 58.2, and 107.3 min. The prevalence of meeting the PA guideline (≥ 60 min per day) was 35.3%. In the home environment, students with sports equipment at home generally had higher MVPA on both school days and weekends than those without sports equipment at home, and such difference was more significant on weekends ($P<0.05$). In the neighborhood setting, students who used community sports equipment had significantly higher MVPA on school days than those who used less. Students with more sports venues within the distance of 10–15-minute walk in the neighborhood had significantly higher VPA on weekdays than those with fewer sports venues. Two groups (remote vs. proximal group) was categorized by the GIS with 800m buffer distance from sport venues. Students in proximal group had longer MVPA than those in the remote group. However, no difference was found in the influence of school environment on students' PA, which may be due to the frequent online courses at home during COVID-19.

Conclusion: Findings suggest that PA is affected by several environmental correlates. This study provides a basis for further PA promotion and intervention strategy among migrant children.

Oral presentations

OP-PN33 Metabolism

THE COMBINED EFFECTS OF GREEN TEA AND ECCENTRIC EXERCISE ON NUCLEAR FACTOR ERYTHROID 2-RELATED FACTOR 2 SIGNALING

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INTRODUCTION: Nuclear factor erythroid 2-related factor 2 (Nrf2) is a transcription factor that regulates cellular resistance against oxidative distress by coordinating the expression of endogenous antioxidants such as catalase (CAT) and glutathione reductase (GR). Both exercise and dietary (poly)phenol supplementation have been shown to increase Nrf2 signaling, ostensibly via oxidative or electrophilic cysteine modification of kelch-like ECH-associated protein 1 (Keap1). We hypothesized that combining exercise with 6-days of (poly)phenol (green tea) supplementation would lead to greater activation of Nrf2 than exercise alone.

METHODS: In a double blind, randomized design, healthy, recreationally active males (n = 24; mean [SD]; 23 [3] years, 179.6 [6.1] cm, 78.8 [10.6] kg)) consumed a 1 x 500 mg capsule of green tea (n = 12; 482 mg of (poly)phenols) or a 1 x 500 mg capsule of an inulin placebo (n = 12) for 6 days. On day 6, participants performed eccentric exercise (100 drop jumps, 20 reps x 5 sets, 20 seconds rest between jumps). Blood and urine were collected pre-, post-, 1 and 24 h post-exercise. Systemic Nrf2 levels were measured in plasma and Nrf2/ARE binding activity in peripheral blood mononuclear cells. Nrf2 gene targets CAT and GR, leukocyte counts, and 8-hydroxy-2'-deoxyguanosine (8-OHdG) were also measured. A 2 (supplement) x 4 (time) mixed model ANOVA was performed to detect time, supplement, and interaction effects.

RESULTS: Nrf2/ARE binding activity did not change over time ($p = 0.12$, $\eta2 = 0.10$) or between supplement groups ($p = 0.19$, $\eta2 = 0.08$) (fold change from rest: green tea = [POST] 0.78 ± 0.45, [1H] 1.37 ± 0.98, [24H] 1.09 ±0.57; placebo = [POST] 1.59 ± 1.68, [1H] 2.92 ± 3.73, [24H] 1.17 ± 0.57). There were no time ($p = 0.86$, $\eta2 = 0.01$) or group effects ($p = 0.88$, $\eta2 = 0.01$) for systemic Nrf2 concentration. Exercise increased mean GR activity by 36% (29.2 ± 2.6 vs 39.8 ± 3.5 nmol/min/ml-1, $p = 0.002$, $\eta2 = 0.20$); however, no differences were observed between groups ($p = 0.77$, $\eta2 = 0.01$). CAT activity and 8-OHdG excretion did not change after exercise (CAT: $p = 0.12$, $\eta2 = 0.10$; 8-OHdG: $p = 0.41$, $\eta2 = 0.05$) and did not differ between groups (CAT: $p = 0.79$, $\eta2 = 0.004$; 8-OHdG: $p = 0.67$, $\eta2 = 0.01$). Leukocyte (5.2 ± 1.2 vs 6.36 ± 1.91 x 109 cells/L-1) and neutrophil (2.89 ± 1 vs 4.01 ± 4.9 x 109 cells/L-1)) concentrations were only elevated post-exercise ($p < 0.001$).

CONCLUSION: Eccentric exercise did not increase Nrf2 activation, and this response was not altered by green tea supplementation. Despite the acute biochemical response, the low metabolic stress induced by eccentric exercise may not have been sufficient to trigger Keap1 modification and subsequently Nrf2 activation. The dose of green tea may have been too low to influence Nrf2 activation in vivo. Future research should experiment with different exercise models and (poly)phenol doses.

HEPCIDIN LEVELS DURING THE SEASON OF ELITE ROWERS – A USEFUL MARKER OF IRON NEED SUPPLEMENTATION

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INTRODUCTION: Top sports performance and elite training make significant demands on an athlete´s iron metabolism. Iron deficiency is one of the most common nutrient deficiencies in athletes, especially females. Hepcidin emerges as a key regulator of iron metabolism. It regulates the absorption of iron in the intestine and the export of iron from macrophages. Although methods for hepcidin determination have become more available recently, hepcidin is not routinely used as a diagnostic parameter for assessing iron stores. The reason is also the unavailability of reliable reference values. In this study, the iron status is monitored in a group of elite female rowers throughout one year. The study aims to follow the hepcidin levels and correlate them with ferritin as the most commonly used diagnostic parameter for athlete´s iron stores. In addition, part of the results will be compared with a group of elite male rowers.

METHODS: In a group of elite female rowers (n=8, age=22.4±2,7 years), iron stores were monitored at 8 time points (F1-F8) during the one-year period (April – April). In a group of elite male rowers (n=9, age=21.4±1.4 years) iron stores were monitored at 4 time points during the pre-season training from November to April (M5-M8). The level of serum iron, transferrin, ferritin, hepcidin and C-reactive protein were measured in the morning fasting venous blood. Samples with CRP above 5 mg/L were excluded from further analysis. Female athletes with low iron stores supplemented 200 mg of iron (Fe2+) orally every day for three months (June-August). All female athletes supplemented with twice the daily recommended iron intake 7 days per month during the whole year to prevent iron loss due to menstruation.

RESULTS: In the female rowers, ferritin and hepcidin levels were initially 28.1±19.9 µg/L and 3.76±2.83 ng/mL, respectively. Both levels increase to the statistically significant maximum of 63.8±12.7 µg/L and 12.0±6.07 ng/mL after supplementation. Further, in the period F5-F7 ferritin keeps above 50 µg/L, while hepcidin fluctuates significantly (ANOVA, n=28, F=4.93, $p<0.01$). At the final time point F8 during the final pre-season training ferritin and hepcidin level decrease to a minimum. In comparison, in the male rowers there are no significant changes in ferritin and hepcidin levels between the time points M5-M7. Hepcidin correlates with ferritin, transferrin saturation and serum iron, but the strongest correlation is found for ferritin ($r=0.66$, n=94, $p<0.05$).

CONCLUSION: To our knowledge, this is the first study following hepcidin levels in elite athletes regularly on a long-term basis. We demonstrated that ferritin and hepcidin levels fluctuate significantly in female rowers during the season in comparison to male rowers. Our data suggest that hepcidin could be a useful additional marker for the need for iron supplementation in female elite athletes, especially when a history of individual ferritin levels is not available.

ACUTE AEROBIC EXERCISE INCREASES CIRCULATING IRISIN IN HEALTHY ADULTS

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INTRODUCTION: Irisin is a cytokine mainly secreted by muscle tissue via Ca2+–AMPK–PGC-1α–FNDC5 pathway. Physical exercise can increase its circulating level, inducing browning of white adipose tissue, promoting autocrine effects on muscle, maintaining glucose and bone homeostasis (1). However, previous studies reporting the effect of acute aerobic exercises on irisin secretion across adulthood are partially contradictory (2,3). Therefore, the aim of the present study was to evaluate the time course of circulating irisin level following a cycling incremental exercise to exhaustion in two age groups.

METHODS: 34 healthy male subjects were divided into two groups: young adults [YA] (N: 22; age, 24,6±3,6 yrs; BMI, 23,2±2,4 kg/m2; peak oxygen uptake [V'O2peak] 47,3±7 ml/kg/min) and middle-aged adults [MA] (N: 12; age, 54,6±5,7 yrs; BMI, 23,4±2,2 kg/m2; V'O2peak 44,8±5,1 ml/kg/min). Subjects completed the International Physical Activity Questionnaire [IPAQ] and performed an incremental cycling exercise test to exhaustion. V'O2peak via direct gas analysis was determined and blood samples were collected before the exercise, 15min and 24h post-exhaustion. Quantification of irisin levels in serum was performed using irisin-ELISA Kit (EK-067–29). Subjects were asked not to be engaged in moderate or vigorous physical activity [PA] during the 48h before the test. Level of significance was set at $p<0,05$.

RESULTS: A significant increase of serum irisin levels at 15min ($p<0,001$) and 24h ($p<0,001$) compared to baseline was found, with the greatest increase by 58% after 24h. Irisin levels at baseline, 15min and 24h post exercise were significantly higher in YA compared to MA (baseline: 9,5±1,5 vs 7,2±1,6 ng/ml, $p<0,001$; 15min: 10,9±1,7 vs 8,4±1,5 ng/ml, $p<0,001$; 24h: 14,5±2,2 vs 11,6±2,3 ng/ml, $p<0,001$, respectively). However, MA showed a similar percentage increment in serum irisin 15min and 24h post exercise to their younger counterparts. Irisin was negatively correlated with age at baseline, 15min and 24h ($r=-0,677$, $r=-0,711$, $r=-0,649$; all $p<0,001$). Moreover, a positive correlation was found between basal irisin and self-reported PA ($r=0,391$; $p<0,05$), while a negative correlation was observed with sedentary behavior ($r=-0,414$; $p<0,05$) only when adjusted with age.

CONCLUSION: Circulating irisin levels were elevated in response to acute exercise, with a greater increase after 24h post exercise. YA and MA showed a similar irisin response to acute aerobic exercise, nevertheless irisin levels were higher in YA than MA. Basal irisin seems to be positively influenced by PA and negatively by age and sedentary lifestyle.

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HUMAN FIBER-SPECIFIC MUSCLE DIFFERENCES IN PROTEIN SYNTHESIS AND OXIDATIVE METABOLISM PATHWAYS BETWEEN OBESE AND HEALTHY INDIVIDUALS

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INTRODUCTION: Skeletal muscle demonstrates remarkable plasticity in response to different environmental and physiological stimuli such as energy availability and physical activity. Overfeeding and low physical activity may lead to obesity, which could affect skeletal muscle mass, metabolism, and fiber distribution (1). Skeletal muscle adaptations have shown to be fiber type-specific (i.e., type I or slow-twitch and IIa or fast-twitch)(2). Aim: to compare the protein content of the protein synthesis and oxidative metabolism proteins pathways in type I and IIa skeletal muscle fibers from obese and healthy individuals.

METHODS: Nine obese (OB; age=42.6±8.4 y; body mass index=33.7±4.5 kg/m2) and twelve healthy (HI; age=29.1±5.4 y; body mass index=24.9±1.6 kg/m2) individuals underwent a muscle biopsy from the vastus lateralis. Muscle specimens (10mg) were lyophilized for 48h after which muscle fibers were identified and isolated manually. Dot-blot technique was used to identify type I, IIa and IIx MHC isoforms, after which the same fiber-type fibers were pooled. Akt-1, mTOR, p70s6K, S6 ribosomal protein, COX-IV, ERK 1/2, AMPk total proteins from whole muscle and fiber-type pooled samples were quantified by Western blot. Two-way ANOVA and independent Student´s t-test were used to compare conditions and fiber types, and whole muscle samples, respectively.

RESULTS: Total levels of Akt-1, mTOR, p70S6K and S6RP protein were similar between muscle fiber types and between whole muscle homogenates from both OB and HI. Total levels of COX-IV were similar between OB and HI, with both groups showing greater (OB=35%, P= 0.04, HI 32%, P= 0.03) levels of this protein in type I muscle fibers. OB showed similar levels of total ERK (1/2) and AMPK proteins in both muscle fiber types. However, HI showed greater levels of total ERK (1/2) (70%; P= 0.003) and AMPK proteins (110%, P= 0.005) in type IIa muscle fibers compared to type I. There were no significant differences in total protein ubiquitination between muscle fiber types and between whole muscle homogenates from obese and healthy individuals (p=0.06).

CONCLUSION: These results suggest that healthy individuals seem to have greater machinery for protein synthesis in type IIa muscle fibers, particularly through a MAPK-dependent pathway. Greater COX-IV level in type I compared to type IIa muscle fibers was expected in both conditions as per the type I muscle fiber metabolism, which suggests a similar oxidative activity in both groups. In addition, the elevated levels of AMPK in type IIa fibers of healthy individuals suggest that AMPK may exert other roles rather than only increase oxidative metabolism, which needs to be explored further. Finally, we provide evidence that muscle adaptations occur specifically to muscle fiber type, and these changes could be masked when analyzed in whole muscle.

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Oral presentations

OP-SH20 Women in sport

A COMPARATIVE ANALYSIS OF THE MEDIA IMAGE PRESENTATION OF FEMALE ATHLETES BY CHINESE AND AMERICAN MEDIA: TAKE THE REPORTS OF PEOPLES DAILY AND THE NEW YORK TIMES DURING THE BEIJING WINTER OLYMPICS AS

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SHANGHAI JIAO TONG UNIVERSITY

Introduction

There is explicit or implicit gender inequality existing in sports communication. The quantity, content, quality, and angle of media coverage of female athletes are affecting the visibility of female athletes. To study the image of female athletes in the mass media, the comparison of Chinese and American reports on female athletes during the Beijing Winter Olympics will help us understand how the mainstream official media of different countries reproduce the image of female athletes.

Methods

Using word frequency analysis, content analysis, tools such as the Divominer platform and LDA topic modeling were used to search the Peoples Daily (PD) and New York Times (NYT) databases with "Winter Olympics" and "Olympics " as keywords for full-text search, during the Beijing Winter Olympics. Finding 43 and 104 articles that met the criteria were selected as the samples. By counting the high-frequency words and doing quantitative statistical analysis, we understand the emo-

tional tendencies and themes of news reports, deconstruct the narrative discourse and explore how the two major media reproduce the images of female athletes.

Results

The study found that the number of female athletes reported by PD is significantly lower than that of the NYT, and the themes of the reports focus on positive and collective narrative discourse such as unity, glory, and struggle dream, and pay attention to showing the spirit of group cooperation of female athletes. It reports mainly on domestic female athletes. The NYT, however, focuses on positive personalized narrative discourse such as leadership, defeat, love, and overcoming, focusing on showing the individual competitive ability of female athletes. Moreover, a considerable number of articles show the narrative discourse of female athletes overcoming adversity, reporting both at home and abroad.

Discussion

The research shows that when Chinese and American mainstream media reported on female athletes during the Winter Olympics, there were significant differences in the number of reports, themes and inclinations. This phenomenon reflects the different cultural and educational backgrounds of China and the US: the Chinese Olympic culture focuses on the performance of individual female athletes in the country and the group. Individual success is largely due to the existence of the nation and group. The concept of nation permeates the growth of the athletes, and it is also reflected in the subconscious attachment of the Chinese official media to the nation and collective. However, the image of American female athletes remains at the individual level. In American society, individuals who succeed through hard work are respected and praised by society.

PROBABLY JUST SEXISM: GENDERED EXPERIENCES OF RESOURCE ACCESS IN RUGBY UNION

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Introduction

Participation in women's rugby continues to grow, but it remains under-prioritised relative to the men's game, as evidenced by the dearth of women-specific research, the low visibility of the sport and limited access to resources for women in rugby. Indeed, whilst such gender inequalities are often anecdotally acknowledged, there is little rigorous research exploring gendered experiences within rugby, especially in non-elite settings. This study aimed to investigate the experiences of a diverse cohort of rugby players in relation to their navigation of the sport and availability of resources.

Methods

Twenty UK-based rugby players (10 men, 9 women and 1 non-binary person) from school, university, club, military and semi-professional environments took part in semi-structured interviews (mean length 36 ± 12 minutes) discussing their experiences of rugby in relation to their current gender identity and playing level. Interviews were transcribed verbatim, and a reflexive thematic analysis was undertaken.

Results

A widespread under prioritisation of women in rugby was highlighted. Specifically, gender biases were evident in access to changing rooms, pitches, quality coaches and referees, pitch-side healthcare, and opportunities to play rugby. A degree of positive change towards redressing these imbalances was acknowledged, but interviewees expressed that gender biases in rugby were embedded. Gender biases were more commonly propagated by those in decision-making managerial positions rather than by players themselves.

Irrespective of gender, amateur players reported difficulty accessing a suitable environment to play in and referenced rurality limiting access to development opportunities. Insufficient player numbers precluded the formation of second teams, meaning that inexperienced players were competing beyond their ability. This difficulty in accessing a suitable environment was cited as a reason for player attrition, alongside having to endure sexist treatment.

Discussion

This study highlights an urgent need to mitigate the gendered treatment experienced by rugby players and illustrates the detriment to player wellbeing, safety and growth of the game such inequalities produce. Increased representation of women in managerial positions in rugby unions and rugby clubs are recommended to enact meaningful change.

WOMEN'S FOOTBALL IN SOUTHERN AFRICA: AN EXPLORATORY STUDY OF THE CHALLENGES FACING INTERNATIONAL PLAYERS

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LUNEX UNIVERSITY

Introduction

Governments and sports federations are prioritizing women's sport. The Federation Internationale de Football Association (FIFA) have made commitments and allocated resources to member associations (MA) to help them provide better support, better resources, and create an environment to enable more opportunities for female players. More MA are developing strategies for women's football. However, despite increased opportunities to compete, challenges still arise in creating the best environment for players to fulfil their potential.

Methods

This informal qualitative explorative study delved deeper into challenges facing Southern African footballers. Discussions which centered around individual player's development and the challenges facing them, were held with 70 English-speaking players from 5 senior women's national teams. Narrative analysis was used to analyse the data. During the discussions, information was clarified, and time was taken to ensure that the interpretation was correct. Consistent themes in the discussions were identified.

Results

Two main general themes were identified. These related to lack of resources and lack of support. Lack of resources extended to facilities, expertise, and financial resources. Lack of support centered around family, friends and extended to the broader community. A key point that was highlighted was that evidence-based solutions must explore both the homogenous and the heterogenous nature within an African women's context.

Discussion

The findings revealed that while progress in the women's game must be acknowledged, there remain challenges facing players within Southern Africa. The importance of training as well as the resources required for training and the holistic improvement of players are often not a focal area away from international tournaments. Players highlighted the difficulty in improving without enough exposure to high training stimuli. They also mentioned being required to work individually on training, which is challenging in a team sport often leads to often feeling isolated. Even players who seek new and better methods of training, recovery and conditioning tools, are often limited by socioeconomic constraints, or in the case of nutrition, solutions that are Eurocentric and not feasible in the African context.

The socioeconomic challenges facing the continent extend to football resources. These challenges are exacerbated due to the remaining gender stereotypes, cultural norms and firm opposition regarding women's involvement in football. The lack of support can sometimes extend to active critique and undermining of a player's football dreams. Balancing the expectations and venturing towards what community, family and friends see as an undesirable pathway, with one's own vision for their life adds feelings of conflict, guilt and greater conflict for players. More applied research is required to produce evidence-based solutions that are feasible within an African context.

MIDWIVES' AND PREGNANT WOMEN'S PERCEPTIONS OF PHYSICAL ACTIVITY PROMOTION PRACTICE DURING PREGNANCY TO IDENTIFY KEY DETERMINANTS TO PROMOTE AN ACTIVE LIFESTYLE.

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Introduction

Despite scientific evidence on health benefits of an active lifestyle during and after pregnancy for both women and children, healthcare professionals (HCPs) do not sufficiently promote physical activity (PA) during and after pregnancy. To address public health issues of rising rates of complications in pregnancy and non-communicable diseases in adulthood, HCPs, in particular midwives, need to inform women about PA recommendations and benefits for them and their children. Identifying the key determinants of PA promotion from the midwives and womens perspectives enables the development of an evidence-based strategy to integrate PA promotion in the health system.

Methods

Participants were recruited via the maternity department of the Lausanne University Hospital, Switzerland. Seventy-three pregnant women completed an extended version of the Pregnancy Physical Activity Questionnaire, of whom eight took part in semi-structured interviews. Nine midwives delivering prenatal consultations took part in semi-structured interviews. The Theoretical Domains Framework was used for qualitative data analysis. Descriptive statistics were performed on quantitative data. Then the data was combined by triangulation of viewpoints.

Results

Pregnant women were 4.6% in the first trimester, 21.1% in the second, and 74.2% in the third. 54.5% reported meeting PA recommendations before pregnancy and 56.2% were meeting it during pregnancy. 39.4% of pregnant women reported that HCPs did not address the topic of PA during pregnancy. 59.1% would have appreciated receiving more information. Interviewed women perceived a lack of knowledge and skills by HCPs and reported not having received clear information about recommendations and benefits. Because of lack of information from HCPs, women changed their PA practice during pregnancy due to negative emotions (fear and anxiety), beliefs about consequences (risk to harm the baby) and social influences (entourage advice to move less). Interviewed midwives confirmed that promoting PA is part of their professional role. They were aware of their lack of knowledge, skills, and noticed the absence of procedures at the maternity hospital. Women who do not ask questions about PA, who seem not interested in PA and from disadvantaged social groups are at higher risk not to receive information about PA.

Discussion

PA promotion is not systematically delivered during pregnancy. The implementation of new practices among HCPs is perceived as a complex process and depend on several key determinants such as environmental, interpersonal, and intrapersonal factors. Midwives identified advanced training, interprofessional collaboration and environmental resources

to be enablers to improve PA promotion practice, while pregnant women identified easier access to educational resources and clear, individualised, and repeated information from HCPs.

18:00 - 19:00

Conventional Print Poster

CP-MH17 Cardiovascular diseases II

DAILY STEP COUNT AND LEISURE-TIME PHYSICAL ACTIVITY WITH THE PREVALENCE OF HYPERTENSION: A CROSS-SECTIONAL STUDY AMONG WORKERS IN JAPAN

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INTRODUCTION: Limited data are available on the joint relationship of daily step count and leisure-time physical activity with the prevalence of hypertension.

We conducted a cross-sectional study to investigate the joint relationship between DSC and leisure-time physical activity with the prevalence of hypertension among workers in Japan.

METHODS: Participants were 4,887 men [median age 45 years] and 1,161 women [median age 42 years] who completed a self-administered questionnaire on their health habits, including daily step count (< 6,000 steps/day, 6,000–7,999 steps/day, 8,000–9,999 steps/day, and ≥ 10,000 steps/day) and leisure-time physical activity excluding walking (never, only specific seasons, 1–2 times per month, once a week, more than twice a week) in 2017. Participants were classified into fourgroups based on their daily step count and leisure-time physical activity. Low daily step count and low leisure-time physical activity group (LL-G), low daily step count and high leisure-time physical activity group (LH-G), high daily step count and low leisure-time physical activity group (HL-G), and high daily step count and high leisure-time physical activity group (HH-G) were set, respectively. The prevalence of hypertension was obtained using a self-administered questionnaire. Multivariable-adjusted odds ratios and 95% confidence intervals for the prevalence of hypertension were obtained using logistic regression models while adjusting for age (continuous variable), sex (men, women), smoking (current-smoker, former-smoker, never-smoker, other), drinking (never, < 3 times/week, 3–5 times/week, ≥ 6 times/week, other), and sleep time (< 6 hours, ≥ 6 hours, other).

RESULTS: 1,052 participants (17.4%) had hypertension. Using the LL-G as a reference, the odds

ratios and 95% confidence intervals were 0.79 (0.63–0.98) for LH-G, 0.98 (0.81–1.18) for HL-G, and 0.69 (0.55–0.86) for HH-G, respectively.

CONCLUSION: In this cross-sectional analysis, the combination of high daily step count and high leisure-time physical activity group is associated with the lowest prevalence of hypertension among workers in Japan.

LOW INTENSITY STRUCTURED EXERCISE IS ASSOCIATED WITH HEMODYNAMIC CHANGES REVEALED BY INFRARED THERMOGRAPHY IN PEOPLE WITH INTERMITTENT CLAUDICATION

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UNIVERSITY OF FERRARA

INTRODUCTION: In patients with peripheral artery disease (PAD) the assessment of perfusion of the lower extremity districts, of the foot in particular, enables patient's surveillance favoring the disease management and proving the effectiveness of interventions. Among the available techniques, non-invasive non-contact, infrared thermography (IRT) has been recently recognized as a promising method to screen different areas of foot perfusion. The study aimed to detect in PAD patients if at the end of an exercise program changes of foot temperature measured by IRT were observable and whether these variations were consistent with a validated hemodynamic measurement.

METHODS: In this prospective non-randomized trial we enrolled 76 PAD patients (72±4 years; 52 males) at Rutherford's stages 2-3 (claudication). All patients were enrolled in a structured in-home exercise program [1] composed of two daily 8-minute interval walking sessions (1:1 walk:rest ratio) at an initial slow speed, maintained at home by a metronome, and progressively increasing. Patients underwent four consecutive visits throughout the program. At week 0 (T0, baseline), week 5 (T1), week 12 (T2) and week 20 (T3), patients received program prescription and outcome measure assessment including foot temperature by IRT at selected points (anterior tibial, posterior tibial, dorsalis pedis and arcuate arteries [2]), lower limbs segmental pressures, ankle-brachial index (ABI) and 6-minute walk test.

RESULTS: All patients completed the exercise program, with a significant increase of 6-minute walking distance (+45 m; $p<0.001$) and of ABI of the worst limb (+0.10; $p<0.001$).

At baseline, a relationship was observed between mean foot temperature and ABI value ($r=0.33$ $p=0.022$). The foot temperature of both limbs showed a significant increasing trend with a mean variation of 1.3°C for the more impaired limb

and 0.9°C for the contralateral (t=8.88, p<0.001; t=5.36; p<0.001, respectively). Significant changes for all sampled districts were observed at T1 after only 5 weeks of training. At T3, changes in mean foot temperature and changes in ABI were significantly directly correlated (r=0.32; p=0.039).

CONCLUSION: In patients with PAD, a structured low-intensity exercise program significantly improved hemodynamics as assessed by ABI. Favorable correlated changes in foot temperature were also assessed by IRT. Infrared thermography, proved to be an effective method which rapidly displays the vascular adaptations occurring after exercise, also favoring adherence of patients to the exercise program.

VALIDATION OF A NOVEL ISOMETRIC RESISTANCE TRAINING BAND: A COMPARISON OF THE CARDIOVASCULAR RESPONSES BETWEEN EXERCISE MODES

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THE UNIVERSITY OF NORTHAMPTON

INTRODUCTION: Short- to long-term isometric resistance training (IRT) can produce clinically meaningful reductions in resting blood pressure (BP) [1] but established methods are costly or require laboratory access, limiting wider application. An affordable home-based method could improve accessibility, however, there is a need to establish the efficacy, safety, and suitability prior to prescription as an alternative IRT method. The aims of this study were to determine if a novel isometric training band (ITB) can elicit cardiovascular (CV) responses (BP and heart rate [HR]) comparable with established IRT methods, and if the Category Ratio Scale (CR-10) can regulate isometric contraction intensity.

METHODS: Fifteen healthy normotensive participants (systolic [SBP]; 120 ± 3 mmHg, diastolic [DBP]; 71 ± 6 mmHg) reported CR-10 responses (T1-min & T2-min) to a single 2-min isometric handgrip (IHG) exercise at 30% of maximum voluntary contraction (MVC). Participants then completed 2-min contractions for four separate exercises using the ITB (chest fly, seated pull, seated lunge, bicep curl and tricep extension) with the aim of replicating localised sensations of exertion equivalent to the IHG contraction. Cardiovascular responses were measured following each 2-min isometric exercise with CR-10 values recorded on completion of each min. A further 15 normotensive participants (SBP; 118 ± 6 mmHg, DBP; 68 ± 7 mmHg) completed a bout of IRT (IHG, 4 x 2-min at 30% MVC; ITB, 4 x 2-min at pre-determined CR-10 values, [4, and 5 for T1-min & T2-min]) with mean CV responses compared between bouts. Repeated measures ANOVAs and pairwise comparisons were conducted to identify any significant (P <.05) differences, with additional analyses examining association, reliability, and agreement.

RESULTS: There was no difference in BP responses between IHG and all four ITB exercises (P >.05). CR-10 values and HR responses were comparable between IHG and three ITB exercises (P >.05) but were greater during the seated pull (T1-min, P <.05; T2-min, P <.05; HR, 96.8 ± 17.3 bpm·-1 vs. 81.1 ± 13.4 bpm·-1; P <.05). Between bouts, regulating contraction intensity through pre-determined CR-10 values resulted in comparable BP (P >.05) responses, although ITB elicited a greater HR response (91 ± 15.1 bpm·-1 vs. 79 ± 9.9 bpm·-1; P <.001). Between-bout CV responses were strongly positively correlated (r = 0.75-0.88, P <.05), alongside acceptable limits of agreement (bias = -11.13-3.38) and moderate-to-excellent reliability (ICC >0.65 and CoV <9.2%).

CONCLUSION: The CV demands reported during and after undertaking the novel ITB exercises are comparable with established IHG methods. Although the HR response was greater in the ITB bout, values did not exceed reported unsafe thresholds. The present study findings suggest the novel ITB, and associated protocol may serve as a versatile, cost-effective, and accessible alternative method of performing IRT.

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EFFECTS EXERCISE ARM-CRANKING AND TREADMILL WALKING TRAINING ON AMBULATORY BLOOD PRESSURE OF PATIENTS WITH PERIPHERAL ARTERY DISEASE AND CLAUDICATION SYMPTOMS

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INTRODUCTION: Patients with peripheral artery disease (PAD) and claudication symptoms present walking impairment and increased cardiovascular risk. Although walking exercise training has been recommended to improve walking capacity and reduce blood pressure (BP) in these patients, pain during exercise is a main barrier to maintenance in practice. Arm-cranking (AC) exercise training has shown to improve walking capacity of these patients, however, whether this mode of training can improve blood pressure parameters remains unclear. Thus, the aim of this study was to compare the effects of walking and AC exercises on ambulatory BP in patients with PAD and claudication symptoms.

METHODS: Patients with PAD were randomized in arm-cranking (AC) and walking training (WT) groups. Both groups performed a supervised exercise program twice a week for 12 weeks. In both groups the volume of training progressed from 30 min of active exercise to 50 min of active exercise. Before and after 12 weeks of interventions, patients were submitted to a 24-hour ambulatory BP assessment. Mean 24 hr, awake and asleep BP were calculated.

RESULTS: Twenty-three patients finalized the intervention (AC: n=12, 70±8 yrs, 27±4 kg.m2, ankle-brachial index 0.68±0.23; WT: n=11, 70±4 yrs, 28±4 kg.m2, ankle-brachial index 0.72±0.24). At baseline groups were similar for all BP variables (p>0.05). Compared to WT, AC promoted greater decreases in 24 hr mean BP (-4±9% vs. +2±5%, p=0.05), 24 hr

diastolic BP (-5±8% vs. +4±7%, p=0.01), awake mean BP (-5±8% vs. +1±4%, p=0.03) and awake diastolic BP (-7±8% vs. +3 ±7%, p<0.01).

CONCLUSION: This preliminary data indicated that AC training promotes greater reductions in 24 hr BP compared to WT in patients with peripheral artery disease and symptoms of claudication.

WALKING EXERCISE INTENSITY PREFERENCES IN PATIENTS WITH PERIPHERAL ARTERY DISEASE

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UNIVERSIDADE NOVE DE JULHO

INTRODUCTION: Pain during walking exercise has been one of the main barriers for patients with peripheral arterial disease (PAD) and intermittent claudication symptoms (CI). Exercise with self-selected prescription (SSP) by the participant emerged as an alternative to increase the interest, since it has been shown to increase pleasure during exercise in other populations. However, whether similar responses are observed in patients with PAD and IC symptoms are unknown. The objective of this study was to compare exercise preferences, cardiovascular, perceptual and affective responses between the SSP and the prescription recommended by the guidelines (PRG).

METHODS: Nineteen patients (52.6% male, 69.1±7.9 years, 27.2±5.7kg/m², 0.59±0.15 ankle-brachial index) with PAD performed two experimental sessions (i.e., 30 minutes of walking on the treadmill) in random order: the PRG session (i.e., sets of 3-5 min of walking and 2-3 minutes of recovery, with intensity defined on a scale moderate in pain perception) and the SSP session (i.e., participants choose at which speed they preferred to walk, duration of sets and time of recovery between sets). Heart rate, systolic blood pressure, perceived exertion, subjective perception of pain and affective response were monitored every 5 minutes throughout the session.

RESULTS: The average duration of the sets (p<0.001) was higher for the SSP session. However, the number of the set (p<0.001), average walking speed per set (p<0.001), the total recovery time (p<0.001), and total distance covered in the session (p<0.001) were lower for the SSP session compared to PRG session. The intensity markers (i.e., heart rate and perceived exertion) and pain and affective responses were similar in both sessions

CONCLUSION: Patients with PAD and CI symptoms prefer few bouts with longer duration at slow walking speed and, with lower total time recovery compared to the PRG session. This prescription elicited similar cardiovascular and RPE, and pain perception affective responses than recommended by the guidelines.

LIFE'S ESSENTIAL 8 SCORE AND RISK OF ALL-CAUSE AND CARDIOVASCULAR MORTALITY IN SPANISH ADULTS: THE ENRICA STUDY

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INTRODUCTION: Cardiovascular diseases (CVD) continue to be the main cause of morbidity and death globally (1). Focusing on the primordial prevention, the American Heart Association (AHA) has recently updated its algorithm to quantify cardiovascular health, namely "Life's Essential 8" (LE8) (2). Recent evidence indicates that higher LE8 score is associated with lower risk of all-cause and CVD mortality in American population (3). However, little is known about the role of LE8 on mortality in Europe. Understanding the role of the LE8 score to predict mortality in European countries is of interest, particularly in Spain where the CVD mortality is rather low. This study aimed to examine the association of the LE8 score with all-cause and CVD mortality in a representative sample of noninstitutionalized adult population of Spain.

METHODS: Data from ENRICA cohort (4), comprising 11616 participants representative of Spanish population aged >18-years, recruited from 2008-2010 and followed up to 2022. LE8 (range 0-100) was assessed following the AHA definitions and was categorized as low (0-49), moderate (50-79), and high (80-100). The score components are diet habits, physical activity, nicotine exposure, sleep health, body mass index, blood lipids, blood glucose and blood pressure. Associations between the score and mortality were investigated using multivariable-adjusted Cox proportional hazard ratio (HR). Age, sex, social status, and education level were used as covariates.

RESULTS: The mean age of the sample was 47.4 years [95% confidence interval (CI), 47.0-47.7], and 6110 were female (50.5%). During a median follow-up period of 10.9 years (ranging from 0.47 to 13.6 years), 908 all-cause deaths occurred, being 207 (26.2%) due to CVD causes. The LE8 was associated with lower risk of all-cause (HR for per 10-score increase, 0.84; 95%CI, 0.78-0.89) and CVD mortality (HR for per 10-score increase, 0.76%; 95%CI, 0.66-0.89). Nonlinear dose-response relationship was observed for all-cause and CVD mortality.

In comparison with participants having low LE8, those having high LE8 had a reduction of 57% in the risk for all-cause mortality (HR, 0.43; 95% CI, 0.28-0.67). However, for CVD mortality the reduction was not significant (HR, 0.41; 95% CI, 0.14-1.19).

CONCLUSION: Higher LE8 score was associated with a lower risk of all-cause and CVD mortality in Spanish population. Interventions encouraging high levels of LE8 score should be promoted among the general population. Further research into the long-term and causal relationship of LE8 and mortality is needed.

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ASSOCIATION OF ESTIMATED CARDIORESPIRATORY FITNESS AND INSULIN RESISTANCE IN KOREAN ADULTS: THE KOREA NATIONAL HEALTH AND NUTRITION EXAMINATION SURVEY (KNHANES 2020-2021).

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SEOUL NATIONAL UNIVERSITY

INTRODUCTION: Lower cardiorespiratory fitness is associated with various metabolic diseases. However, general physical fitness tests have limitations that require trained personnel and specialized measurements. Therefore, we use verified estimated CRF (eCRF) analysis to confirm the relationship with insulin resistance. The study aimed to examine the association between eCRF and insulin resistance (HOMA-IR) in Korean adults using data from the 2020 and 2021 Korean National Health and Nutrition Survey (KNHANES).

METHODS: This data is a cross-sectional study, and a total of 12,085 participants aged 19 and older were included in the analysis. The data were analyzed using regression models to assess the association between cardiorespiratory fitness and insulin resistance. eCRF was analyzed by dividing it into quartiles using the estimation equation verified by Artero et al. based on age, sex, body mass index, waist circumference, smoking status, resting heart rate, and self-reported physical activity level. Insulin resistance was measured to calculate the HOMA-IR. We used logistic regression to examine the relationship between the two variables after adjusting for potential confounders such as age, sex, body mass index (BMI), smoking, alcohol intake, hypertension, and family history of diabetes.

RESULTS: The study aimed to examine the relationship between cardiorespiratory fitness and insulin resistance by dividing the sample into quartiles. The results showed a clear association between fitness level and insulin resistance, with the highest fitness quartile having the lowest insulin resistance levels. The odds ratio of insulin resistance was calculated for each quartile, with the highest quartile having an odds ratio of 0.14 (95% CI: 0.11-0.17), the third quartile having an odds ratio of 0.27 (95% CI: 0.23-0.31), the second quartile having an odds ratio of 0.52 (95% CI: 0.45-0.59), and the lowest quartile serving as the reference. These results indicate a strong inverse relationship between cardiorespiratory fitness and insulin resistance, with the highest levels of fitness being associated with the lowest levels of insulin resistance. The results support the idea that increasing fitness levels can significantly impact insulin sensitivity and reduce insulin resistance risk.

CONCLUSION: The analysis results demonstrated a significant relationship between the two variables, indicating that higher levels of cardiorespiratory fitness are associated with lower levels of insulin resistance. These findings highlight the importance of maintaining good cardiovascular health for overall metabolic health and suggest that cardiorespiratory fitness may play a role in preventing insulin resistance and related conditions.

REFERENCE VALUES FOR ACCELEROMETER-ASSESSED PHYSICAL ACTIVITY AND ASSOCIATIONS WITH CARDIORESPIRATORY FITNESS: A CROSS-SECTIONAL STUDY OF HEALTHY ADULTS

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INTRODUCTION: Accelerometers accurately quantify physical activity.[1] The traditional method of categorising acceleration using cut-points is inaccurate.[2] Average acceleration (AvAcc) and intensity gradient (IG) have been proposed as cut-point-free alternatives.[3] Yet, their interpretation is difficult and the association with cardiorespiratory fitness (CRF) is unclear. Thus, we aimed to compare the association between CRF and cut-point-free metrics to that with traditional metrics in healthy adults aged 20 to 89 years and 2) provide age- and sex-related reference values for healthy adults.

METHODS: In the COmPLETE study, 463 healthy adults underwent cardiopulmonary exercise testing and wore GENEActiv accelerometers on their non-dominant wrists.[4] Cut-point-free (IG: distribution of intensity of activity in a day; AvAcc: proxy of volume of activity in a day) and traditional (moderate-to-vigorous and vigorous activity) metrics were derived.[3,5]

RESULTS: IG and AvAcc provide a complementary perspective on PA with both IG ($p=0.009$) and AvAcc ($p<0.001$) independently associated with CRF in healthy individuals. The best cut-point-free model and the best traditional model exhibited comparable predictive value for CRF. However, IG and AvAcc are comparable among cohorts and the most widely-used accelerometers, contrary to traditional metrics. We created age- and sex-specific reference values for IG and AvAcc for healthy adults. Moreover, the newly developed R-package 'rawacceleration' will facilitate the transfer of our findings into practice.

CONCLUSION: IG and AvAcc have strong predictive value for CRF and indirectly for the risk of non-communicable diseases and mortality in healthy adults.[6] Our reference values will enhance the utility of AvAcc and IG and simplify their interpretation.

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THE ACCURACY OF SMARTWATCH OPTICAL HEART RATE SENSOR, DURING THREE PROGRESSIVE INTENSITIES: A PILOT STUDY

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UNIVERSITY OF CAMPINAS

INTRODUCTION: Wearable-technology has been developed and investigated as a tool for health and well-being promotion. Along with, smartwatches have emerged with sensors to monitor daily activities and the practice of physical activity. However, the metrics provided by these technologies has been varied by user profile, protocol and sensors adopted [1]. Therefore, the aim of this study was to analyze the accuracy of heart rate by a photoplethysmography (PPG), optical sensor, adopted in the smartwatch, (Samsung Galaxy Watch4), during three different intensities.

METHODS: Eighteen (15 men and 3 women) physically active participants (age: 28.9 ± 7.3 years; height: 172.0 ± 7.0 cm; body mass: 74.6 ± 15.8 kg; BMI: 25.1 ± 4.1 kg/m2). They were informed about all procedures used during protocol. The participants were monitored during walking, jogging and running by two different heart rate monitoring devices. The intensity zones were determined by maximal heart rate percentage [2]: a) light [57-63%] = walking, b) moderate [64-76%] = jogging and c) vigorous [77-95%] = running. The each stage duration was 5-minute. The heart rate monitor Polar RS800-CX (Polar Electro®, Kempele, Finland) was used for a reference device, because of the electrical pulses reading method, and it works by a chest strap on the trunk. In parallel, the participants used a smartwatch (Samsung Galaxy Watch 4 [SGW4], Samsung®, South Korea) at the left wrist, the data was collected by a photoplethysmography (PPG) sensor, an optical one. For statistical analysis the average of values in each intensity zone by Polar and smartwatch was used and applied the Symmetric Mean Absolute Percentage Error (sMAPE, a percentage calculated from difference between actual and forecast values) for analyze the smartwatch accuracy [3], considering sMAPE < 10% as Good and sMAPE < 5% as Excellent. The analyses were performed in Microsoft Excel®, version 365 (Microsoft Office®).

RESULTS: Considering the comparison between SGW4 and Polar in the three intensity zones, it was observed an increase of smartwatch accuracy the greater the intensity according to sMAPE: 16,1% in light intensity; 8,9% in moderate intensity; 6,7% in vigorous intensity.

CONCLUSION: Considering the results of this study, the Samsung Galaxy Watch 4 is reliable for physical activity monitoring, especially in higher intensities, allowing the use of this device in physical exercise monitoring.

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Conventional Print Poster

CP-AP01 Sport Equipment

IMPACT OF CARBON-PLATED RUNNING SHOES ON RUNNING ECONOMY IN INTERMEDIATE RUNNERS

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INTRODUCTION: Numerous sporting goods manufacturers advertise carbon-plated shoes as performance-enhancing products for runners. Some studies showed already a small effect for elite runners [1][2]. The aim of this study was to verify the influence of two types of carbon-plated running shoes on the running economy of intermediate runners like sports students at different percentages of the VO2peak velocity compared to the habitual footwear of the participants.

METHODS: Eight male sports students (mean ± SD 23.8 ± 2.3 years, 182 ± 7 cm, 75.0 ± 8.2 kg) first conducted an incremental treadmill running test until exhaustion wearing their habitual footwear (starting velocity 10 km/h increasing 1km/h per min, incline 1%) to determine their individual VO2peak (mean ± SD 58.13 ± 5.11 ml/kg*min-1). In the main part of the

study, each participant completed three treadmill sessions on three experimental days, each with different shoes (Adidas Adizero Pro 3, Nike Vaporfly 2, and their habitual Own shoes). The order of the three different footwear options was randomized and counterbalanced. During each treadmill session, every participant completed, after an individual moderate warm-up, three 5-minute stages at 60%, 70%, and 80% of their individual VO2peak velocity (mean ± SD 18.1 ± 1.5 km/h) interrupted by a one-minute break to collect the RPE values. Comfort values of the three different conditions were evaluated by a visual analog scale (VAS from 0 to 10). 2-Factor ANOVA was used to verify the impact of intensities and footwear on outcome parameters.

RESULTS: Oxygen consumption [ml/kg*min-1] increased significantly with higher intensities (main effect intensity $p<0.001$) while no effect of footwear ($p=0.364$) and no interaction intensity x footwear ($p=0.992$) was found. Running economy tended to be lower with Own shoes (mean ± SD):

Adidas: 39.0 ± 5.0 [60%], 45.0 ± 4.6 [70%], 50.4 ± 4.8 [80%]

Nike: 39.5 ± 4.3 [60%], 46.6 ± 5.6 [70%], 50.9 ± 5.9 [80%]

Own: 40.6 ± 3.5 [60%], 47.0 ± 4.1 [70%], 52.8 ± 5.2 [80%]

Energy expenditure corresponded to oxygen consumption and reached the highest values during running with the habitual own shoes at 80 % of VO2max (1167 ± 99 kcal/h). RPE post-exercise ratings increased significantly with higher intensities (main effect intensity $p<0.001$) while no effect of footwear ($p=0.193$) and no interaction ($p=0.753$) was found. RPE values tended to be higher with Own shoes at higher intensities. Comfort values were 8.6 ± 1.0 (Adidas), 7.8 ± 2.2 (Nike), and 7.1 ± 1.9 (Own). Overall, there were no significant footwear effects except for the VAS comfort between Adidas and the Own footwear (p-value: 0.024*).

CONCLUSION: We conclude that carbon-plated running shoes have only small positive effects on running economy in intermediate runners. Future studies should include larger and more homogenous samples and longer running distances under more ecologically valid field conditions.

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DO SUPER SHOES OFFER AN ADVANTAGE TO RECREATIONAL RUNNERS?

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INTRODUCTION: Research shows a lower energy cost in athletes using Advanced Footwear Technology (so called "super shoes"), but this has mainly focussed on well-trained runners. It is not clear whether such super shoes benefit recreational marathon runners at slower paces. The aim of this study was to compare physiological and biomechanical variables between a model of super shoes (Saucony Endorphin Speed 2) and regular running shoes (Saucony Cohesion 13) in recreational athletes.

METHODS: Ten participants (1.66 ± 0.04 m, 57.1 ± 3.8 kg, 23.3 ± 1.1 y) began an incremental treadmill test at a running speed corresponding to 50-60% VO2 max. Speed increased by 1 km/h every 2 min until exhaustion. Gas collection was performed during the last 60 s of each stage to attain steady state VO2. The VO2peak was calculated with the speed at VO2peak (vVO2peak) determined as the lowest running speed that elicited a VO2 equivalent to VO2peak. Participants subsequently ran four times in a randomly ordered cross-over design for 5 min (super or normal shoe, at 65% or 80% vVO2 max). Video data were recorded (Casio EX-F1 camera, 300 Hz) during the last 30 s of the 1st and 5th min, with VO2 measurements collected during the 5th min. Averaged contact and flight times during 10 consecutive steps were used to calculate step rate and step length. Vertical and leg stiffness were calculated using the methods of Morin et al. (2005) [1]. Two-way ANOVA ($\alpha < 0.05$) was used to identify differences between shoes and running speeds for O2 consumption and heart rate (HR), and three-way ANOVA (shoes x speed x time elapsed) was used for spatiotemporal and stiffness variables.

RESULTS: O2 consumption in the Endorphin was 3.9% and 5% lower than the Cohesion shoe at 65% vVO2 max (~9.4 km/h) and 80% vVO2 max (~11.2 km/h) accordingly ($P < 0.001$). HR was lower (1.8%) in the Endorphin shoe ($P < 0.001$), although there was no shoe-speed interaction for this variable. The Endorphin condition had shorter step lengths (0.7 - 1.0%), higher step rates (0.7 - 1.4%), shorter contact times (2.0 - 2.7%) and longer flight times (4.8 - 7.9%) ($P < 0.001$). All these variables changed with increased speed ($P < 0.001$). For global stiffness characteristics, vertical stiffness and leg stiffness were greater in the Endorphin shoes (1.6 - 3.3% and 4.6 - 6.3% accordingly, $P < 0.001$). Peak vertical force and vertical stiffness both increased with speed ($P < 0.001$).

CONCLUSION: There was a physiological benefit to running in the super shoes as O2 consumption and heart rate were lower than in the regular shoe. The difference in O2 consumption did increase at the faster speed (5%), but nonetheless there was still a 3.9% advantage at the slower speed. The physiological benefits were accompanied by spatiotemporal and global stiffness benefits to wearing the super shoes, indicating that recreational runners gain a mechanical advantage by using this kind of footwear.

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EFFECTS OF WEARING COOLING TROUSERS ON SKIN TEMPERATURE AND SKIN PERFUSION IN HEALTHY MALES.

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INTRODUCTION: Cold-water immersion (CWI) is a commonly used recovery modality with the aim of positively affecting subjective recovery parameters and reducing inflammatory reactions [1]. The main mechanisms of cryotherapy for recovery enhancements can be attributed to its vasoconstrictive effects, which reduce skin temperature and skin perfusion. However, the use of CWI is sometimes unpleasant and can be a logistical challenge. For this reason, alternatives to CWI, such as cooling trousers by Icebein™, have been developed. Due to their novelty, there exists a lack of scientific research on the basic physiological and perceptual responses to these cooling trousers. Therefore, this pilot study aims to investigate the effects of cooling trousers on i) lower leg skin temperature, skin perfusion, and ii) thermal perception.

METHODS: In this pilot study, 12 healthy males (26±4.2 years old) volunteered to wear the Icebein™ cooling trousers for a duration of 20 min with the water temperature set at 5°C. Lower leg skin temperature (FLIR, A655, Kent, UK), skin perfusion of the m. quadriceps femoris vastus lateralis (moor VMS-LDF-1, Millwey, UK) and thermal perception (ISO 10551) were assessed at baseline, every 4 min during the intervention (except skin temperature) and every 4 min post-cooling up to 20 min follow-up time.

RESULTS: Skin temperature significantly decreased from baseline to post-cooling (–12.4±5.63°C, $p<.001$) and remained lower than baseline until the 20 min follow-up time (all: $p<.001$). Skin perfusion showed an overall significant decrease when compared to baseline ($p=0.038$). Perfusion was decreased by 19.9±23.7% immediately post-cooling and by 22.1±26.4% at the end of the 20 min follow-up time. Wearing cooling trousers induced a significant perception of cold ($p<.001$) compared to baseline values.

CONCLUSION: The present study shows that the cooling trousers from Icebein™ elicit i) significant skin cooling on the legs, reduce skin perfusion and ii) induce a significant perception of cold. These preliminary results demonstrate the physiological effects of this novel cooling strategy for potential performance recovery usage. Future studies should aim to directly compare the effects of cooling trousers and CWI with a larger sample size.

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IDENTIFICATION OF SPATIAL COGNITION FOR MULTIPLE SOUNDS IN BLIND FOOTBALL PLAYERS USING A VIRTUAL ACOUSTIC SYSTEM

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INTRODUCTION: Although spatial cognition based on auditory information, or sound source localization ability, is important in blind football, there is no simple, and quantitative method for evaluating it. Therefore, this study aimed to develop a virtual acoustic system for identifying the unique sound source localization ability of blind football players.

METHODS: A. Development of the system

Using stereophonic technology, we developed a virtual acoustic system that can generate three types of sound sources at arbitrary locations in a virtual space: the sound of the ball, the players vocalizations, and the sound of the guide hitting the goalposts, and simulate the sound on a blind football pitch simply by putting on headphones. Comparing the system and real space shows that the spatial resolution of the sound sources that the system can reproduce is approximately 0.42 m.

B. Evaluation of sound source localization ability

The subjects were six clear-sighted, inexperienced players and six visually impaired blind football players. First, as a single task, a stationary sound source (ball sound) was generated in a virtual space, and the subjects responded verbally to the sound source location (azimuth and distance) when they heard the sound. Twenty-four positions were generated, with each being generated 5 times, i.e., 120 times in total. Because various audio information was heard simultaneously during the competition, the ability to simultaneously grasp the positions of multiple sound sources was evaluated. Then, as a double task, two types of sound sources were generated at two points in the virtual space. Next, as a triple task, three types of sound sources were generated, and the above procedure was repeated. Considering the systems spatial resolution, the minimum distance between the generated sounds was approximately 1 m.

RESULTS: In the single-task test, the mean percentage of correct responses was 67.4% (SD 9.25) for experienced players and 57.9% (SD 17.2) for inexperienced players, indicating that experienced players had a significantly higher percentage of correct responses. In the double- and triple-task tests, the percentage of correct responses for all sound sources was significantly higher for the experienced players.

CONCLUSION: The correct response rate for inexperienced players significantly decreased as the number of tasks increased, whereas experienced players showed no significant difference between single and double tasks. Therefore, sound source localization ability for multiple sound sources is considered important in blind football.

As an application of this research, it is possible to iteratively train sound source localization ability by focusing on the type of sound source, distance, and direction that each user has difficulty with. In the future, we plan to develop a training system and verify its effectiveness.

COMPARING THE EFFICIENCY OF DIFFERENT KAYAKING PADDLE LEAVES.

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INTRODUCTION: Flatwater kayaking performance was revolutionized following the introduction of the "wing" paddle in 1986, which was significantly more efficient than the traditional "drag" one. Since then, many sports equipment manufacturers have proposed several new designs based on the "wing" paddle leaf concept, in an attempt to further improve performances. Yet, to our knowledge, no quantitative comparison of the efficiency of such new designs was carried out so far. Here we set out to experimentally compare two popular new paddle shapes and determine whether the different designs do have an effect on performance.

METHODS: We used two Kayak Power Meters and a GPS smartwatch to record 8 college-level athletes each performing four 200m runs with each one of the two tested leaf models, at a predefined, sub-maximal stroke rate while focusing on the correct stroke technique and on maximizing the exerted power. The collected data were analyzed both in terms of individual strokes and as overall means, focusing on stroke power trace morphology, peak stroke power, and time-averaged stroke power. The two latter parameters were individually normalized on each participant's performance and then compared through statistical analysis.

RESULTS: The morphological analysis of the power exerted during individual strokes showed that the main characteristics of right and left strokes are independent of the paddle blade as they are preserved across each subject's runs. On the other hand, more subtle parameters of the stroke morphology as its initial slope and the time of peak power relative to the stroke duration are influenced by the shape of the leaf and were higher and occurred sooner, respectively, with one model compared to the other.

Also the value of the normalized mean peak stroke power and that of the normalized mean time average power of each stroke were found to be higher with one paddle design compared to the other.

Finally, the comparison of completion times taking into account the direction of the trial with respect to the weak current flow was also in favor of a statistically significant difference related to the paddle leaf used.

CONCLUSION: Here we set out to perform a comparison of the biomechanical efficiency of two different paddle blade designs, and we devised an experimental study on a group of college-level athletes to answer such question. Although the differences in power delivery and boat speed were subtle, an accurate data analysis and statistical comparison highlighted a consistently better performance obtained with one model over the other, in spite of the several confounding factors involved. Future developments will attempt to further reduce such factors and their influence to simplify and promote quantitative analyses of performances.

REDUCING HEAD INJURY IN WRESTLING: A BIOMECHANICAL AND IMPACT TESTING STUDY USING POLYUREA-COATED FOAMS AS WRESTLING MATS

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INTRODUCTION: Wrestling is a sport that involves various moves, including throws and takedowns, which can cause the athletes to hit the mat with significant force. The impact of such falls can lead to various injuries, with head injuries being the most dangerous due to their potential negative consequences, including Chronic Traumatic Encephalopathy (CTE) or Second Impact Syndrome (SIS). These injuries may have severe, long-lasting effects on the athletes health, including permanent neurological damage and impaired cognitive functions. Therefore, developing wrestling mats that can reduce the risk of these injuries is crucial for ensuring the safety and well-being of athletes.

METHODS: Three Hungarian male wrestlers were involved in a biomechanical study to determine the typical loads on wrestling mats. A BTS Smart DX400 system with six infrared cameras and two regular video cameras was used to analyze the motion of the athletes during the seven most typical wrestling movements. The maximum velocity of the head was determined from the collected data, which was then used as input data in the subsequent impact testing. An impactor equivalent to an average human head (Triax Touch E-Missile) was used to investigate the shock-absorbing capacity of a traditional (30 kg/m3 density, 50 mm thick cross-linked polyethylene foam) and a polyurea-coated wrestling mat. Head Injury Criterion (HIC) was calculated, and the probability of different severity head injuries was determined.

RESULTS: The comparison of different wrestling movements showed that executing the forward bridge technique had the highest possible head impact velocity with 5.94 m/s. The impact tests conducted from a 180 cm drop height indicated a greater injury-preventing effect for the polyurea-coated mat, with a significant reduction in Head Injury Criterion to 793±1 compared to 1347±39 for the traditional foam. The probability of severe head injuries (associated symptoms: skull fracture, loss of consciousness, and neurological damage) decreased from 42.1% to 8.6% with the polyurea-coated mat. Compared to the traditional mat, the polyurea-coated mat also had a lower probability of minor (96.6 vs. 99.9%), moderate (74.7 vs. 97.9%), serious (33.3 vs. 81.3%), critical (0.9 vs. 10.1%), and fatal (0.0 vs. 0.8%) injuries.

CONCLUSION: The use of polyurea-coated foam structures as wrestling mats significantly reduces head injury probability, making the sport safer for its athletes. The coating provides four times higher protection against severe injuries with neurological damage, decreasing potential long-term negative effects such as CTE. Moreover, the longer lifetime of the polyurea-coated mats suggests their implementation may be economically viable in the long term. However, further studies are necessary to evaluate the practicality of this technology in competitions.

A PROPOSAL FOR A HIGHLY EFFICIENT RECEIVING PRACTICE METHOD IN VOLLEYBALL USING VIRTUAL REALITY ENVIRONMENTS: ESTIMATION OF LOW-RETURN RATE SPIKE COURSES BY DEEP LEARNING BASED ON RECEIVER POSE

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INTRODUCTION: Among the many volleyball skill types, improvement of spike-receiving skills have been considered critical [1]. Therefore, we have developed a volleyball spike receive-training system using 3D-VR [2]. Although focusing practice on courses that have appeared difficult to receive individually was effective, thereby enhancing receiving skills, it remained hard to judge the course's position because it changed with time, depending on the receiver's posture. Hence, this study used the previously proposed VR training system to develop a deep-learning model that would be able to predict challengingly receiving courses based on the receiver's time-varying posture.

METHODS: A. Dataset creation

The player wears a HMD and stands at the center of the court within the VR space. Spikes were continuously hit from the net's center of the opponents court at regular time intervals. Then, a male subject (age 24) performed 538 spike receives within the VR. We recorded the spike course, the receivers time-varying posture information before receiving, and the success or failure of the receive for each trial. For the posture information, we attached trackers at seven points (waist, left thigh, right thigh, left ankle, right ankle, arm and ball contact point, and head) to obtain the 3D coordinates and three-directional rotation angles for each point.

B. Development of the deep learning model

Subsequently, we developed a model that could predict whether a receiver will be able to receive a spike based on their posture information up to the moment the spike is hit. Remarkably, the model should make it possible to instantly determine low-return rate spike courses according to the receivers current posture. We constructed the model using LSTM since it is superior to others in extracting features from time-series data.

RESULTS: Applying our model to the test dataset, we obtained an accuracy of 69 %. It is important for this study to predict low-return rate spike courses precisely and the precision that the model predicted a receiver would fail and that the receiver actually failed was 79%.

CONCLUSION: Although this study developed a model using deep learning that could predict low-return rate spike courses with high precision (79%), we only investigated one subject. Therefore, future studies must increase the sample size to consider individual differences. For future prospects, this model should be integrated into the VR system, which can hit a specific course as many times as needed to enable repetitive practice by hitting only low-return rate spike courses determined by the model. It would greatly contribute to the improvement of receiving skills in real space.

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AN INNOVATIVE COMPLEX SPORTS LIGHTING SYSTEM AND THE RELATED OPTIONS FOR THE ENHANCEMENT OF SPORTS PERFORMANCE

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INTRODUCTION: The significance of the impact of light on human activity and performance has been well known for a long time. Nowadays new LED light sources and the state of the art computerised control options can be utilised for the enhancement of sports performance. Said developments result in a complex sports lighting system. This integrated and innovative product simultaneously responds to the current pandemic-related challenges and makes use of the latest lighting technology and control features while providing an optimal environment for even the indoor activities of athletes.

METHODS: The theoretical foundations of the project were established via secondary research and analysis performed by the Hungarian University of Sports Science. The experimental development effort and the construction of the prototype took place within the framework of an innovation support project at the GET Ltd. The given effort resulted in the elaboration of the experimental lighting of the sports hall at the University of Sports Science hosting the respective performance assessments as well. Twelve basketball players performed 100 free throws and 100 three-point shot in low (cc. 600 lux, lack of 483 nm) and strong (over 800 lux, rich in 483nm as the midday natural light) light. The statistical analysis was done by R (version 4.2.2) statistical program.

RESULTS: The theoretical findings resulted in the development of a unique prototype facilitating the realization of the respective goals. The prototype included individually controlled LED lights and an UV-C fluorescent tube.

The regulation of colour temperature implies the ability of LED lights to provide lighting with a wavelength similar to that of the midday sunlight. Such light capable of influencing the melatonin system of the human body can increase the activity of athletes as well.

Our study introduces the forms and results of the initial comparative assessments performed in three point shot and free throw in basketball. Regarding the three point shot, there was a singnificant association between the two types of illumination $x2(1)=7.1$; $p=0.008$. However, there was no singnificant association between the two types of illumination $x2(1)=3.62$; $p=0.057$ during the free throw.

CONCLUSION: By now, the lighting technology industry has reached a level of development facilitating the construction of a complex indoor lighting system capable of improving sports performance along with protecting the health of athletes via the elimination of viruses and other pathogens. Said progress can revolutionize indoor lighting and provide quantifiable and assessable assistance to athletes in achieving better performance. The results are truly encouraging and regarding the initial assessment results we could highlight that the players performed significantly better at the strong, blue light session during the three point shot.

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CP-SH10 Social science and humanities (mixed)

THE PLAY HABITS OF CHILDREN DURING THE EARLY YEARS – EXPLORING ETHNIC DIFFERENCES IN THE BORN IN BRADFORD COHORT STUDY.

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Background: Play is an integral component of the physical activity (PA) children engage in during the early years (0-4 years). PA levels differ between White British and South Asian populations during childhood and adulthood. However, there is contradictory evidence regarding different types of activity behaviours (e.g., PA and screen time) during the early years, and ethnic differences in play during the early years have not yet been investigated.

Methods: Questionnaires were administered to children's parents/carers when their child was 24 and 36 months. Differences in time spent in different play behaviours, the frequency of play behaviours, who children played with, and the use of indoor play facilities and parks/playgrounds, were analysed.

Results: The final sample included 311 White British and 509 Pakistani children. Pakistani children engaged in active play and outdoor play less frequently and for lower durations than White British children. Boys from both ethnic groups engaged in active play more often and for longer than girls. There were also significant variations between ethnic groups in who children frequently played with. There were no significant interactions with mother's education on any of the outcome variables.

Conclusion: Findings suggest interventions to increase active and outdoor play may need to be tailored to account for ethnic differences in play habits.

RESEARCH ON THE RELATIONSHIP BETWEEN PHYSICAL ACTIVITY CONSCIOUSNESS AND INTENTION: A SURVEY OF CHINESE COLLEGE STUDENTS

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Background

Physical inactivity and fitness decline have been significant issues among college students, becoming a major concern in most nations. Specifically, in China, which now has the worlds largest higher education system, more than 60% of college students feel inadequate in physical activities (PA). The issues root was indicated as they have a low rate of PA consciousness and implementation. PA consciousness promotes an understanding of perception and attitude towards PA including sports. The stronger an individuals consciousness, the more active one is in PA. Additionally, behavioural intention demonstrates that people tend to act in favour of a specific item; so, PA intention must link awareness to implementation. However, despite numerous inquiry studies aimed at elucidating the consciousness position of college students, previous studies indicated that empirical research on the relationship between PA consciousness and intention in China is insufficient. Thus, this study aimed to discuss the relationship between PA consciousness and intention among Chinese college students after identifying their PA consciousness.

Method

Four universities from the north, south, east, and west of China participated in a questionnaire survey. 508 valid questionnaires were gathered. The sports awareness scale developed by Tokunaga et al. (1984) served as the foundation for the questionnaires content. The questionnaire also includes two items about PA intention based on Qu et al. (2012). By using Data SPSS 28.0, factor analysis correlation coefficients, cluster analysis, Chi-squared test and one-factor analysis of variance were performed to analyse the data.

Results and Discussion

Three factors: Positive Perception, Negative Attitudes and Peripheral Expectations, were extracted in Chinese college students consciousness. PA intention showed a high positive correlation ($r = .779$, $p < .001$) with Positive Perception; a low significant negative correlation ($r = -.285$, $p < .001$) with Negative Attitude; a high positive correlation ($r = .640$, $p < .001$) with Peripheral Expectations. Three factors showed significant group differences. Four clusters were discovered, which means four consciousness styles were categorised according to the characteristics of each cluster through multiple comparisons. In addition, the four types of PA consciousness scored differently for PA intention, and significant between-group differences in scores were identified. This demonstrated the significant connection between PA consciousness and intention.

This study concludes that improving students' PA consciousness based on their traits increases their intention efficiently, which may successfully encourage college students in China to participate in PA and sports. This study will also help address the problem of physical inactivity among college students on a global scale.

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PHYSICAL EDUCATION TEACHERS AND THEIR STATUS: WHY ARE THEY NOT SEEN AS PROFESSIONALS?

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Introduction

Physical education (PE) teachers express that their professional status is lower than that of teachers in theoretical subjects. Studies shows that it might be because the subject is not a core subject and of the uncertainty about the subjects goals (James, 2011). Nonetheless, there is a lack of knowledge about PE teachers' status which both can be negative for the reputation of the subject and the recruitment of new PE teachers. Using concepts of social closure when analyzing historical texts about PE teachers and physical education teacher education (PETE), the aim of the study is to contribute with new knowledge about how claims have been produced and reproduced over time and maintained an animated debate about PE teachers' lack of status.

Method

An analysis of ten historical texts about PE teachers and PETE was done, to identify how PE teachers negotiate about their occupation and how that negotiation results in the use of certain social closures. The texts are written by PE teachers (n=5) and government officials (n=5). They range from the beginning of the 19th century to present day and describe partly the PETE and PE teachers of that time and partly make suggestions on how to make changes in PETE to acquire higher status for PE and PE teachers. The analysis is made in two steps: first using thematic analysis to identify relevant themes and then distinguish how the concept of social closure is used. Social closure is divided into two types, exclusionary and usurpationary closure, and is derived from theories of profession (Parkin, 1979).

Result

The study shows that PE teachers try to create a higher status profession for themselves by using exclusionary closure on nearby occupations. They also use usurpationary closure on higher standing professions, partly through the monopolization of education and professional titles, and partly by trying to imitate the education systems of other professions.

Discussion

By using the concept of social closure we can identify PE teachers attempts to create a high status occupation, which might lead to benefits as a higher salary and a better reputation. An example is the ambition to create an expert education with a specialist degree through which they can gain a monopoly over PE teaching positions in schools. However, they still have difficulties distinguishing their occupation from other closely related occupations and can therefore not create a sufficiently exclusionary closure in relation to competing occupations. This can be seen in PE´s strong relation with sports, which results in difficulties for PE teachers making exclusionary closure against sport coaches. They also use usurpationary closures when they imitate educational systems of professions that are considered having higher status.

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TEACHERS' PERCEPTIONS ON PHYSICAL EDUCATION IN ITALIAN SCHOOL: A MIXED METHODS APPROACH

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After a long legislative process, the educational offer of physical and sports education in Italian primary schools will be able to make use of the specialized physical education teacher as of this school year (Low n. 234/2021). With the aim of understanding the state of the art of the quality of physical education teaching (UNESCO, 2015), highlighting training needs and perceived strengths and weaknesses, an exploratory survey was conducted with a mixed methods approach.

Through the administration of a specially constructed semi-structured questionnaire, a sample of 691 participants in the support teacher course took part in the research, 59% of whom are currently employed teachers.

Some of the results show that PE is for 69% of the sample an extremely (69%) and for 30% a very important vehicle for promoting biopsychosocial well-being and an active lifestyle. The discipline is considered to be extremely (56%) and very (41%) important for promoting the development of life skills and for 56% and 41% respectively extremely and very important for promoting the acquisition of life skills; for 68% and 30% extremely and very important for promoting healthy lifestyles. Whereas for only 34% PE is an extremely important tool for promoting learning and memorizing other subject content (51% very and 14% moderately important). The same applies to the acquisition/development of key competences for lifelong learning where only 36% consider it extremely important and 49% and 14% very and moderately important respectively.

With regard to the possibility of improving the quality of teaching, 69% and 28% respectively consider it extremely and very important to have adequate spaces and facilities; 45% and 47% of the sample consider economic resources to be allocated to extracurricular projects to be extremely and very important; finally, 59% and 31% indicated the presence of a teacher with a degree in motor sciences as extremely and very important. In addition to the quantitative analysis of the data, the contents of the open answers in the questionnaire were analyzed starting from two general theoretical categories generated by the questions themselves, namely: Critical points and Strong points of inclusive teaching in PE in schools.

The didactic and organizational scenario of PE in primary schools needs a change that can enhance corporeity in its multiple expressions as a personal right and a cognitive learning tool. It is necessary to take note of the balance that emerged from the survey, which highlights the need for a review of the curriculum and a strong investment in terms of organization, structure and human resources.

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ASSESSMENT TOOLS IN PHYSICAL AND SPORTS EDUCATION IN SCHOOL CONTEXT: AN OVERVIEW.

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Introduction: During the developmental age the acquisition of skills is a priority objective in all learning contexts. The student will be competent when he will be able to use knowledge, skills, attitudes, emotions to effectively face the situations that everyday reality proposes to him in relation to his potential and attitudes. In motor-sports contexts this affirmation is declined in the ability to use ones personal, social and methodological resources in the expressive, sports, well-being and leisure fields. In the design of learning environments aimed at the development of competences it is essential to consider the following dimensions of competence: cognitive, operational-motor, social, metacognitive. The aim of this paper is to identify the different assessment tools available in the literature that are able to detect the different dimensions of competence and the complex relationships between them that manifest themselves in the context of physical and sports education.

Methods: We reviewed the assessment tools that have been used to measure motricity, cognition and emotion in young people/youth aged between 6 and 18 years old. We identified assessment tools more functional in the educational field. In order to identify them we used the keywords "motor/cognitive/emotional/social-dimension" "children" "scales" "questionnaire" "school" "assessment tools" "competence" in scientific platforms like Google scholar, PubMed, ResearchGate, Scopus, Web of science.

Results: The scientific literature analysis has identified assessment tools for motor development cognitive, emotional and psychosocial development. We selected tools that are more suitable for use in the school environment to provide an overview summarising the specific evaluation domains of the most appropriate tools for understanding the specific assessment.

Discussion: The evaluation of competence in the field of motor sports in the school context is very complex. The study shows strong interconnections between the different dimensions of competence (1), highlighting the need to use different evaluation tools that, integrating with each other, can give us the information and feedback useful to act effectively in the design of educational interventions.

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COMMERCIAL RUNNING APPS: HOW MUCH DO THEY SUPPORT USERS' PSYCHOLOGICAL NEEDS?

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Physical inactivity and sedentary lifestyles are major health-related risk factors. Running is quite relevant when studying the design and implementation of interventions aiming at increasing PA levels, as it is a very popular activity. A growing strategy to promote PA is to design interventions using "motivational technology."

Several commercial apps are specifically designed for running, but it remains unclear how much they rely on motivational theories and support users' needs. The purpose of the present study was twofold; firstly, to identify relevant apps available to the running community and secondly, to gain knowledge on how much they support three fundamental psychological needs: autonomy, competence, and relatedness (Self-Determination Theory; SDT [1]).

We extensively reviewed the top 8-ranked commercial running apps' features for 2022, using "best/most used/top-ranked running apps" as keywords in search engines. We included those with a clear running goal (e.g.: activity tracking, proposing training programs) and that systematically appeared in different ranks of most used apps. We compared eight running apps, and analysed five other applications and web services with interesting features, even if they were not con-

sidered the most used apps. To examine how these apps supported the above-mentioned psychological needs, we considered the following: Competence – applications offered articles on running to increase users' knowledge and tips to improve performance; Autonomy – freedom in the choice of functions, training programs, location, or time of the sessions; Relatedness – offered some interaction between users.

Findings showed that none of the apps explicitly considered any psychological need in their design. However, we can rate these apps according to SDT dimensions. All the apps satisfied autonomy to some extent. Six out of eight also included features allowing for competence satisfaction. Relatedness was present in every app but in different forms; some had an interface mimicking social networks, whereas others merely let the users share photos. Personalisation is another critical option to guarantee program adherence–only one of the eight apps produced personalized motivational messages.

To conclude, findings suggest that researchers may use existing commercial running apps when designing interventions. However, further research is warranted to fully understand what aspects are critical when using motivational technology to encourage long-term adherence and establish a common framework valid for different runners' profiles—ranging from health to performance.

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BARRIERS AND FACILITATORS TO PHYSICAL ACTIVITY FOR YOUNG ADULT WOMEN: A QUALITATIVE SYNTHESIS

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Introduction: Physical activity (PA) promotion for women of all ages is needed, especially for young adult women, who have remained at a lower level of PA than men for the past two decades and have not been extensively studied than other age groups. Moreover, young adult women generally face a sharp decline in PA from transition into adulthood, possibly due to societal and cultural impact. Thus, the current review aimed to synthesize the qualitative studies of young adult womens self-perceived barriers and facilitators to PA and provide some contextual implications for future research.

Methods: The review followed the PRISMA guideline. Medline, Pubmed, Scopus, SPORTDiscus, and Web of Science were searched to identify qualitative studies published between January 2000 and February 2022. Studies examined the barriers and facilitators of healthy young adult women's PA between ages 18 and 40 were included. Research quality was appraised using the Critical Appraisal Skills Programme tool. Data were extracted and thematically analyzed based on the social-ecological model (SEM) tenets.

Results: Twenty-three studies were included, and four themes with sub-themes were identified: 1. Body image, health, and beauty (body dissatisfaction & health, weight stigma & social embarrassment, body image & beauty standards); 2. Multiple roles, social support, and PA (multiple roles & patriarchal family, motherhood & children's needs); 3. Religious identity, cultural identity, and PA (Muslim identity and PA, embodied cultures); 4. Safety issues and women's fears.

Discussion: The results showed that barriers and facilitators of young adult women's PA were intertwined and integrated between SEMs intrapersonal, interpersonal, organizational, community, and environmental levels. At the intrapersonal level, PA was closely linked to health and women's body. Two discourses predominated and were seen as facilitators: the health discourse, which served as the primary justification for PA engagement; the beauty discourse, which was closely related to womens bodies and self-improvement. Beyond the individual level, young womens narratives tended to emphasize more on barriers at the interpersonal, organizational, and community levels. Young womens multiple social roles mostly drove these barriers within and across organizations after they entered adulthood, namely mother, employee, and self. In addition, gender norms and expectations were deeply ingrained in womens identities and shaped their lives, which extend to PA. Overall, young womens PA is a multilevel experience and multifaceted decision largely influenced by social relationships, cultural norms, and the societal environment. Future studies targeting the social-cultural level rather than merely individual behavior change could pave the way for successful interventions in this population. Additionally, qualitative research is critical and indispensable for comprehending the context and effects of implementations.

DUAL–TASK TRAINING EFFECTS ON THE COGNITIVE-MOTOR INTERFERENCE IN INDIVIDUALS WITH INTELLECTUAL DISABILITY

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INTRODUCTION: Individuals with intellectual disability (ID) present both cognitive (Spaniol, & Danielsson, 2022) and postural balance (Enkelaar et al., 2012) impairments. Recent studies showed that they are more prone to cognitive-motor interference during dual task (DT) condition when performing postural and cognitive tasks simultaneously compared to those with typical development (Van Biesen et al., 2018; Kachouri et al., 2020). The cognitive-motor interference (CMI) refers to a decline in the performance of a motor or/and cognitive task when executed concurrently relative to when each task is performed separately (Woollacott & Shumway-Cook 2002). Since it has been documented that DT training could reduce the CMI (Tait et al., 2017), it is particularly relevant to explore the effect of such training program in individuals with ID. This study explored the effect of DT compared to single task (ST) training program on the CMI in adolescents with ID.

METHODS: training group (DTTG) performed the same physical exercises with the STTG but simultaneously associated with cognitive tasks whereas the control group (CG) was not involved in any intervention. Motor and cognitive DT costs (DTC) were calculated as DTC=[(DT-ST)÷ST]×100 and then analyzed.

RESULTS: Before training, both CoPVm and cognitive performance were significantly higher in the DT condition compared to DT one in all groups. After training CoPVm values were significantly higher in the DT condition compared to the ST one only in the STTG and the CG. CoPVm values decreased significantly in both trained groups during DT and ST conditions. The cognitive performance increased only in the DTTG. After training the motor DTC was lower compared to before training only in the DTTG whereas no change was observed in the STTG or the CG. The cognitive DTC did not vary after training in any group.

CONCLUSION: Both ST and DT training programs improved postural balance whereas only the DT training enhanced cognitive performance and reduced the effect of CMI on postural balance during DT condition in these individuals.

Conventional Print Poster

CP-SH11 Physical activity promotion for children and youth

THE EFFECT OF COVID-19 ON PHYSICAL FITNESS PERFORMANCE AMONG UNIVERSITY STUDENTS

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Introduction: In recent years, physical education in school has been decreasing year by year, and the trend is deteriorating. Studies have found that physical exercise showed beneficial for individuals mental and physical health. (Gust & Bryan, 2021). In 2019, the new coronavirus (COVID-19) started spreading in many countries around the world. According to UNESCO, nearly 90% of students around the world have been out of school due to the new Corona Virus and have been affected by the suspension of classes and are unable to attend school. Moreover, most classrooms have been moved online, and implemented distant learning using online classes.

Method: A total of 64659 students were recruited to participate in the study which they were enrolled in the physical education program from 2017 to 2020. This study assessed the cardiorespiratory endurance, muscular power, muscular endurance, flexibility, and body composition. The physical fitness assessment for these items was assessed using the standardized assessment method developed by the Department of Physical Education, Ministry of Education in Taiwan (MOE, 2015) This study was conducted to investigate the impact of the new coronavirus epidemic on physical fitness performance before and after the epidemic from year 2017 to 2020.

Result: From the study 30,088 males and 34,571 females, the result showed that physical fitness during 2017 -2018 prior to the epidemic had a pass rate of (80.8%, and 79.7%) However, during the COVID-19 epidemic there was a significant impact leading to 77.4% in 2019 and 71.5% in 2020.

Discussion: Exercise was significantly reduced during the COVID-19 epidemic, both in terms of frequency and duration of exercise. Similar results have been found in studies from other countries, with reduced exercise frequency occurring not only in young adults, but also in children, adolescents, middle-aged adults, and older adults (Qi et al., 2020). This study found significant decline for all assessment from 2017 to 2020, this is all due to the suspension of the opening of sports fields, students can only do home exercises and unassisted fitness activities (such as gymnastics, yoga, dance, martial arts, etc.) The epidemic prevention measures and social distance will affect human life, behavior patterns and psychological states, thus facing new challenges in body, mind and spirit. Schools are encouraged to organize more physical activity and health activities in the post-epidemic era, and to encourage students to exercise more and change their lifestyle habits to increase physical activity. The best way to prevent the epidemic is to maintain good physical fitness and to develop regular exercise habits.

DEVELOPMENT OF A MODEL FOR AFTER-SCHOOL EXERCISE PROGRAM IN ELEMENTARY SCHOOLS IN JAPAN, ITS EFFECTIVENESS AND CHALLENGES

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Objectives

There is a need to make effective use of public facilities such as schools to ensure that children have time for exercise. The purposes of this study are to provide a model of an after-school exercise program for elementary school students, to build and implement the system, to design a system to support the instructors from outside of the school, and to examine its effectiveness and issues.

Methods

An after-school exercise program was designed and implemented for a public elementary school (714 students and 25 teachers) from October 2021 to January 2022in Kobe City. Nineteen different exercise programs were created 5 days a week from Monday to Friday: 5 review-type programs of physical education, 9 physical manipulation-type programs and 5 game-type programs. Thirteen external exercise instructors provided guidance and 167 children, 512 in total, participat-

ed in the program. A private-tutoring school management website was applied for child registration, attendance management, and communication with parents. A questionnaire survey was administered to the children and their parents at the beginning and at the end of the program.

Results and Discussion

The overall attendance rate for the program was 83.1%, with the highest rate of 91.6% for mat exercise for grades 1 and 2, and the lowest rate of 73.6% for basketball. By week, the highest attendance was 93.0% in the first week and the lowest was 73.8% in the twelfth week.

Among children, satisfaction with the exercise program was more than 70% positive. For 5th-6th grade girls, 35.7% of the responses were positive and 28.6% of the responses were negative. The desire to continue the program was high among 3rd-4th grade boys (85.3%) and girls (69.6%), and among 5th-6th grade boys (72.0%) and girls (35.7%). 93.5% of the parents/guardians wanted the exercise program to continue.

The following issues were identified in implementing the exercise program.

1) School facilities are not available when there are club activities that are regular school classes for 5th and 6th graders. 2) School events that did not appear on the plan often took place, and programs had to be canceled on short notice. In order to solve these problems, it is necessary to share information closely in advance. 3) The gymnasium could not be used for long periods (about a month) due to other annual school events. The annual plan to use the gymnasium should be reviewed for events other than athletic purposes during long periods. 4) If the system is independent from the school, the school infirmary cannot be used when a child is injured. In fact, children were confused by the unavailability of the school nurses room. 5) A management system dedicated to after-school exercise programs needs to be developed. 6) Although instructors from universities and private clubs could be utilized in this model, the actual recruitment and securing of instructors is an issue.

ASSOCIATION OF PARTICIPATION ON SPORTS VIDEO GAMES AND REAL-LIFE SPORTS INVOLVEMENT OF UNIVERSITY STUDENTS

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Association of participation on sports video games and real-life sports involvement of university students

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INTRODUCTION: Playing video games is one of the most popular entertainments in adolescents. Particularly, sports video games are the main genres which stimulate the real sports training and competition. Most of the past research related to video games has focused on its sedentary nature, it often has been characterized as a predictor of physical inactive and obesity [1]. However, recent research demonstrated that playing sports video game predicted higher involvement in real-life sports clubs over time among adolescents [2]. Sports video games may be used as a tool to create and enhance peoples' interest in sports [3]. The aim of this study is to examine the association of sports video games playing and involvement in real-life sports among university students. We will further investigate the link between involvement in sports team and sports video game play.

METHODS: Participants were 1625 undergraduate students (F = 58.6%). An online questionnaire about the video game playing habit and exercise habit was distributed to the participants (M = 18.72 years, SD = 1.71).

RESULTS: Within students who played video games, for those participated in sports video games (M=2.13, SD=1.10) had an average daily exercise time 1.13 hour more than those did not participate in sport video games (M=1.01, SD=1.20), 95% CI [.94, 1.32], t(266.83)=12.31, p<.001. The Cohen's d = .97 indicated a large effect. The odds ratio of sports team members who participated in sports video game is 3.38 times, 95% CI [2.28, 5.08], compared with that of non-sports team.

CONCLUSION: The findings revealed that there is a strong association between participation on sports video games and involvement in real-life sports. There is a higher probability that a sports team member would also participate in sports video games.

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SOCIO-STRUCTURAL DETERMINANTS OF PHYSICAL ACTIVITY BEHAVIOR IN CHILDREN AND ADOLESCENTS: THE RELEVANCE OF SOCIAL SUPPORT

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INTRODUCTION: The purpose of this study is to look in more detail at the socio-structural determinants of physical activity behavior in children and adolescents. We expected that socioeconomic status, social support, and physical environment influence physical activity directly while socioeconomic status also has an indirect influence via social support and physical environment. In addition, we hypothesized that social support shows an indirect effect through the perceived physical environment.

METHODS: Cross-sectional data from the German Motorik-Modul study (MoMo) were used (Wave 2, 2014-2017). The sample consisted of N = 2525 children and adolescents aged 6-17 years. Socioeconomic status (parental education, occupational status, and net income), perceived social support, and perceived physical environment were measured by questionnaires. To measure physical activity, children and adolescents were instructed to wear ActiGraphGT3X+/wGT3X-BT accelerometers for seven consecutive days. Path analysis was used to analyze the direct and indirect effects separately for children (6-10 years) and adolescents (11-17 years).

RESULTS: Goodness-of-fit statistics showed satisfactory model fit for both models (children and adolescents). The analysis revealed similar effects for both age groups. Among the socio-structural determinants, only social support had a direct effect on physical activity behavior. Socioeconomic status did not have a direct but an indirect effect on physical activity via social support. Furthermore, social support showed a direct effect on the perceived physical environment. Physical environment had no significant influence on physical activity in both models. Overall, the analysis revealed rather small to moderate effects.

CONCLUSIONS: The results of this study emphasize the relevance of social inequalities and social capital, as a source social support, for health-related behavior such as physical activity in young age groups. Interventions to increase children and adolescent physical activity levels should thus focus on components of social support from family and peers.

GAIT ANALYSIS USING POSE ESTIMATION - BASIC RESEARCH FOR DEVELOPMENT OF INTERACTIVE HEALTH PROMOTION SYSTEM-

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Introduction

We are considering using digital signage to interactively display feedback on gait with the aim of promoting exercise. In this study, we investigate what kind of gait analysis is possible to make using a webcam to show instant feedback. In previous studies, it has been reported that differences in gait with age tend to appear in stride length and walking speed, but stride length does not seem to be appropriate for instant computational feedback. In this study, we set three gait pitch conditions and examine whether changes in gait can be analyzed instantaneously using pose estimation, and what kind of differences they make.

Methods

Fifteen university students participated in the experiment. They walked for 10 steps, and the fourth and fifth steps were captured from the side by a webcam. Three walking pitch conditions were set: 70-bpm (elderly people), 130-bpm (20 or 30–year-olds), and free walking. They were instructed to adjust their walking pitch to the metronome sound on the 70-bpm and 130-bpm conditions.

Body positions were estimated using MediaPipe. From the estimated skeleton, we calculated the minimum values of the hip joint angle and knee joint angle during the gait cycle, the ankle joint angle when the toes left the floor, the stride length, and the maximum distance at which the toes were lifted off the floor.

Results

The knee and hip joint angles were the smallest on the 130-bpm condition, followed by the free walking condition. Both conditions showed significant differences from 70-bpm ($P<0.01$). The ankle joint angle was larger on the 130-bpm and free walking conditions ($P<0.01$). Stride length decreased in the order of 130-bpm, free walking, and 70-bpm, with significant differences between 130-bpm and 70-bpm, and between free walking and 70-bpm. Significant correlations were found between stride length, knee joint angle and hip joint angle ($P<0.01$).

Discussion

The significant correlations suggested that a faster gait pitch results in a wider stride length because the toes kick the floor with greater force, which in turn results in smaller knee and hip joint angles. Previous studies have reported that stride length varies with age but estimating stride length with a single webcam is computationally demanding and not suitable for providing interactive gait feedback on digital signage since the calculation of stride length requires taking into account the depth and tilt of the image. In contrast, joint angles do not need to take into account such factors as distance from the webcam, so the load of computation is relatively small and joint angles are estimated to play a significant part in age estimation. In the future, these results help to develop a better system capable of providing interactive gait feedback.

Conventional Print Poster

CP-AP03 Training and Coaching

TRAINING INTENSITY DISTRIBUTION CONSIDERING SPORTS SPECIFICITY, QUANTIFICATION METHODS AND TIME OF SEASON IN ELITE TO WORLD CLASS ENDURANCE ATHLETES – ANALYSIS OF CURRENT SCIENTIFIC LITERATURE

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INTRODUCTION: The current review examined the literature about retrospective analyses of training intensity distribution (TID) in elite to world class endurance athletes by clustering the different sport disciplines, quantification methods (QM) and time of season.

METHODS: TID data was obtained from PubMed, using varying combinations of the search terms "training intensity distribution", "TID", "training intensity", "endurance training", "training characteristics, "endurance," "training" and "athletes". Inclusion criteria: peer-reviewed English articles of endurance athletes categorized as Elite Level (Tier 4) or World Class (Tier 5) with internal (e.g., heart rate [HR]), external (e.g., velocity, power) and/or subjective (e.g., rating of perceived exertion [RPE]) QMs. All different QMs were categorized. The TID data expressed in percentages or in absolute numbers was included.

RESULTS: 33 reports quantified the TID of 425 athletes (67 females) from different endurance sports. 162 different TIDs could be extracted from all studies and clustered according to the sport, different seasonal phases, and different QMs. The TIDs derived from cycling (9 studies), rowing (n=7), running (n=6) skiing (n=6), swimming (n=2), hand cycling, triathlon and ice speed skating (each n=1). 69 (42%) TIDs were based on single-case reports of which 44 TIDs stemmed from cross-country skiing. 45 TIDs reported an entire season, n=7 mean values for multiple seasons, n=65 preparatory periods and n=54 competition periods. TIDs were categorized in 9 different QMs: HR time-in-zone (HR-TiZ), HR session goal – number of sessions (SGSession), HR session goal – total time/session (SGTime), HR session goal/time-in-zone (HR-TiZ/SG), session RPE (sRPE), RPE time-in-zone (RPE-TiZ), velocity time-in-zone (V-TiZ), power time-in-zone (PO-TiZ), race pace time-in-zone (RP-TiZ). 7 studies directly compared different QMs in their reports. 66 TIDs (41%) showed a polarized TID with 34 (52%) of these reported by single case analysis in cross-country skiing. 72 TIDs (44%) showed a pyramidal TID. Analysis of the most comparable TID QMs (HR-TiZ,V-TiZ, PO-TiZ) show proportion ranges for the moderate (Z1), high (Z2) and severe (Z3) intensity domain of 20-96%, 0-70% and 0-19%, respectively. Independent of the QM and time of season 91% (n = 147) of all analysis report Z1 proportions ≥65%, whereas 70% of all analyses report Z2 and Z3 proportions < 10%.

CONCLUSION: Current evidence on TID in Tier 4 and 5 athletes is equivocal and influenced from a high number of single case reports. The QM influences the TID pattern which must be recognized in the TID debate in endurance sports. The number of reports considering pyramidal and polarized TIDs are approximately equal. The most comparable QMs using the TiZ-approach highlight high variation in proportion ranges in the different intensity zones. Most noticeable, high volume of low intensity training zones (≥ 65%) is applied across all sports, seasonal phases, and quantification methods.

POSITION-SPECIFIC EXTERNAL WORKLOAD OF PROFESSIONAL RUGBY UNION PLAYERS DURING TACTICAL PERIODIZATION TRAINING

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INTRODUCTION: Tactical periodization (TP) is a training strategy that emphasizes the tactical aspect of the game. It originated in soccer and is quickly gaining traction in other team sports, particularly rugby union (RU) [1]. RU differs in external workload (EWL) response during training and matches depending on player position [2]. A greater understanding of the external workload of TP for different positions within three acquisition days (strength, StD; endurance, EnD; and speed SpD) would support coaches in planning loads for specific positional groups. Therefore, the purpose of this study was to shed light on the effect of TP acquisition days on different positions of RU players and apply the knowledge gained to the training environment.

METHODS: Twenty-six professional RU players (27.0 ± 3.5 years; 185.6 ± 7.1 cm; 101.7 ± 15.7 kg) were recruited from the French second-division rugby club by playing position: forwards (n = 15) and backs (n = 11). EWL was measured using a global positioning system and accelerometer microtechnology throughout 10 weeks of in-season home games. The following global positioning system (GPS) metrics were studied: arbitrary units of PlayerLoadTM (AU; extracted from all triaxial accelerometers in each unit); PlayerLoadslow (AU; extracted from all triaxial accelerometers when speed was below 2 m/s) ; total distance (TD) covered; distance covered in different intensity zones: > 15 km/h (D15), > 21 km/h (D21), and > 25 km/h (D25); the number of repeated high-intensity efforts (RHIE); and the number of low (> 2 m/s2; [A-D]2) and medium (> 2.5 m/s2; [A-D]2.5) speed accelerations/decelerations. A total of 780 observations were analysed, and differences between positions were assessed using Cohen's d effect size (ES) and magnitude-based inferences.

RESULTS: There were different EWL profiles for each position under each acquisition day. Mean PlayerLoadTM, TD, D15, D21, D25, RHIE, [A-D]2, and [A-D]2.5 were significantly higher ($p \leq 0.01$; ES = 0.41 to 1.93) for backs compared with forwards for all acquisition days. However, forwards experienced greater PlayerLoadslow than backs on EnD (152.59 ± 27.39

vs. 133.10 ± 28.03 AU; $p < 0.001$; ES = 0.70). Furthermore, the difference between positions in PlayerLoadslow was unclear on StD and SpD ($p = 0.23$ and 0.22, respectively).

CONCLUSION: PlayerLoadTM combined with PlayerLoadslow demonstrated acceptable reliability for EWL and provided different information between positions. Validating EWL characteristics on TP acquisition days enables extensive analysis of training load data, which can then be utilised to discover the unique characteristics of each position and design position-specific acquisition days to improve performance.

EFFECTS OF AN 8-WEEK OF BRIEF MINDFULNESS MEDITATION COMBINED WITH A RUNNING PROGRAM ON THE PERFORMANCE AND HEALTH OF TRAINED RUNNERS.

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INTRODUCTION: The impact of Mindfulness Meditation (MM) during Physical Activity (PA) have been well documented.1 However, these studies2,3 have often focused on the response of MM when the intensity of PA was low. Interventions addressing the influence of MM when PA intensities are typically experienced by athletes in sports club are lacking in the literature.1 The main goal of this study was to evaluate the influences of brief MM in trained runners on Intermittent Maximum Speed (IMS), Ratings of Perceived Exertion (RPE), Heart Rate Variability (HRV), Fat Mass (FM) and Physical Fitness (PF) level.

METHODS: Fifty-four trained athletes were randomized in a control group or a brief MM group following the same running training program including high intensities. They performed at 3 times: baseline (T0), 4 (T4) and 8 weeks (T8) after baseline IMS test (i.e., 45"- 15" of Gacon).4 The RPE scale of Borg (RPE6-20) was documented at each stage of the IMS test. As an indicator of HRV, the Root Mean Square of Successive R-R interval Differences (RMSSD) was measured using the Polar® V800 (Polar® Electro OY; Kempele, Finland) during 5 minutes in a supine position before the IMS test. The FM using the Biody Xpert® (Aminostats Bio-ZM II, Aminogram, La Ciotat, France) and PF level with the Diagnoform® Actif (IRFO, Loos, France) were measured at T0 and T8. A 2-way repeated measures ANalysis Of VAriance (ANOVA) was conducted for each outcome. A Bonferroni post-hoc test was realized when significant differences were noted.

RESULTS: A decrease of IMS was reported for the control group between T0 and T8 ($p = 0.004$) whereas a stagnation was observed for the brief MM group ($p = 0.056$). The speed reached at RPE13, RPE15 and RPE17 decreased with time ($p \leq 0.05$). No statistical differences were detected for RMSSD ($p = 0.681$). FM and PF level increased between T0 and T8 ($p \leq 0.01$).

CONCLUSION: Brief MM combined with a running program does not seem to have an impact on RPE, HRV, FM and PF level in trained runners. According to speed performance, the decrease observed for the control group on IMS could be partly explained by the high training load at this time of year for athletes. The stagnation of IMS for the brief MM group might be illustrated by the development of psychological skills (e.g., awareness of one's sensations, acceptance and refocusing) allowing the athletes to regulate their speed during the training according to his own sensations. More studies with a larger sample size need to be conducted to confirm our

results.

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LIFESTYLE AS A MODULATOR OF THE EFFECTS ON FITNESS OF AN INTEGRATED NEUROMUSCULAR TRAINING IN PRIMARY EDUCATION: A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Being fit as a child increases the likelihood of being active as an adult and reduces the risk of having several cardiovascular risk factors. The objective of this study was to evaluate changes on fitness after an integrated neuromuscular training (INT) intervention designed to improve motor competence in primary school children and to evaluate how lifestyle behaviours and parental education modulate those changes.

METHODS: One hundred and seventy children (7.45±0.34 years; 52% girls) were included in this randomized controlled trial. Cardiorespiratory fitness (½ mile run test), 10 × 5 m shuttle run test, standing broad jump (SBJ), handgrip dynamometer, body mass index (BMI) and fat mass percentage (FM%) were assessed before and after the 3 months intervention (20 minutes of INT in the physical education class, twice per week). Mediterranean Diet (MD), sleep time and parental education level (PEL) were evaluated by questionnaires and adherence to physical activity (PA) recommendations was measured with an accelerometer before the intervention.

RESULTS: After the intervention, there were improvements in the 10x5 test and the SBJ. Only girls had improvements in the handgrip test, BMI SDS and FM%. After correcting for confounding variables only BMI was significantly improved whereas strength improved in the participants non-compliant with the PA recommendations or pertaining to families of high PEL.

CONCLUSION: The INT produced improvements in fitness in a brief period and in different subgroups of pupils (inactive and with diverse sociocultural environments).

ATTEMPTING TO THRIVE DURING THE OLYMPIC QUALIFICATION WINDOW: A NARRATIVE ANALYSIS

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Background. The desire to succeed at the highest levels of sport has resulted in vast investment and, with it, greater scrutiny and accountability for performance. Consequently, this 'need' to succeed has fostered a 'win-at-all-costs' mentality and led to some environments that prioritize results and performance at the expense of athlete welfare. Although the existence of such 'performance-narratives' may be prominent in elite sport, there is growing recognition that such narratives need not be at the cost of welfare, and that more should be done to create and maintain environments that promote both high performance and athlete well-being.

Purpose. Our purpose for the present study was to better understand track cyclists' experiences of attempting to thrive (i.e., experience high levels of performance and well-being concurrently) during the Tokyo Olympic qualification window. In so doing, we hoped to shed light on the prevailing narratives underpinning their accounts, and to reflect the dynamism and complexity in experience inherent with competing for high-performance sporting organizations.

Methods. Underpinned by ontological relativism and epistemological constructionism, a longitudinal design was employed with interviews conducted with eleven international track cyclists on three occasions over a six-month period. At the time of the first interview, the cyclists had competed in 126 major sporting events (e.g., World Championships, Olympic Games) and won 36 medals at these events. We adopted a storyanalyst stance and used thematic narrative analysis to understand the narrative themes that underpinned the cyclists' stories as they attempted to thrive during the Olympic qualification window.

Results and Discussion. Our results comprise four realist tales that reflect narratives of family dynamics, labor of love, discovery, and redemption that we believe were embodied in the cyclists' experiences during this time. These tales are the first representation of athletes' attempts to thrive during a critical part of their Olympic journey and offer a unique insight into how these experiences evolved over time. Moreover, they highlight the complexity, variety, and dynamism in athlete experience, and provide direction to allow us to proactively support people (e.g., by developing adaptability and acceptance, and ensuring a sense of safety) and systems (e.g., to raise organizational awareness of how and when friction may occur) to thrive sustainably at the highest level of sport.

Funding. This research was supported by a grant from the International Olympic Committee's Olympic Studies Centre.

USING NETWORK SCIENCE TO IDENTIFY THE PROMINENT COURT ZONE OF TENNIS LONG RALLY

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INTRODUCTION: In the process of the tennis match, the interaction between two competing players involves the decision-making of stroke, positioning and ball direction and rotation. To unveil the playing pattern within such interaction and to interpret player performance, a recent study has applied network science to the analysis of rallying in other racquet sports such as badminton. However, little has been done in tennis given it contains more constraints like ball location and wider court space. Therefore, this study aimed to construct a tennis stroke network that considers the consecutive ball placement during long rallies and to identify the prominent court zone within the network.

METHODS: The study randomly selected 15 rallies that ended with nine and more strokes from 12 mens singles main-draw matches of the 2019 Australian Open, which contains 163 strokes, excluding the serve and return strokes. All included players are right-handed. The tennis stroke network is a paradigmatic example of a bipartite network, where nodes are grouped into two disjoint sets, with nodes of the same set devoid of a direct link between them. The size of nodes was proportional to their importance in the network, with the links' width proportional to the number of times a specific path was repeated. Therefore, a 40*40 adjacency matrix was established, with 20 zones on each player's side of the court. Finally, the centrality of each node (after transforming the corresponding nodes on both sides of the court into the same half) and frequency of all the network edges were calculated in order to evaluate zone importance and ball direction.

RESULTS: Zone_7 (Zone_34) has the greatest degree centrality of 2.3, representing the most frequent zone where players made the strokes. It is followed by Zone_8 (Zone_33), Zone_11 (Zone_30) and Zone_5 (Zone_36), with values of 1.85, 1.75 and 1.65, respectively. Considering the zones of the baseline, the highest degree centrality is shown at Zone_4 (Zone_37) with a value of 1.2, where players used more backhand strokes. Considering the network edges, Zone_31 (Zone_10) and Zone_5 (Zone_36) are most frequently connected for forehand strokes, while Zone_7 (Zone_34) and Zone_33 (Zone_8) are most frequently connected for backhand.

CONCLUSION: The current study provides preliminary knowledge about tennis long rally performance considering the evolution of the shot information. The findings reveal that hitting the ball to the backhand side of the opponents is the most frequent tactical choice during the long rally, given that there are more related zones of high centrality degree. Nonethe-

less, the edge between forehand Zone_31 (Zone_10) and Zone_5 (Zone_36) is also highly connected, probably indicating a preferred ball direction to end the point. The results explored the stroke patterns of professional tennis and the most favorable zone for players. Future researchers and analysts could adopt the method to analyze tactics and specific striking styles of individual players.

DIFFERENCES BETWEEN TIME-MOTION CHARACTERISTICS AND SERVING VELOCITY IN WINNING AND LOSING MATCHES OF ELITE MALE TENNIS PLAYERS – A PILOT STUDY

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INTRODUCTION: Tennis is a game characterized by physical activities such as running at different speeds, accelerations, decelerations, changes of direction, slides and different strokes [1]. Therefore, mechanical loads (e.g., accelerations and decelerations) are more relevant to the dimensions of the court than the locomotive loads (eg. total distance, running at different speeds). Besides time-motion characteristics, it is useful to measure serving velocity (SV) because it is one of the most important performance determinants in both gender's tennis in the junior age [2], and serves are the most repeated strokes in the game that directly influences the outcome of points [3]. The aim of this study was to examine differences in time-motion characteristics, including mechanical load and SV, between winning and losing match conditions of elite male tennis players.

METHODS: Four elite male tennis players (one of them ATP world-ranked) played simulated matches on an indoor clay court in a round robin system, resulting in a total of six matches. To determine the time-motion characteristics, mechanical load-related parameters were measured using portable micro-sensors (Catapult OptimEye S5, Catapult Sports, Melbourne, Australia) which sampled at a frequency of 10 Hz for the GPS and 100 Hz for the tri-axial accelerometer, gyroscope and magnetometer. Regarding the SV, the peak velocity of the first- and second serves was measured with a radar gun (Pocket Radar Ball Coach, model PR1000-BC, Pocket Radar Inc., Santa Rosa, CA). Descriptive statistics were used to present mean and standard deviation results, and Mann-Whitney U test was used to determine the differences between winning and losing match conditions. Significance level was set at $p<0.05$.

RESULTS: Only one significant difference between the two conditions was found for the mechanical load in the high deceleration/minute parameter ($U=5$, $Z=-2.08$, $p=0.037$, $r=-0.60$). Regarding the SV, we found significant difference in favor of winning matches for both the first ($U=1$, $Z=-2.72$, $p=0.006$, $r=-0.79$) and second serve ($U=2$, $Z=-2.56$, $p=0.010$, $r=-0.74$). Apart from these, there was no significant difference for the other variables.

CONCLUSION: Overall, the results suggest that the velocity of the first and second serves is an important factor in the success of tennis matches. With a high SV, players can hit more aces and win points more efficiently. Therefore, serving speed training is important because SV seems to be a fundamental predictor of match results.

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Conventional Print Poster

CP-MH18 Obesity/Weight loss II

THE EFFECT OF UNIVERSITY PHYSICAL EDUCATION CLASSES ON BODY COMPOSITION

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INTRODUCTION: Up to 5 million deaths a year could be prevented if the world population were more active. Inactive people have a 20-30% higher risk of dying than sufficiently active people (1). Weight problems and obesity are increasing rapidly with age in most EU Member States (2). The causes can be traced back to lifestyle, including physical inactivity. Schools are important places to promote physical activity, as students spend much of their lives in schools. They, therefore, play an essential role in promoting healthy lifestyles (3).

METHODS: 340 people enrolled in the 14-week programme, of whom 100 (61 women, 39 men) participated in the before and after programme surveys. 187 only at the beginning of the semester and 53 only at the end of the semester. Body composition and waist and hip circumferences were measured before and after the intervention. The survey aimed to determine whether and how the students values changed due to physical education at university.

RESULTS: The results are for the 100 people surveyed twice. The average age was 19.62 years. After the 14-week program, we observed significant changes in Total Body Water ($p=0.003$, $d=0.344$), Protein ($p=0.00008$, $d=0.127$), Minerals ($p=0.0007$, $d=0.05$), Skeletal Muscle Mass ($P=0.0007$ $d=0.328$), InBody Score ($p=0.03$, $d=0.52$), Waist-Hip Ratio ($p=0.002$, $d=0.006$). The BMI index showed a significant but negligible change ($p=0{,}00001$, $d=0{,}243$).

CONCLUSION: The programme effectively improved various body composition values, contributing to a healthy lifestyle. To better understand the relevance of the results another study with a control group is recommended.

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THE EFFICACY OF THE WEIGHT LOSS PROGRAM ON GUT MICROBIOTA AND METABOLIC HEALTH IN PATIENTS WITH OBESITY

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INTRODUCTION: Obesity has spread from Western countries to third-world countries and has become a global pandemic. Weight loss programs containing regular physical activity and lower calorie intake became an effective non-pharmacological approach to treat and prevent metabolic diseases in patients with obesity. In addition to body composition (body fat, BMI), cardiovascular variables (blood pressure), and common blood characteristics (glycemia, cholesterol), the results from the last decade point to changes in gut microbiota composition in individuals with obesity. Therefore, the purpose of this study was to investigate whether the 3-month weight loss program can affect gut microbiota composition and metabolic health in patients with obesity.

METHODS: We conducted a randomized controlled trial in 23 patients with obesity. From the group of recruited patients, 12 participants completed a 3-month combined nutrition-physical exercise program 2-times a week (EP), and 11 participants were controls. The fecal microbiota was classified using specific primers targeting the V3–V4 region of 16S rDNA, whereas biochemical parameters were analyzed in a certified hospital laboratory.

RESULTS: As expected, we observed a significant decrease in serum concentration of glucose, uric acid, and liver enzymes (AST, ALT, GMT) in EP compared to controls. However, we detected a significant increase in relative abundance of beneficial bacteria (e.g., Akkermansia muciniphila, Parabacteroides merdae, Alistipes finegoldii) and a significant decrease in pathogenic bacteria (e.g., Erysipelatoclostridium ramosum, Clostridium spiroforme). Notably, a significant inverse correlation was recorded between A. muciniphila and body weight, body fat, BMI, waist and hip circumference, visceral fat, uric acid, and creatinine. However, a significant positive association was found between pathogenic E. ramosum and body weight, body fat, BMI, waist and hip circumference.

CONCLUSION: The main findings of our study were a positive shift in body composition, gut microbiota, and serum metabolomics after a 3-month weight loss program in patients with obesity. We believe that even a short 12-week non-pharmacological treatment is effective to stimulate changes in bacteria linked to health or illness.

Funding: This study was supported by the Development Agency, VEGA Grant No. 1/0260/21 (VB) and Grant No. APVV-17-0099 (VB) and APVV-22-0043 (AP) and APVV-22-0047 (VB) of the Slovak Research.

IMPACT OF SUPERVISED EXERCISE ON HEART RATE VARIABILITY, BLOOD PRESSURE, AND ARTERIAL STIFFNESS FOLLOWING BARIATRIC SURGERY: EFIBAR STUDY

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INTRODUCTION: Obesity is associated with type 2 diabetes, dyslipidemia, and cardiovascular disease (CVD), among others [1]. Bariatric surgery has been proposed as an effective method to reduce weight. This study aimed to determine the impact of a 16-week concurrent exercise program on heart rate variability (HRV), blood pressure, and arterial stiffness in participants undergoing bariatric surgery [2].

METHODS: 80 individuals with severe obesity (body mass index ≥35 kg/m2) were randomized to an exercise group (n=40) or a control group (n=40) following bariatric surgery. At baseline (before the surgery), week 16 and 12 months, heart rate variability was measured using a heart rate monitor (Polar V800) with the participant seated for 10 minutes. Blood pressure and arterial stiffness parameters (i.e., Augmented index at 75% of heart rate) were assessed using an oscillometer-based pulse wave analysis system (Mobil-O-Graph). The exercise program consisted of 48 sessions (three times per week over 16 weeks) of 60-min sessions that include (1) warmup [light aerobic activity at 50–65% of HR reserve (HRR)], (2) compensatory training (i.e., core stability and stabilizer muscle exercises), (3) strength training (whole-body exercises progressing from 1 to 3 sets, from 12 to 6 repetitions per set, from 24 to 10 repetitions maximum (RM) (≈50 to 75% of 1RM), (4) aerobic training (on a treadmill, progressing from 15 to 25 min, from 65 to 85% of HRR), and (5) cool down.

RESULTS: Although both groups improved HRV following bariatric surgery, there were no between-group differences in any HRV-derived parameters. The mean changes (95% Confidence Interval [CI]) in systolic blood pressure from baseline to 16 weeks were -14.1 (-18.8 to -9.4) in the exercise group and -7.9 (-12.6 to -3.3) in the control group (between-group difference -6.7 mmHg, 95%CI [-12.8 to -0.4], $p < 0.05$) although this difference disappeared at 12 months. In contrast, the mean change (95% CI) in Aix75 from baseline to 12 months were 0.3 (-6.8 to 7.5) in the exercise group and -9.1 (-14.6 to -2.4) in the control group (between-group difference 9.4 %, 95%CI [2.3 to 16.5], $p = 0.011$).

CONCLUSION: In this randomized controlled trial involving participants with severe obesity who undertook a 16-week concurrent exercise intervention immediately after bariatric surgery, exercise did not significantly improve HRV-derived parameters compared to a control group following usual care after surgery. However, we found that the exercise group

decreased their systolic blood pressure at 16 weeks more than the control group and that the control group had their Aix75 increased at 12 months. Further research using different exercise configurations is needed.

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RELATIONSHIP BETWEEN GUT MICROBIOTA COMMUNITY AND SHORT-CHAIN FATTY ACID PRODUCTION IN TLR5 KNOCK-OUT MICE AFTER VOLUNTARY EXERCISE

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INTRODUCTION: Immunometabolism is that the impact of immune cells on metabolism and, conversely, the metabolic needs of immune cells during homeostasis and pathological settings. In recent years, it has been known that the gut microbiota may be a factor in the induction of immunometabolism. Exercise is well known as an improvement factor for metabolism such as obesity, but it is not clear whether the exercise habit itself has a preventive effect on obesity through changes in the intestinal microbiota. In this study, we aimed to investigate the preventive effect of voluntary exercise on obesity in Tlr5 gene knockout mice via the gut microbiota.

METHODS: Tlr5 gene-deficient (Tlr5-/-: KO5, n=15) and wild-type (Wild Type: WT, n=16) mice (C57BL/6J, 4 weeks old) were used in this experiment, and mice were lorded to voluntary wheel running (W: individually housed in a cage with a rotating wheel with 24-hour access), or rest (C) for 20 weeks. Fasting blood glucose levels and tissue weights were measured. Collected fresh feces were used for analysis of microbiota, and organic acid analysis was performed using cecum contents. This study was conducted with the approval of the Recombinant DNA Experimental Committee (19-44) and the Animal Experimentation Committee of Kawasaki Medical School (21-103).

RESULTS: A significant increase in body weight due to gene deletion ($p<0.01$) and its suppression by exercise ($p<0.01$) were observed. Also, a high epididymal fat weight in KO5 mice ($p= 0.05$) was inhibited by exercise ($p<0.01$). Moreover, high level of fasting blood glucose in KO5 mice was improved by voluntary exercise ($p=0.057$, $p<0.01$). The α-diversity of the gut microbiota was observed to be significantly higher in Tlr5 gene deficiency. β-diversity was classified into two populations, differing between KO5 and WT. Mucispirium showed a positive correlation with propionic acid and succinic acid, while Parasutera showed a positive correlation with propionic acid. Furthermore, we observed a positive correlation between Anaeroplasma and succinic acid.

CONCLUSION: The increased weight gain and fat accumulation induced in KO5 mice, as well as impaired glucose metabolism, may be prevented by voluntary exercise. The involvement of the gut microbiota in the prevention of obesity and abnormal glucose and lipid metabolism by exercise was demonstrated. Our results suggest that changes in the gut microbiota via exercise may have preventive effects against abnormal immunometabolism.

EFFECT OF DIFFERENT EXERCISE MODES ON FAT LOSS IN RECESSIVE FEMALE UNIVERSITY STUDENTS

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INTRODUCTION: In recent years, the physical fitness of university students has been declining, and the recessive obesity has become one of the most easily ignored health problems, among which recessive obesity in female university students is the more prominent. High-intensity interval training is one of the popular exercise and fitness methods in recent years, but there are few empirical studies on recessive obesity in female university students. This paper probes into the effect of different modes of exercise training with equal amount on weight loss in female university students with recessive obesity, and to provide a reference for the formulation of exercise prescription.

METHODS: Forty-five university students (21.6±2.1yrs) with recessive obesity were recruited and participated in the study that was approved by IRB at Beijing Sport University. They were randomly divided into three groups, a moderate-intensity continuous training(MIT) group, a high-intensity interval training(HIT) group and a blank control(COL) group. The MIT and HIT groups completed exercise on the cycle ergometer. The HIT group performed an interval cycling session consisting of 4×4 min bouts (4 min of cycling at 85%-95%HRmax followed by 3 min of cycling at 50%-60%HRmax). The MIT group did equal amount of cycling with HIT group at 60%-75%HRmax. The exercise intervention last eight weeks. Body composition was determined before and after the exercise intervention to explore the effect of different modes of exercise training on recessive obesity in female university students.

RESULTS: (1) After eight-week intervention, participants in the MIT group and HIT group had significant reductions in the body weight (1.50kg, 1.52kg) and body mass index(BMI) compared with COL group ($P<0.01$). There was no significant difference in changes of body weight and BMI between the MIT group and HIT group. (2) The MIT group and HIT group demonstrated significantly decreased level of waist-to-hip ratio(WHR) compared with COL group (-2.4% & -3.6% vs +1.2%, $P<0.01$) after eight-week intervention, and the decrease of WHR in the HIT group was significantly greater than that in the MIT group ($P<0.05$). (3) After eight-week intervention, compared with the COL group, participants in the MIT and HIT groups had significant declines in percentage of body fat(PBF) and body fat content, and the decline of PBF (2.7% vs 3.6%) and body fat content (5.7% vs 6.6%) in the HIT group was significantly greater than that in the MIT group ($P<0.05$). (4) There was no significant change in skeletal muscle mass in the MIT, HIT and COL groups. There was also no significant change in body weight, BMI, WHR, PBF and body fat content in the COL group.

CONCLUSION: Both high-intensity interval training and moderate-intensity continuous training could reduce fat of female university students with recessive obesity, which were beneficial to prevent obesity and related diseases in early life. It was suggested that high-intensity interval training may be advantageous in reducing the accumulation of abdominal visceral fat in female university students with recessive obesity when compared to moderate-intensity continuous training.

INVOLVEMENT OF EXTRACELLULAR VESICLES IN EXERCISE-RELATED INFLAMMATION REDUCTION IN LEAN AND OBESE SEDENTARY ADULTS

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UCLOUVAIN

INTRODUCTION: Obesity prevalence has dramatically increased in the last 50 years worldwide. This abnormal fat accumulation has serious consequences as it increases the risk to develop cardiovascular diseases, diabetes, musculoskeletal disorders or some cancers. In addition, obesity is characterized by a low-grade systemic inflammation related to multiple health issues. To reduce this systemic inflammation, endurance exercise appears to be an effective method, but the underlying mechanisms are not fully understood. Recently, growing interest has emerged around the extracellular vesicles (EVs) and their role in inter-organ cross talk and exercise adaptations. By transporting exercise factors ("exerkines"), EVs could participate in the inflammation reduction observed after a training period. Here, we investigated if inflammation reduction in obese people could be related to acute and chronic change in EVs content.

METHODS: Thirteen lean (CTRL) and ten obese (OB) sedentary adults (30–55 years old) were recruited to participate to a 3-month endurance program (30min at 60-80% of VO2peak, 3 sessions/week). Fitness level and body composition were evaluated prior and at the end of the program. Venous blood samples were taken before and after the first endurance session and after the training period. Plasma EVs were isolated by size exclusion chromatography and their content was analyzed by mass spectrometry.

RESULTS: After 12 weeks training, VO2peak increased in the two groups (CTRL: +10%; OB: +17%; p=0.016) whereas body weight and fat mass remained unchanged. Respiratory exchange ratio (RER), reflecting substrate utilization, decreased at submaximal intensities (100, 130 and 160W, p≤0.001) in both groups. Fasting glucose, HOMA-β, QUICKI, HDL and LDL did not change while insulin (-21%, p=0.087) and HOMA-IR (21%, p=0.098) tended to be reduced after the program only in the obese group. Additionally, CRP levels decreased in obese participants (-57%, p=0.045). Preliminary results from EVs content analysis reveal the presence of several proteins involved in inflammation process such as complement C proteins, serum amyloid A proteins, alpha-2-macroglobulin, histidine-rich glycoprotein or CD5 antigen-like protein.

CONCLUSION: The present study shows that a 3-month low intensity endurance training is efficient to attenuate systemic inflammation and insulin resistance in obese sedentary adults. This reduction of inflammation is not statistically related to fat mass loss suggesting that other mechanisms as change in EVs content might be involved.

HIGH-FREQUENCY BIO-IMPEDANCE EQUATION FOR APPENDICULAR SKELETAL MUSCLE MASS IN OLDER PEOPLE

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INTRODUCTION: Whole-body bioelectrical impedance analysis (BIA) has been accepted as a doubly indirect method to estimate appendicular skeletal muscle mass (ASMM) comparable to dual-energy X-ray absorptiometry (DXA). Single or limited frequencies currently used for these estimates may over or under-estimate ASMM. Accordingly, there is a need to measure the impedance parameter with appendicular muscle-specific across multiple frequencies to more accurately estimate ASMM. Therefore, we aimed to validate the appendicular muscle mess-specific frequency BIA equation for ASMM using multifrequency BIA (MF-BIA) with DXA as the reference.

METHODS: 195 community-dwelling Korean older people (94 men and 101 women) aged 70~92y participated in this study. ASMM was measured by DXA and bioimpedance measures at frequencies of 5kHz~3MHz were assessed for independent predictive variables. Regression analyses were used to find limb-favorable frequencies of bioimpedance, to develop the ASMM equations and to conduct the internal cross-validation. The six published equations and the final equation of MF-BIA were externally cross-validated.

RESULTS: 195 participants completed the measurements of MF-BIA and DXA. Using bivariate regression analysis, the 2MHz impedance index explained R2 = 91.5% of variability (P < 0.001) in ASMM and predictive accuracy of standard error of estimate (SEE) was 1.0822kg ALM (P < 0.001). Multiple stepwise regression analysis obtained in the development group had an adjusted R2 of 9.28% (P < 0.001) and a SEE of 0.97kg ALM. The cross-validation group had no significant difference between the measured ASMM and the predicted ASMM (17.8±3.9kg vs. 17.7±3.8kg, P=.486) with 93.1% of R2 (P < 0.001) and 1.00kg ASMM of total error. The final regression equation was as follows: ASMM = 0.247ZI@2MHz + 1.254SEXM1F0 + 0.067Xc@5kHz + 1.739 with 93% of R2 (P < 0.001), 0.97kg ASMM of SEE (Subjective Rating as "excellent" for men and "very good" for women). In the analysis of the diagnostic level for sarcopenia of the final regression, the overall agreement was 94.9% (k = 0.779, P < 0.001) with 71.4% of sensitivity, 98.8% of specificity, 91.3 of positive prediction value and 95.3% of negative prediction value.

CONCLUSION: The newly developed appendicular muscle mass-specific high-frequency BIA prediction equation has high predictive accuracy, sensitivity, specificity, and agreement for both individual and group measurements. Thus, the high-

frequency BIA prediction equation is suitable not only for epidemiological studies but also for the diagnosis of sarcopenia in clinical settings.

EVALUATION OF THE CHARACTERISTICS OF BEHAVIORAL CHANGE IN THE FACE OF PHYSICAL ACTIVITY IN SCHOOLCHILDREN IN BOGOTÁ, COLOMBIA.

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INTRODUCTION: The acquisition of a healthy lifestyle entails a series of behaviors that the person can develop from their first years of life. The school is a scenario where these mechanisms can be evaluated based on different models and theories, such as the Transtheoretical Model developed by Prochaska & DiClemente. The studys objective was to assess the characteristics of behavioral change in the face of physical activity in schoolchildren from educational institutions in Bogotá, Colombia. [2].

METHODS: A cross-sectional analytical study was carried out with 348 students of both sexes between 8- and 17 years old belonging to 5 district educational institutions (IED), in whom the Behavior Change Questionnaire (CCC) was applied in a self-filled manner [1]. Additionally, information on grip strength, blood pressure, and the calculation of the Body Mass Index (BMI) were recorded, and the data were compared according to sex between the groups of children 8 to 13 years old (211; 60.6%) and adolescents 13 to 17 years (137; 39.3%).

RESULTS: Significant differences were found in the categories of behavioral change compared to contemplation physical activity (p=0.003) and maintenance action (p=0.021) between the sexes in the entire sample. In the group of children, these differences were maintained (contemplation, p=0.02; maintenance action, p=0.039), but in adolescents only in the contemplation category (p=0.03), these differences were held between the groups. Sexes. A higher proportion of overweight and obese children and adolescents was found compared to girls and adolescents (24.5% versus 4.3%, p<0.001). In grip strength, men achieved better results, 22.8 kg (S.D.=7.08) compared to 19.73 kg (S.D.=4.18) for women, p<0.001. No significant differences were found in blood pressure measurements between the sexes.

CONCLUSION: Although a higher proportion of overweight and obese boys was found compared to girls, the latter is located in a lower ratio in the category of action and maintenance compared to physical activity. This situation evidences the potential risk of a healthy lifestyle for both sexes in educational institutions in Bogotá, Colombia.

Conventional Print Poster

CP-AP05 Monitoring

TELEMEDICAL MONITORING FOR SAFE HOME-BASED EXERCISE TRAINING OF SENIORS

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INTRODUCTION: The number of seniors gradually increases worldwide; by 2030, 1 in 6 people will be 60 years or over. With an increasing number of seniors arises the question of how to help seniors reach healthy ageing and enhance their quality of life. There is plenty of papers on the beneficial effect of regular exercise training on both, quality of life and healthy ageing. However, many seniors refuse to exercise due to fear of the potential deterioration of their health.

METHODS: Our project aims to create safe home-based exercise training supervised by telemedical monitoring. For the purpose of the monitoring, we use telemedical monitoring already in use at the National Institute of Cardiovascular Diseases in Bratislava (Slovakia) for patients with cardiovascular diseases. The telemedical monitoring kit consists of the web and mobile application connected with sensor devices: chest strap with ECG sensors (BioHarness 3, Zephire, USA), oximeter (Nonin 3230, USA) and blood pressure monitor (OMRON M7 Intelli IT, Japan). Data recorded to the mobile application can be checked immediately by the user or delivered to the medical specialist (e.g. cardiologist), who can work with the data on the web page both online or offline.

RESULTS: The first step in our project is to adapt the ECG measurement for the senior exercise training. The ECG measurement is realized during exercise training and the oximetry and blood pressure measurement before and immediately after the exercise. The main goal is to adapt ECG, blood pressure and oximetry measurements for real-time analysis. In case of unexpected heart arrhythmia, fibrillation or an increase/ drop in blood pressure, the application will alert the senior with the recommendation to stop the exercise. It also allows to set up sending this alert information to a doctor or other assigned person to provide medical assistance if necessary.

CONCLUSION: Telemedical monitoring should be attractive for patients with cardiovascular diseases and should also help increase the number of seniors practising home-based training. The continual availability of data related to a health status of senior through the web application is the next benefit. It enables a senior to be under the doctor´s supervision without the need for a personal visit to the health facility.

INDIVIDUALIZED INTERPRETATION OF RAW VALUES IN TRAINING LOAD AND RECOVERY MONITORING - ROBUST SCALING AS A POTENTIAL ALTERNATIVE TO ACWR (AND BEYOND)

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INTRODUCTION: Load and recovery monitoring aims to support decision making in daily practice. This regularly calls for an indication of how high or low a current value is for the individual player (rather than in absolute terms). Considering the substantial interindividual variation in the habitual levels of common indicators even within professional and elite teams, standard group-based reference values are therefore inappropriate. Rather, individualized interpretations takeing into account the distribution of previous observations in the same player (what is "normal" for him / her) are warranted. For such "scaled" indicators, a specific value means the same for every player, thereby allowing for a uniform interpretation across individuals which is particularly important for routine use in team sports.

In recent years a variety of approaches has been proposed ranging in sophistication from individual means to Bayesian methods. Regarding training load, the acute-to-chronic workload ratio (ACWR) is a widespread "scaled" indicator, that puts current (acute) load in relation to what the player is used to (chronic load). However, while ratio-based indicators are intuitive, they are associated with severe limitations which have recently been demonstrated specifically for ACWR. We therefore propose robust scaling of acute training load as an alternative to ACWR including a proof-of-concept application to monitoring data from professional soccer. Of note, robust scaling can also be applied to other monitoring parameters e.g. questionnaire results.

METHODS: Robust scaling is a standard method used for engineering informative features in machine learning. In its simplest form (as applied here) it is calculated as the difference of the respective value from the individual median in inter-quartile-range units. Robust scaling was applied to acute training load (sessionRPE method, linearly weighted 3-day trailing average) and subjective recovery needs (short recovery and stress scale, SRSS). Data of 82 outfield players from 4 professional soccer teams collected during the 2019-2020 season were included.

RESULTS: Substantial interindividual variation was present for acute training load (mainly reflecting interindividual variation in RPE rather than time) as well as for daily responses to the SRSS. As intended, after scaling the median was 0 for all individuals and measures. Interindividual variation in the range of scaled values was minor and independent from the median of raw values.

CONCLUSION: Robust scaling may be a simple, well-understood alternative to ACWR which can also be applied to monitoring parameters beyond training load.

INVESTIGATING THE INFLUENCE OF REPRESENTATIVE SCALING IN FOOTBALL PRACTICE GAMES VIA POSITIONAL DATA

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INTRODUCTION: One major problem in football practice is defining the scaling of the field size when a chosen practice game reduces the number of players unlike the formal 11 vs. 11 game (FG11vs11) [1]. In common practice, the frequency of actions per player increases due to a much smaller area per player in sub-task designs (e.g. 5 vs.5) [2]. Whereas the emergence of individual and collective skills is constrained by the ambient information of the learning environment [3]. Thus, the representative (RP) interpersonal layout given in training remains to be elucidated, particularly on how collective behaviors change when the area per player is reduced in sub-task designs.

METHODS: 22 male football players (age: 23 ± 5 years) of a professional German U21 football team are separated into two teams, competing in five different field conditions: One FG11vs11 and two practice game conditions (RP7vs7, RP5vs5) are played with an area per player that represents an official match scaling (296m²/player). In contrast, two practice game conditions are played with a commonly smaller (S) area per player [2] (S7vs7, 174m²/player; S5vs5, 184m²/player). Each team plays six attacks per condition in a crossover study design (60 attacks total). Players' positional data are computed using a GPS unit (10Hz, Catapult®). The data is processed to calculate the parameters distance-to-nearest-opponent, convex hull, and relative convex hull.

RESULTS: Results from the repeated-measures ANOVA revealed significant differences between the played conditions for distance-to-nearest-opponent, $F(4, 55) = 14.76$, $p < 0.0001$, $\eta 2 = 0.52$, convex hull, $F(4, 55) = 275.07$, $p < 0.0001$, $\eta 2 = 0.95$, and relative convex hull, $F(4, 55) = 53.41$, $p < 0.0001$, $\eta 2 = 0.80$. Tukey's post-hoc pairwise comparisons revealed that merely the RP7vs7 showed a similar distance-to-nearest-opponent as the FG11vs11. Furthermore, the convex hull differed notably between the sub-tasks S5vs5 compared to the RP5vs5 and S7vs7 compared to the RP7vs7.

CONCLUSION: Data show, that the space occupied by both teams and thereby their collective behaviour, is highly influenced by the available space surrounding them. Moreover, smaller field scales as well as fewer players tend to reduce the representativeness of the interpersonal layout in practice tasks. Further investigation of RP field scales might be fertile ground to improve the effectiveness of practice designs.

[1] Clemente et al. (2023)

[2] Owen et al. (2013)

[3] Pinder et al. (2011)

CONTEXTUAL FACTORS INFLUENCING EXTERNAL AND INTERNAL LOAD IN COLLEGIATE WOMEN'S BASKETBALL

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INTRODUCTION: Basketball is a physically demanding sport that requires repetitive high intensity efforts. Monitoring training load (TL) metrics- external (eTL) and internal (iTL), are vital to maximize performance and minimize the risk of injury/illness (1,2). These TL metrics are known to vary based on contextual factors like player role (starter, reserve), game (G), and training days relative to game (e.g. the day before a game (G-1)) in other sports (1); little investigation has been done in women's basketball. The primary purpose of this study was to examine the influence of player role on eTL and iTL during games among female collegiate basketball athletes. Secondarily, we investigated the relationship between G and G-1 on performance metrics for starters.

METHODS: Sixteen G and 12 G-1 during the 2022-23 season were monitored. Data were collected from 11 players (21.9±1.45 years; 177±9.39 cm) of the university women's basketball team. Player role and minutes played were retrieved from the box score for each G. Player load (PL), PL/min, and heart rate exertion (HRE) were captured using Catapult® S5 IMU sensors (version 2, indoor) with integrated HR devices and OpenField Console version 2.5.2. The data were visualized using Catapult OpenField Cloud 4.7 and exported to excel for data quality analysis resulting in 79 observations from starters and 56 observations from reserves. For our secondary aim, 4 G were excluded due to lack of G-1 data, resulting in 12 G and 12 G-1 sessions for analysis. There were 59 G and 60 G-1 observations. Jamovi 2.3.16 was used to calculate descriptive statistics for each variable. Relative TL metrics for role and days relative to the game were also calculated.

RESULTS: Starters played a mean of 31.8±7.9 mins, while reserves played 12.5± 8.2 mins. For G eTL, mean PL for starters was 474±152 and reserves was 191±117, while PL/min for starters was 7.75±1.2 and reserves was 7.08±1.3. For G iTL the mean HRE was 9665±5076 for starters and 4160±3294 for reserves. In games, reserves accumulated 40.3% of starter PL, 91.4% of starter PL/min and 43% of starter HRE. For our second aim, 12 G and 12 G-1 showed starters had a mean PL 495±149, PL/min 7.74±1.2; mean HRE was 9664±5252 for G and for G-1 PL 404±135, PL/min 4.62±1.3; mean HRE was 6531±1608. In G-1 starters accumulated 81.6% of G PL, 59.9% of G PL/min and 65.5% of G HRE.

CONCLUSION: Our results indicate reserves accumulated less G specific PL and HRE than starters, which is consistent with past literature in football (1). However, reserves PL/min was over 90% of starters suggesting they maintained similar game intensity as the starters. Starters accumulated high G-1 PL relative to G, with a low to moderate PL/min and HRE suggesting G-1 was high volume with low to moderate intensity. These results contrast with the suggestions for tapering TL volume before games (1,2). Further work exploring TL programming and contextual factors in women's basketball is needed.

1. Curtis et al (2020) 2. Reina Román et al (2018)

DEEP NEURAL NETWORK-DRIVEN TIME SERIES ANALYSIS OF POSTERIOR LEGS SURFACE RADIATION DURING CARDIOPULMONARY EXERCISE TESTING AND ASSOCIATIONS WITH CORE TEMPERATURE AND INTERNAL LOAD

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INTRODUCTION: Infrared Thermography (IRT) measures the surface radiation of the skin (Tsr [°C]). Specific Tsr variations are proposed to be associated with individual acute thermoregulatory and cardiopulmonary responses to exercise [1]. Recently, deep neural network-driven automatic thermal image analysis was developed and enabled reproducible time-series data analysis during running for the first time [2]. This study investigated the relationship between continuous Tsr data, internal load, and core temperature during cardiopulmonary exercise testing (CPET).

METHODS: Twelve endurance-trained subjects [6=male; 6=female; age=24.83y (±2.17); body mass=67.9kg (±8); height=173.8cm (±6)] completed a CPET on a treadmill (start 6 km/h; 3 min per stage; 2 km/h increase per stage at 1.5% slope). Thereby, we measured Tsr, oxygen uptake (VO2), heart rate (HR), rated perceived exertion (RPE), core temperature (Tcore) and blood lactate (LA). We performed descriptive data analysis, bivariate correlation analysis, and repeated measures ANOVA (significance level: $p<0.05$).

RESULTS: The Tsr decreased during stages and immediately increased during standing breaks, which is directly inverse to variations in HR and VO2. Furthermore, Tsr and Tcore showed a significant difference between all relevant levels of the CPET (rest; ventilatory thresholds one and two; maximum load; recovery) ($p<0.05$). The gradient (TG) between Tsr and Tcore increased by 2.6°C (±1) from pre to post. Global correlation analyses revealed statistically significant correlations for TG with VO2 ($r = .402$), HR ($r = .504$), LA ($r = .449$), and RPE ($r = .533$) $p<0.001$. Further analyses revealed high interindividual differences, such as correlations ranging from $r = .43$ to $r = .97$ for TG and VO2.

CONCLUSION: The direct inverse relation of Tsr and cardiopulmonary parameters confirm the association with acute stress response and reveal the high value of the enabled time series analysis. Synchronous measurement of cardiopulmonary and thermoregulatory exercise response allows a comprehensive view of the individual acute physiological adaptation. The origin of interindividual differences requires further analysis. Classification algorithms will be implemented to may enable the non-invasive and contact-free IRT quantification of internal load or the identification of individual training zones.

COMPARISON BETWEEN BODYWEIGHT LUNGES AND SQUATS ON MUSCLE OXYGEN SATURATION, HEART RATE AND PERCEIVED EXERTION

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INTRODUCTION: Squat and Lunges exercises are strongly focused on lower limbs, differing among them in the symmetry of the movement. Several commonly different task constraints related to technical variations or training targets, such as type of surface, type of contraction and range of motion, can promote different acute physiological responses. This study aimed to compare the effect of 6 Lunge and Squat variations on the muscle oxygen saturation (SmO2) of the vastus lateralis (VL) muscle, on the heart rate (HR) response and on the cardio and muscle perceived exertion (RPEc and RPEm, respectively) [1].

METHODS: Ten healthy adults participated in this study (age=26.1±3.1yrs; body mass=74.8±7.9kg; height=173±7cm; BMI=25.0±3.1kg/m2; VL skinfold=14.2±4.8mm). A familiarisation session for each exercise was conducted followed by two sessions, on separate days, where the 6 variations were held in random order for 90sec and 5min rest (cadence 40-60bpm). Variations were chosen so there were unstable (squat Terracore | side-lunge Terracore), reactive (squat Jump | Jumping lunge), single leg (Pistol squat | Bulgarian) and isometric (Wall squat | lunge) and range of motion (Deep squat | Walking lunge and Uneven squat | Cross lunge). Both VL SmO2 percentage (Moxy Fortiori Design, Hutchinson, USA) and HR were collected continuously (last 30sec data was used) and RPE (Borg 6-20) after each variation [2].

RESULTS: Repeated measures ANOVA with Bonferroni's correction revealed no differences on the VL SmO2 in exercise variations (F[11.66]=0.765, p=0.673, n2=0.055). HR (F[11.66]=4.83, p=0.001, n2=0.237) was lower in Isometric lunge vs Walking lunge (p=0.05), and no differences between exercises. Higher RPE were found in reactive Jumping lunge and Jump squat (RPEc 15.1±3.0 and 15.5±1.3 and RPEm 18.6±1.0 and 18.6±0.9). Unstable variations Lateral lunge and squat Terracore, reported lower RPEc (11.1±1.5 and 11.9±2.0) and RPEm (12.9±1.3 and 13.1±2.1) with slightly higher SmO2. Lunge vs squat isometric variations revealed no difference on SmO2 and reported similar RPEc (13.1±3.0 and 12.9±2.6) and RPEm (16.2±1.8 and 16.8±3.2). Both reactive variations revealed higher RPEm compared to unstable ones (F [11.77] =10.2, p=0.001, n2=0.517), squat Jump vs side-lunge Terracore (p=0.003) and vs squat Terracore (p=0.011), Jumping lunge vs side-lunge Terracore (p=0.002) and vs squat Terracore (p=0.025).

CONCLUSION: Squat and lunge variations promoted a similar response in VL SmO2, and the isometric lunge promoted lower HR. Despite no differences in SmO2, reactive variations were perceived by participants with higher RPEm, and unstable variations with lower RPEm regardless the exercise.

[1] Núñez et al., PLoS One. 2018

[2] Gómez-Carmona et al., J. Strength Cond. Res. 2020

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WORK!: AN EXTERNAL LOAD FRAMEWORK FOR TENNIS MATCHES

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INTRODUCTION: Electronic performance and tracking systems (EPTS) are already very common in some team sports like football and the play a vital role in the monitoring of athletes and match analysis. In tennis the use of tracking systems is still sparse. One of the main reasons for this is that players were not allowed to play with wearable technology (like GPS Sensors) and video tracking is by now only feasibly via Hawk-Eye system, which is rather expensive. We therefore created a tracking approach using a one low-cost camera-system and a Deep-Neural Network algorithm for player tracking using YOLOv5 via Pytorch. To evaluate this system, we compared it´s accuracy on typical external load variables with a reference system (Xsens).

METHODS: Ten experienced tennis players took part in the study. They performed 5 different basic exercises (5m, 10m, 20m sprint, a sport specific sprint test, & Pendle sprint) and a short test match. Performance of the participants was recorded with Xsens and video on both sides of the pitch to account for differences in the resolution of the tracked players. To evaluate the new tracking approach (WORK!), distance covered, mean velocity, max velocity, max acceleration and number of accelerations above 3 m/s^2 were extracted from both systems. For synchronisation, start and end times of the exercises were annotated in Dartfish. Statistical analysis was performed with SPSS. Accuracy of fundamental XY-position data was estimated by means of the root mean square error (RMSE). Inter-system differences in accuracy levels on the output variables were tested using an independent t-test.

RESULTS: There was strong agreement between WORK! and three-dimensional motion capture across each activity undertaken. The root mean square difference for speed was 0.55 $m{\cdot}s{-}1$ and for position was 4.2 m .

CONCLUSION: WORK! had strong agreement with the criterion three-dimensional motion capture system three-dimensional motion capture for football-related movements tested in typical tennis court environments. WORK! can thus be used to monitor tennis players during training and matches. This could spark future research on physiological factors in top tennis and injury prevention.

HOW TO MAXIMIZE PERFORMANCE DURING PARALYMPICS BY ANALYZING THE HUMAN-WHEELCHAIR-ATHLETIC TRACK INTERACTIONS ?

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INTRODUCTION: Sciences2024 is a collaborative French research project between sport federations and academic researchers aimed at improving athletics and para-athletics performance for the Paris Olympic and Paralympic Games. Thus, for instance, maximizing the velocity of the wheelchairs during competitions requires to increase the grip between gloves and handrims during the propulsion phase as well as to understand the friction dissipation between the wheelchair tire and the athletic track during the rolling phase.

METHODS: A lab-field approach was carried out. From experiments with French national athletes in real conditions, an analysis of the kinematics was performed and force sensors, strapped on the athlete glove, provided additional data on the glove/handrim interface.

The propulsion phase kinematics was experimentally simulated in LTDS by means of the LORRY tribometer that allows one to control both the contact and release times of the glove/handrim interface. The rolling/sliding phase between the wheelchair tire and various tracks was experimentally investigated thanks to the LUG tribometer. It allows us to realize contacts between a rubber barrel sample, representative of the tire, versus various tracks, from smooth transparent glass discs to real athletic tracks. The contact kinematics was controlled with each solid velocity ranging from 50 □m/s to 1 m/s and the contact forces were measured up to 10 N. The composition of rubber samples (both handrim and tire) provided by Hutchinson was varied in terms of fillers, keeping the elastomer matrix constant.

RESULTS: Our first results on the model glass/rubber contact in rolling/sliding conditions helped us to identify the relative influence of adhesive and viscoelastic contributions of the rubbers. When investigating more realistic scenarii with rolling-sliding conditions on athletic tracks, friction depended on the sliding-rolling ratio (SRR): at low SRR, a levelling of friction was observed and at higher SRR, the friction level did not correlate directly with the rubber bulk properties. These results highlighted the influence of track viscoelasticity and roughness, confirming field experimental results focusing on the coefficient of rolling resistance.

The contribution of adhesion was marked during the propulsion phase and this will be confronted to field results.

CONCLUSION: The methodology proposed here was based on the analysis of the interactions of the wheelchair with either the Human athlete or the track, during rolling-sliding and propulsion phases. Confronting measurements on field to lab experiments, we were able to discuss the role of the roughness, adhesion and viscoelasticity, defining a promising way to enhance athletic performance.

HOW IS SPORTS INJURY PREDICTION PERCEIVED BY ELITE SPORTS STAKEHOLDERS? AN ONLINE SURVEY DURING THE MUNICH 2022 EUROPEAN CHAMPIONSHIPS.

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INTRODUCTION: The development of artificial intelligence and machine learning techniques may enable measuring an individual athlete's own risk of injury occurrence and can also be used to further investigate the relative importance of risk factors related to sports injuries. In the near future, elite stakeholders (athletes, coaches, health professionals) could have the opportunity to access to the injury risk estimation provided by predictive algorithms in order to manage training and injury risk as an additional injury risk reduction measure. The aim of this study was to explore the perception and beliefs of elite sports stakeholders towards the use of injury prediction as an injury risk reduction measure.

METHODS: During the 2022 European Championships in Munich (Germany), a multi-sports event, all registered athletes, coaches and health professionals from the nine sports disciplines (i.e., athletics, beach volleyball, canoe sprint, cycling, gymnastics, rowing, sports climbing, table tennis, triathlon) were asked to complete an online questionnaire on their perception and beliefs of the use of injury prediction as an injury risk reduction measure. The interest, intent to use, perceived help, potential stress and dissemination scores were assessed using an analogic scale from 0 (not at all) to 100 (totally).

RESULTS: There were 79 participants: 35 athletes, 14 coaches, 29 health professionals, from 23 countries and from 8 sports disciplines (54 athletics, 8 canoe sprint, 4 cycling, 2 gymnastics, 2 rowing, 2 sports climbing, 5 table tennis, 1 triathlon). They all expressed a high level of agreement regarding the interest (86±15), intent to use (84±16), and perceived help (85±16) of injury prediction as an injury risk reduction measure. Regarding potential stress induced by injury prediction, the level of agreement was moderate (41±33), and there was an important inter-individual variability in each stakeholder group (athletes, coaches, health professionals) with scores ranging from 0 to 100. They expressed a high level of agreement regarding the dissemination for athletes (85±17), coaches (84±20) and health professionals (86±18).

CONCLUSION: This innovative study shows that regardless of the stakeholder group (athletes, coaches, health professionals), there was a high level of acceptance of injury prediction as injury risk reduction measure. In contrast, potential stress induced by injury prediction seems to be more nuanced and affected by individual factors. Our results provide new insights into how elite stakeholders may respond and apply to this preventive measure. This is an important step for properly defining implementation strategies and may have implications for future research and practice in the use of sports clinical prediction modelling as an injury risk reduction measure in elite sports field.

Conventional Print Poster

CP-PN10 Physiology II

IRISIN AND BONE REMODELING REGULATORS AFTER HIGH-INTENSITY INTERVAL EXERCISE OF HIGH AND LOW IMPACT IN YOUNG ADULT FEMALES

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INTRODUCTION: Recent evidence indicates that exercise leads to increased secretion of irisin, a muscle-derived cell signalling protein, which, in turn, seems to play a major role in bone homeostasis. Moreover, while high-impact activities such as running are known for their beneficial effects on bone remodelling, the evidence on whether low-impact activities have similar effects on bone cell processes appears contradictory. Thus, the purpose of this study was to investigate potential changes in irisin, and several upstream and downstream regulators of bone cell signalling in young adult females following high-intensity interval exercise of high and low impact.

METHODS: Healthy, recreationally active, young adult females (n=18; 22.5±2.7 years) performed two exercise trials in random order; high-intensity interval running on a treadmill and high-intensity interval cycling on a cycle ergometer. The exercise trials involved eight intervals of 1-minute running or cycling at high intensity (≥ 90% of maximal heart rate, with 1-minute passive recovery breaks in between. In both trials, blood samples were taken before the exercise (resting), and three times after exercise (5 minutes, 1 hour, and 24 hours). The myokine irisin, the bone-modulating parathyroid hormone (PTH), and three Wnt signalling-related osteokines, including sclerostin, osteoprotegerin (OPG), and receptor activator nuclear factor kappa-β ligand (RANKL), were analyzed in serum. Post-exercise concentrations were corrected for exercise-induced changes in plasma volume.

RESULTS: Irisin did not increase immediately following either the running or cycling trial but was 20% higher 24 hours post-exercise compared to pre-exercise in both trials (6.2±0.5 versus 5.±0.3 ng/ml; time effect p=0.005). PTH, sclerostin, and RANKL were higher 5 minutes post-exercise compared to pre-exercise (18%, 37%, 83% and 33%, respectively; time effect p<0.05), returning to pre-exercise 1 hour after exercise irrespective of exercise mode. Specifically, compared to pre-exercise, 5 minutes post-exercise, PTH increased from 76.2±10.6 to 163.0±12.1 pmol/L (p<0.001), sclerostin increased from 99.0±7.6 to 134.5±10.4 pg/ml (p<0.001), and RANKL increased from 89.8±10.0 to 118.9±16.5 pg/ml (p=0.017) with no differences between trials. OPG showed a time effect (p<0.05), reflecting an overall increase from pre-exercise to 5 minutes and 1 hour post-exercise (525.7±31.7 versus 579.0±39.9 and 565.2±41.4 pg/ml, respectively), which was not significant after the Bonferroni adjustment for three comparisons.

CONCLUSION: This study found that high-intensity interval running and cycling produce similar responses in the circulating levels of irisin and regulators of bone cell signalling in young adult females. This finding suggests that when performed at high-intensity, high and low-impact exercises seem to have similar effects on muscle and bone cell signalling pathways.

BONE (RE)MODELLING MARKER CONCENTRATIONS THROUGHOUT MENSTRUAL CYCLE PHASES IN RESPONSE TO AN ECCENTRIC RESISTANCE TRAINING PROTOCOL

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INTRODUCTION: Bone remodelling may be altered by sex hormone fluctuations during the menstrual cycle [1]. Bone formation determined by procollagen type 1 N propeptide (P1NP), and bone resorption measured by carboxy-terminal cross-linking telopeptide of type I collagen (β-CTX-1), can reflect changes in bone metabolism. Although there is evidence suggesting that resistance training could have positive effects on bone health [2], it is unknown how these sex hormone fluctuations may affect the acute response to this modality of training/exercise. Thus, this study aimed to observe the impact of resistance training on bone (re)modelling markers throughout the menstrual cycle.

METHODS: Seven eumenorrheic resistance-trained females (age: 23.7±2.86years; weight: 61.1±3.93kg; height 162.2±4.2cm; body fat: 28.3%±6.93%; BMI: 23.3±2.49kg/m2; 1RM: 65.1±11.31kg) performed an eccentric-based resistance training protocol [3], in which participants performed 10x10 of parallel back squats at 60% of 1RM. P1NP and β-CTX-1 serum concentrations were measured pre- and 0h post-exercise in the early-follicular phase (EFP), late-follicular phase (LFP) and mid-luteal phase (MLP). Menstrual cycle phases were determined by the 3-step methodology [4]. A mixed linear model was conducted, where phase and time were set as fixed effect and subjects as random effect.

RESULTS: Significant differences were found in P1NP values between the EFP (73.0±17.24 ng/ml) and MLP (82.1±26.4 ng/ml; p<0.035). Moreover, higher β-CTX-1 values were observed in the LFP (0.6±0.07 ng/ml) compared to the EFP (0.5±0.07 ng/ml; p<0.045) and MLP (0.5±0.07 ng/ml; p<0.003). Furthermore, significant differences were also found in P1NP/β-CTX-1 ratio when comparing the LFP (126.4±31.71) with the MLP (154.9±34.4; p<0,004). Additionally, higher post-exercise P1NP/β-CTX-1 ratio value (176.7±16.56) was obtained compared to pre-exercise values (142.9±10.17; p<0.007).

CONCLUSION: The observed higher bone formation and lower bone resorption, determined by P1NP and β-CTX-1 respectively, could lead to increased resistance training-induced bone anabolism during the MLP. Therefore, these findings may

indicate that menstrual status may influence the resistance exercise response of bone metabolism, highlighting its importance for proper menstrual health. Nevertheless, the long-term implications of the higher P1NP/ β-CTX-1 ratio observed during the MLP remain unknown, as well as the potentially greater bone health benefits derived from resistance training during this phase.

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INFLUENCE OF EXERCISE MODALITY (ENDURANCE VERSUS RESISTANCE) ON BONE (RE)MODELLING MARKERS IN ORAL CONTRACEPTIVE USER WOMEN

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INTRODUCTION: The osteogenic effects of exercise depend on its nature and features. Previous results have shown that multidirectional sports (e.g. volleyball or gymnastics) are more beneficial for bone health in comparison to endurance sports (e.g. running, cycling or swimming) (1). Moreover, given the effects of oestrogen on the regulation of bone metabolism and the high prevalence of oral contraceptive use, the different hormonal profiles of women of reproductive age should be considered. However, there is limited evidence about the effect of the exogenous hormones on bone (re)modelling markers. This study aimed to analyse the influence of the exercise modality (resistance vs. endurance) in OC users.

METHODS: Fifteen OC users exercising women participated in this study (25.6±3.5 years; 27.1±7.2% fat mass). Eight women performed an interval running exercise (8 bouts of 3 min at 85% of the maximal aerobic speed) while seven participants performed an eccentric-based resistance training session (10x10 of barbell parallel back squats at 60%1RM) (2). Volunteers were evaluated in the withdrawal phase (WP) and the active pill-taking phase (APP). Procollagen type 1 N-propeptide (P1NP) and carboxy-terminal cross-linking telopeptide of type I collagen (β-CTX-1) serum concentrations, representing bone formation and resorption respectively, were analysed pre-exercise and just (0h) post-exercise and delta values were calculated (units: ng/ml).

RESULTS: Delta values of P1NP were significant affected by the exercise modality (Endurance: 12.4±5.03; Resistance: -1.79±3.05; $p<0.001$) showing higher delta values of P1NP during the endurance exercise. There was a significant phase*protocol effect ($p=0.018$). Delta values of P1NP were significantly higher ($p<0.001$) at WP (14.74±4.71) and APP (10.06±4.42) during the endurance exercise compared to the WP (-2.6±3.25) and APP (-0.98±2.85) during the resistance exercise. Delta values of β-CTX-1 were also significant affected by the exercise modality (Endurance: 0.016±0.052; Resistance: -0.110±0.124; $p<0.001$) with higher delta values during the endurance training.

CONCLUSION: Exercise modality affects bone formation markers, showing a large increase after the endurance exercise in both OC phases. On the contrary, P1NP and β-CTX-1 showed a decrease after the resistance exercise. Further investigation of the mechanism on microdamage repair in bone tissue is necessary to explain this increase in P1NP with the endurance training since it seems inconsistent with the classical remodelling theory (3). On the contrary, the direct repair theory (4), demonstrated in vitro models, could be supported by these results.

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INCREASED PHYSICAL LOADING ON AND OFF THE PITCH: DEMANDS OF FULL-TIME ACADEMY PROGRAMMES AND IMPLICATIONS FOR GROWTH, MATURATION AND BONE HEALTH.

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INTRODUCTION: We have previously reported that male academy soccer players from the English Premier League (EPL) complete training loads [1] and exhibit daily energy expenditures [2] that are comparable to (and in some cases exceed) their first team counterparts [3]. Given the implications of "under-fuelling" upon growth and maturation, such data demonstrate the necessity of consuming sufficient energy intake. However, the extent to which being enrolled on a full-time academy programme increases the total daily energy expenditure (TDEE) and physical loading (PL) patterns of adolescent soccer players compared with non-academy players is not yet known. Accordingly, the aim of this study was to test the hypothesis that the TDEE of male academy soccer players is significantly greater than players not enrolled on a formalised academy programme.

METHODS: In a cross-sectional design, eight male soccer players from an EPL academy (ACAD: 13 years, 51±8 kg, 89±3% predicated adult stature (PAS) and six aged-matched non-academy players (NON: 13 years, 53±12 kg, 89±3% PAS) were

assessed for TDEE (using the doubly labelled water method) during a 14-day in-season data collection period. External loading was evaluated during soccer training sessions (ACAD: n=8, NON: n=2) and competitive games (ACAD: n=2, NON: n=2) via GPS technology whilst daily physical activity (PA) was also evaluated using triaxial accelerometery sampling at 30Hz.

RESULTS: In accordance with a greater frequency of training and games, academy players completed a greater accumulative duration of soccer activity (ACAD; 975±23min, CON; 397±2min, 95%CI 557 to 599, p<0.01) and distance covered (ACAD; 54.2±8.3km, CON; 21.6±4.7km 95%CI 24.3 to 40.8, P<0.05) during the 14 day-period. Additionally, academy players also spent more time engaging in daily moderate-to-vigorous (ACAD; 124±17min, CON; 79±18min, 95%CI 25 to 65, p<0.001) and high intensity PA (>600 mg; ACAD: 13±3mins, NON: 7±3mins, 95%CI 2 to 10, P>0.05). In considering higher physical activity levels, both absolute (ACAD; 3380±517kcal.d-1, CON; 2641±308kcal.d-1, 95%CI 218 to 1258, P<0.05) and relative TDEE (ACAD; 66±6kcal.kg.d-1, CON; 52±10kcal.kg.d-1, 95%CI 5 to 24, P<0.05) was also greater in academy players versus non-academy players.

CONCLUSION: We report for the first time that the daily energy requirements of male adolescent soccer players engaged in a formalised academy program are significantly greater than age matched non-academy players. Our data demonstrate the necessity for academy players to consume sufficient daily energy intake to support the energetic demands of growth and maturation alongside the enhanced energy cost associated with the training and competition academy programs. The present data form the basis of stakeholder (e.g. governing bodies, coaches and parents) and player education and behaviour change strategies that promote sufficient daily energy intake, contributing to long-term player development.

DETERMINANTS OF RESTING CEREBRAL BLOOD FLOW AND ARTERIAL TRANSIT TIME IN HEALTHY OLDER ADULTS

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INTRODUCTION: The relationship between fitness and cerebrovascular health in older adults remains unclear. Previous research using pseudo-continuous arterial spin labelling (pCASL) shows that resting grey matter cerebral blood flow (CBF) declines with age, is lower in males than females, and is inversely associated with body mass index (BMI) (4). However, fitness has been shown to be both a positive and negative determinant of CBF (1,2). Disparities in results may be because few studies use multiple post-label delays to correct CBF values for differences in arterial transit time (TT) between groups that possibly accompany the changes in CBF. This study aims to establish the key determinants of CBF in healthy older adults, measured using pCASL with multiple post-label delays.

METHODS: On separate days, 79 healthy older adults (65±5 yrs, 39 females) completed a modified Balke fitness test, and an MRI scan to measure CBF and TT using pCASL with a 3D GRASE readout (6). 8 post-label delays (200, 975, 1424, 1850, 2025, 2150, 2250, 2300 ms) were used (7) to enable CBF and TT to be measured. ASL data were analysed using BASIL toolbox, FSL. Separate linear regressions were performed with CBF and TT as dependant variables, both including age, sex, education level, Montreal Cognitive Assessment (MoCA) score, systolic and diastolic blood pressure, BMI, handgrip strength, and fitness as independent variables.

RESULTS: For CBF, BMI was the only significant determinant (β = -0.44, p = 0.001), while fitness was a non-significant negative determinant (β = -0.29, p = 0.077). For TT, BMI (β = 0.27 p = 0.031), age (β = 0.38, p = 0.011), and handgrip strength (β = -0.47, p = 0.030) were all significant determinants. For CBF and TT, all other independent variables were non-significant (p > 0.100).

CONCLUSION: The CBF-BMI and TT-age associations observed in the current study were consistent with previous research, as was the lack of association between TT and fitness in older adults. Further, our data indicate that fitness may be negative determinant of CBF (though p = 0.077). Previous research has shown both a negative (2) and a lack of (3) association between CBF and fitness in older adults. The tentatively negative relationship between fitness and CBF may be a compensatory response to neurovascular inefficiency (5).

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GRIP STRENGTH CORRELATES WITH BODY COMPOSITION AND BASAL METABOLIC RATE IN OLDER ADULTS WITH LOW APPETITE

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INTRODUCTION: Grip strength (GS) and lean mass have been identified as robust indicators of functional impairment, morbidity, and mortality (1) throughout the lifespan (2,3). Although, GS is widely used in clinical settings its relationship with lean mass, anthropometric measurements and cross-sectional area of the thigh is still unclear. In the present study we examined this relationship in healthy older adults with low appetite a population at risk of developing undernutrition and a plethora of pejorative health outcomes including sarcopenia. Thus, the aim of this study was to establish the efficacy of both GS and maximal voluntary contraction (MVC) of knee extensors (KE) in predicting body composition, anthropometric measurements, and KE cross-sectional area (CSA) in healthy older adults with low appetite.

METHODS: Prior to enrollment in the study, eight healthy older adults (>65 yrs.) underwent appetite assessment using the Simplified Nutritional Appetite Questionnaire (SNAQ) where low appetite was defined as SNAQ score <16. Waist-Hip Ratio (WHR) was measured with a tape. Bioelectrical impedance analysis was used to assess fat free mass (FFM_kg) and to estimate basal metabolic rate (BMR). A hand dynamometry measured GS of both arms and the highest value among the two limbs was retained for analysis. A custom-made knee dynamometer was used to measure MVC of KE. Vastus lateralis and rectus femoris CSA were evaluated using extended-field-of-view ultrasonography imaging.

RESULTS: The non-dominant arm expressed the highest GS value in 2 out of 8 subjects. Analysis revealed that in older adults GS is correlated with WHR (r2=0.496; p=0.034), FFM_kg (r2=0.646; p=0.009) and BMR (r2=0.814; p=0.002). No correlations were found when considering muscle CSA or MVC (KE). At the same time, MVC is not a predictor for the other dependent variable.

CONCLUSION: GS confirms to be a good indicator in evaluating body composition and metabolic rate in older adults but it is not specific in predicting muscle mass and strength of lower limbs. Moreover, assessment of GS has proven to be an effective screening tool for predicting both BMR and total energy expenditure, which are crucial factors in maintaining an adequate level of physical activity in older adults. The potential of MVC to predict general fitness and body composition variables in this particular population has yet to be evaluated, and thus, remains unclear.

THE ETIOLOGY OF AGE-RELATED FATIGABILITY REVISITED

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INTRODUCTION: Aging is associated with a decline in muscle mass and force/power. These alterations can exacerbate fatigability, defined as an exercise-induced reduction in force/power, and reduce autonomy. The mechanisms underlying fatigability are insufficiently known, especially at very old age (> 80 years). The aim of this study was to further investigate the causes of fatigability with the ultimate goad to adjust exercise intervention to prevent the age-related fatigability and thus maintain autonomy and improve quality of life.

METHODS: Thirty young (YM; 19-35 years), 28 old (OM; 65-80 years) and 16 very old (VOM; >80 years) men performed an incremental fatiguing task on a validated cycle-ergometer that allows to block instrumented pedals at 90° for the right knee. The fatiguing test consisted of 3-min stages with incremental workload based on the subjects' body weight. Before, at the end of each stage and at exhaustion, subjects performed a neuromuscular evaluation consisting of a maximal isometric voluntary contraction (MVC) of the knee extensors and single-pulse stimulations during MVC and on relaxed muscles to evaluate voluntary activation (VA) and resting twitch amplitude (Tw). Perceived exertion (RPE) was rated at the end of each stage on a 6-20 Borg scale. In a second session, subjects realized a VO2max ramp-test on a similar ergocycle.

RESULTS: The total number of stages completed decreased with age (YM: 9.5±1.3, OM: 7.4±1.4, VOM: 4.7±1.0; p<0.001). At exhaustion, the decrease in MVC was lower for VOM (21.4±12.7%; p<0.001) than YM (34.7±12.4%; p<0.001) and was 27.0±23.0% for OM (not significantly different from YM and VOM). The decrease in Tw was greater in YM (44.1±18.1%; p<0.001) than both OM (27.0±23.0%; p<0.05) and VOM (15.6±17.9%; no significant), and there was no age-related difference in VA. RPE at exhaustion was higher for YM (17.8±1.3) than OM (16.2±1.8) and VOM (14.4±1.5; p<0.01). However, the mean RPE for the first three stages was higher for VOM (14.3±1.6) than both OM (13.0±1.8) and YM (9.7±1.0; p<0.001) whereas MVC loss after stage 3 was similar for the 3 groups. RPE at last stage and VO2max were positively correlated (r=0.59; p<0.001).

CONCLUSION: The age-related decreases in MVC and Tw suggest that the increase in fatigability at exhaustion is mainly due to peripheral mechanisms (i.e. within the muscle). In VOM, despite a ~ 20% decrease in MVC, neither Tw nor VA declined significantly. This could be due to the fact that the task ended before maximum effort, as shown by the relatively low RPE at the last stage. Interestingly, the correlation between VO2max and RPE at the last stage indicated that participants who had a high VO2max could sustain higher levels of perceived effort. Therefore, a low VO2max and RPE at exhaustion, together with a higher RPE for a given submaximal workload could contribute to limit VOM performance when compared to OM. These results suggest that the targeted level of RPE during rehabilitation programs should be adjusted for VOM.

GENDER DIFFERENCES IN THE EFFECTS OF SARCOPENIA ON COGNITIVE FUNCTION, DEPRESSION, AND PHYSICAL FUNCTION IN THE ELDERLY: A SYSTEMATIC REVIEW AND META-ANALYSIS

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INTRODUCTION: Sarcopenia is defined as an age-related loss of skeletal muscle mass and functional impairments. Further, critical symptoms of the disease in the elderly include impaired cardiopulmonary performance and unfavorable metabolic effects, decreased physical capabilities such as falls and motor disability, and cognitive deficits and depression. Although age-induced sarcopenia often appeared in both elderly men and women, the symptoms of sarcopenia may differ depending on gender. However, common findings on the differences caused by sarcopenia in men and women are still lacking and have not been clearly presented. Therefore, the purpose of this meta-analysis was to identify potential effects of sarcopenia on cognitive function, physical function, and depression in the older adults based on gender, respectively.

METHODS: Our systematic literature search was conducted in the electronic databases of PubMed and Web of Science from March 1, 2010 to February 15, 2022 by two independent authors (CL, NK). We used the following search terms for each searching engine: (Cognition OR Cognitive) AND (Sarcopenia) AND (Elderly OR Older People). A total of 17,054 participants (7,680 women and 9,374 men) from the 29 qualified studies was examined in this meta-analysis.

RESULTS: Sarcopenia had significant negative effects on (a) cognitive function assessed by mini-mental state examination for women: SMD (standardized mean difference) = -0.714, p<.0001 and for men: SMD = -0.505, p<.0001, (b) body composition assessed by body mass index for women: SMD = -0.630, p<.0001 and for men: SMD = -0.570, p<.0001, and (c) appendicular skeletal muscle mass index for women: SMD = -1.119, p<.0001 and for men: SMD = -0.832, p<.0001 indicating relatively greater effects for women than those for men. In contrast, sarcopenia revealed significant negative effects on depression assessed by geriatric depression scale for women: SMD = -0.186, p<.0001 and for men: SMD = -0.261, p<.0001) and (b) physical function assessed by gait speed for women: SMD = -0.725, p<.0001 and for men: SMD = -1.018, p<.0001 indicating relatively greater effects for men than those for women. Finally, sarcopenia showed a significant negative effect on muscle strength assessed by handgrip strength for women: SMD = -1.271, p<.0001 and for men: SMD = -1.231, p<.0001 with minimal gender difference.

CONCLUSION: The current meta-analytic findings showed that sarcopenia had greater negative effects on cognitive function and body composition for women, whereas greater negative effects of sarcopenia for men were found in depression and physical function. No gender effect of sarcopenia appeared in muscle strength. These results suggested basic guidelines for preventing sarcopenia according to men and women in the elderly.

THE COMBINED TREATMENT OF ACETIC ACID SUPPLEMENT AND EXERCISE INTERVENTION ALLEVIATES SKELETAL MUSCLE MITOCHONDRIAL DYSFUNCTION IN OVARIECTOMIZED MICE

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INTRODUCTION: Menopause is a major factor causing negative changes in body composition and metabolic function in women. The present study aimed to investigate whether, using ovariectomized mice, acetic acid supplement and exercise intervention effectively alleviate the adverse effects of ovariectomy in terms of metabolic function including mitochondria.

METHODS: Female C57BL/6J wild-type mice (n=40, 8 weeks old) were randomly assigned to sham (SHM, n=8), ovariectomy (OVX, n=8), ovariectomy with exercise (OVX-E, n=8), ovariectomy with acetic acid (OVX-A, n=8), and ovariectomy with acetic acid and exercise (OVX-AE, n=8) groups. Following a 1-week recovery from ovariectomy, acetic acid supplement (5% in chow diet) and voluntary wheel running exercise intervention were administered according to group assignment for 13 weeks. Body composition, whole-body metabolic rate, and glucose tolerance were analyzed via DXA, indirect calorimetry, and intraperitoneal GTT, respectively. Mitochondrial function and pAMPK protein content in soleus and gastrocnemius were measured by OROBOROS-O2k and Western blot.

RESULTS: Ovariectomy significantly increased total body weight and fat mass, and decreased whole-body metabolic rate and glucose tolerance. Acetic acid supplement or exercise intervention failed to alleviate the ovarietomy-associated negative changes in body composition, whole-body metabolic rate and glucose tolerance. There was no significant difference between groups in mitochondrial respiration of soleus muscle. Interestingly, in gastrocnemius, ovariectomy significantly decreased mitochondrial respiration (53.079 ± 5.03 vs. 35.31 ± 4.13 pmol*sec-1*mg-1, P=0.003, SHM vs. OVX), which mitochondrial dysfunction was rescued by the combined treatment of acetic acid and exercise (35.31 ± 4.13 vs. 50.94 ± 5.17 pmol*sec-1*mg-1, P=0.015, OVX vs. OVX-AE). In addition, the combined treatment increased the activity of AMPK, the ratio of phosphorylated to total AMPK (2.35 ± 0.56 vs. 10.53 ± 1.65 AU, P=0.040, OVX vs. OVX-AE).

CONCLUSION: These findings suggest that single treatment of acetic acid or exercise cannot alleviate the ovariectomy-associated metabolic problems, but there was a synergetic effect on mitochondrial function when acetic acid supplement and exercise intervention were combined. The underlying mechanism by which the effect of the combined treatment differs between soleus and gastrocnemius muscle should be investigated in the future studies.

GETTING THE MOST OUT OF IT - DOES MEMORY BENEFIT FROM SYNERGIES OF SLEEP AND TRAINING?

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INTRODUCTION: There is emerging evidence that high-intensity interval training (HIIT) may affect procedural and declarative memory consolidation as well as nocturnal sleep. Roig et al. (2022) postulated a theoretical framework of synergistic effects of exercise and sleep on memory. Recently, it has been shown for the first time that exercise followed by a day nap enhanced declarative memory formation. There was a positive correlation between performance and sleep spindle density, a sleep parameter associated with memory consolidation, only in the combined exercise and nap group (Mograss et al., 2020). Whether these effects can also be transferred to other memory systems, and in particular to nocturnal sleep, has not yet been studied. Therefore, the aim of this study was to investigate the potential influence of HIIT on sleep-dependent memory consolidation.

METHODS: 19 healthy subjects (23.7, ±4.0, m: 9, w: 10) were tested in a within-subject design. In counterbalanced order, two experimental nights with either (i) a HIIT (90%/25% Wmax) or (ii) a control condition (documentary) were performed immediately after the encoding of the memory tasks (7pm). The memory tasks were a finger tapping task (FTT) and a paired-associate learning task (PAL). Subsequent nocturnal sleep was recorded by polysomnography (N=13). Retention tests were carried out the following morning (8am). Consolidation was measured by the percentage change between encoding and retention. Differences between the conditions and associations between memory and sleep parameters were analysed using paired t-tests and Pearson correlations.

RESULTS: After encoding, there was no significant difference in performance between the two conditions (FTT: $t(18)=-1.899$, $p=.074$; PAL: $z = 1.844$, $p = .065$). HIIT had a small non-significant positive effect on procedural consolidation ($t(18)=1.324$, $p=.101$, $d=0.304$) and a significant small positive effect on declarative consolidation ($t(18)=1.767$, $p=.047$, $d=0.405$). HIIT also increased N2 sleep ($t(14)=1.857$, $p=.042$, $d=0.480$) and decreased REM sleep ($t(14)=-2.893$, $p=.006$, $d=0.747$). Notably, the exercise-induced change in N2 correlated significantly with the change in procedural memory consolidation ($r=0.475$, $p=.037$). Exploratory analyses of oscillatory brain rhythms revealed non-significant small effects on sleep spindle count in N2 and slow wave activity (SWA) in N3 ($t(12)=1.590$, $p=.138$, $d=0.441$; $t(12)=1.296$, $p=.219$, $d=0.359$).

CONCLUSION: The results confirm previous findings of increased N2 and reduced REM sleep after HIIT. The expected increase in memory consolidation was partially confirmed. The correlation between exercise-induced changes in N2 and FTT consolidation suggests that HIIT may favour procedural memory formation by lengthening relevant sleep stages. Exploratory analyses of oscillatory brain rhythms revealed no significant differences. However, we can gain some insight in exercise-induced changes, as small effect sizes indicate an increased spindle count in N2 and an increased SWA in N3.

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CP-PN11 Physiology III

EFFECTS OF CONCURRENT SPRINT INTERVAL TRAINING AND VELOCITY-BASED RESISTANCE TRAINING ON MUSCLE STRENGTH AND VO2MAX: A PILOT STUDY

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INTRODUCTION: This study aimed to examine the effects of concurrent sprint interval training (SIT) and velocity-based resistance training using two different velocity loss cut off (VLC) on muscle strength and VO2max in three weeks.

METHODS: Eight trained subjects (two women and six men) participated in this study. The subjects characteristics were as follows; age; 24.2 ± 3.9 years, height; 168.7 ± 5.7 cm, body mass; 68.5 ± 9.7 kg, one repetition maximum (1RM) of parallel squat; 107.8 ± 26.1 kg, VO2max; 44.2 ± 6.3 mL/kg/min. Subjects performed two training sessions per week for three weeks and randomly divided into three groups; 10% of VLC resistance training and SIT (VLC10; n = 3), 40% of VLC resistance training and SIT (VLC40; n = 3), and only SIT (SIT; n = 2). Parallel squats at 80% 1RM (four sets, rest intervals; 4 min) was performed before SIT in VLC10 and VLC40. SIT was performed using a bicycle ergometer, with six bouts of 10 s sprint pedalling with 80 s rest intervals. Body composition, maximal oxygen uptake, 1RM test, countermovement jump (CMJ), and Wingate test were measured before and after the training session.

RESULTS: All groups improve in a VO2max after the three-week training session (SIT; 6.8%, VL10; 5.7%, VL40; 3.9%). Only the group with the resistance training had changed more 1RM (VL40; 10.6%, VL10; 7.3%, SIT; 1.7%). Similar results were observed for CMJ (VL40; 5.1%, VL10; 2.7%, SIT; -2%). There were no changes in peak and mean powers in the Wingate test in all groups.

CONCLUSION: Our results showed increased 1RM and CMJ only in the resistance training group. Conversely, in VO2max, there were high individual differences in effectiveness in the resistance training group. Therefore, increasing the number of subjects eventually is necessary.

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ASSOCIATION BETWEEN ACTN3 R577X POLYMORPHISM AND MUSCLE STRENGTH AND POWER PERFORMANCE: A SYSTEMATIC REVIEW AND META-ANALYSIS

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INTRODUCTION: R577X polymorphism in the α-actinin-3 gene (ACTN3) is associated with muscle strength and power performance (Kikuchi et al. 2015, Yang et al. 2017). A previous study suggests that there is an additive relationship in muscle performance, which increases in the following order: RR, RX, and XX (Garton et al. 2016). However, there is no meta-analysis on the association between ACTN3 R577X polymorphism and muscle strength and power performance. Therefore, through a systematic review and meta-analysis study, we examined the effect of the ACTN3 R577X polymorphism on strength and power performance.

METHODS: Relevant studies published before July 27th, 2022 were identified from the PubMed database using the following keywords and Boolean operators: ("muscle strength" OR "muscle function" OR "muscle force" OR "power") AND ("α-actinin 3" OR "ACTN3 R577X genotype" OR "ACTN3 polymorphism" OR "ACTN3" OR "alpha-actinin 3"). Studies that met the following criteria were included: (1) published in English, (2) included human participants, (3) included healthy participants, (4) provided muscle function measurements, and (5) analysed the ACTN3 R577X genotype. Measurements were divided into maximum voluntary contraction (MVC), 1 repetition maximum (1RM), and jump and sprint performance and examined for association with ACTN3 R577X polymorphism. All analyses were conducted using R (version 4.1.3) and its "meta" package. The additive genetic model was assessed using a meta-regression model.

RESULTS: A total of 101815 participants from 33 studies were included in the meta-analysis (MVC: 19 studies, n=7419, 31 measurements; 1RM: 4 studies, n=657, 7 measurements; jump performance: 18 studies, n=3594, 44 measurements; sprint performance: 6 studies, n=1701, 7 measurements). Additive relationships in MVC, 1RM, and jump were observed and increased in the following order: RR, RX, and XX (MVC $p=0.005$, 1RM $p=0.005$, jump $p<0.0001$). There was no significant association between ACTN3 R577X polymorphism and sprint performance (sprint $p=0.168$).

CONCLUSION: MVC, 1RM, and jump performance had additive relationships with ACTN3 R577X polymorphism among muscle function measurements in the meta-analysis.

Further investigation is needed to determine whether the effects of ACTN3 R577X polymorphism on muscle strength and power performance differ by sex, ethnicity, and age.

THE RELATIONSHIP BETWEEN INDIVIDUAL MRI-DERIVED MUSCLE GROWTH AND STRENGTH GAINS AFTER RESISTANCE TRAINING

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INTRODUCTION: Resistance training (RT) is well-recognised as an effective intervention to elicit profound improvements in neuromuscular strength and power. Although the muscle size-strength relationship has been extensively documented over decades, the contribution of muscle hypertrophy to strength changes following RT is still under debate (1,2). In addition, several methods to assess the size changes are available (such as anthropometry, biopsy, various imaging techniques), which may influence the consistency of previously reported relationships. Thus, only a few studies have assessed the relationship between individual muscle growth and strength gain after RT using high-resolution magnetic resonance imaging (MRI), the gold standard method of determining muscle size. This study aimed to explore the relationships between firstly, muscle hypertrophy and strength change, and secondly the hypertrophic response of different muscle groups. We hypothesised that in response to a standardised RT regime (1) quadriceps (Q) hypertrophy would be the biggest predictor of knee extensor (KE) strength gains rather than changes in neuromuscular activation or pre-training strength, (2) their would be a positive relationship between the hypertrophic response of different muscle groups.

METHODS: This study was a secondary analysis of longitudinal data from a randomised controlled trial, a two-arm 15-week RT intervention (3 times/week) study in young, healthy males (n = 39, mean age 25.7 ± 4.3 y) (3). Measurements pre and post-RT included: KE isometric maximum voluntary torque (MVT); KE one repetition maximum (1RM); Q, hamstrings (H) and gluteus maximus (GM) volume (VOL) with MRI; and Q neuromuscular activation (QEMGMVT and QEMG1RM).

RESULTS: Percentage changes (Δ) in Q VOL and QEMGMVT were correlated to ΔKE MVT ($r = 0.593$, $P < 0.001$, and $r = 0.347$, $P = 0.035$, respectively), while only ΔQ VOL correlated with ΔKE 1RM ($r = 0.334$, $P = 0.05$). Pre-training KE strength was not correlated with muscle strength changes (KE MVT and KE 1RM). Also, muscle hypertrophy of the different muscles were associated (All $r > 0.4$; $P<0.05$). The linear stepwise regression analysis only retained change in QVOL which explained 27.5% of the variance in KE MVT change and 11.8% of the variance in KE 1RM change.

CONCLUSION: The individual changes in quadriceps muscle volume were the biggest predictor of changes in KE strength after RT. However, this association differed in magnitude, depending on the measure used to capture muscle strength change (KE MVT vs 1RM). Also, the observed positive relationship between the hypertrophic response of different muscle groups indicates a significant contribution of systemic factors.

ACKNOWLEDGEMENTS:

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ACUTE STRESS RESPONSE IN HUMAN SKELETAL MUSCLE AFTER LOW-LOAD BLOOD FLOW RESTRICTED COMPARED TO HIGH-LOAD RESISTANCE EXERCISE IN TRAINED INDIVIDUALS

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INTRODUCTION: Low-load resistance exercise with blood flow restriction (LL-BFR), has been shown to induce similar increases in muscle mass and strength as high-load resistance exercise (HL-RE) (1). However, it remains unclear whether the cellular stress induced by LL-BFR in human skeletal muscle is different from that of HL-RE in trained individuals (2). Small heat shock proteins, such as αB-crystallin, are known to translocate from the cytosolic to cytoskeletal structures upon exercised-induced stress and damage (3,4). Therefore, the aim of the present study was to compare αB-crystallin translocation to cytoskeletal structure between LL-BFR and HL-RE.

METHODS: Eighteen strength-trained males and females (24±3 years) performed 9 weeks of lower body strength training (2-3 exercises, 3/week) with either LL-BFR (30-15-15-15 reps, 30-60% of 1RM, n=10) or HL-RE (4 x 8 reps, 75-90% of 1RM, n=8). Five days after the last session, participants performed an additional LL-BFR or HL exercise session to assess acute responses. Biopsies from vastus lateralis were collected before and after 9 weeks of training and at 2, 24, and 48 hours after the acute exercise sessions. The αB-crystallin levels in the cytosolic and cytoskeletal fractions were analyzed by Western blotting and immunohistochemistry on cross-sections. The cross-sections were counterstained for fiber type.

RESULTS: The αB-crystallin staining intensity in type I and II fibers did not change from before to after the training period. In the acute experiment, staining intensity of αB-crystallin was increased 2 hours after exercise; similarly in both groups in type II fibers (50-90% $p<0.05$), but in type I fibers staining intensity tended to increase more in LL-BFR than in the HL-RE group (92±72% vs 34±43% respectively, $p=0.08$). The αB-crystallin levels increased in the cytoskeletal fraction 2 hours after exercise in both groups ($p<0.05$), and this was mirrored by non-significant reductions in the cytosolic fractions (3-11%). The αB-crystallin levels in both the cytosolic and cytoskeletal fractions were not different between groups at any time point. Two hours after exercise, the increased αB-crystallin staining intensity correlated with the increase of αB-crystallin in the cytoskeletal fraction ($r=0.69$, $p<0.05$).

CONCLUSION: Acute resistance exercise with both LL-BFR and HL-RE induced translocation of αB-crystallin from the cytosolic to cytoskeletal structures and subsequent accumulation in the cytoskeletal structure. However, αB-crystallin accumulation in type I fibers tended to be higher with LL-BFR than HL-RE. Our results suggested that LL-BFR can yield muscle cellular stress comparable to that elicited by HL-RE in trained individuals. Finally, the αB-crystallin levels did not seem to be up-regulated by either LL-BFR or HL training for 9 weeks.

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EFFECTS OF STEPWISE LOAD REDUCTION RESISTANCE TRAINING ON POWER PERFORMANCE AND MUSCLE STRENGTH: A PILOT STUDY

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INTRODUCTION: A previous study described a new training concept, "stepwise load reduction training", which starts at high and gradually decreases the exercise load (Ozaki et al. 2022). However, fatigue levels may be high due to the stepwise-to-exhaustion protocol. Therefore, it is possible that reduction in load without repetition to failure may improve power. The present study examined the effects of stepwise load reduction (SLR) resistance training on power performance and muscle strength.

METHODS: Nine participants (six men, two women, one drop-out) were randomly assigned to one of three training groups: high-load (HL [n = 3]); SLR [n = 3]); or low-load (LL [n = 2]). Exercise training was performed twice per week for three weeks. Resistance training for each group comprised the following: HL, three sets of five repetitions (rep[s]) at 85% one-rep maximum (1RM); SLR, three sets of two reps at 85% 1RM, two reps at 75% 1RM, and two reps at 55% 1RM; and, LL, three

sets of eight reps at 55% 1RM. The rest interval between sets for all groups was 3 min. The exercise consisted of free weight bench press. Participants performed a bench press 1RM test, bench press maximal isometric muscle strength (maximal voluntary contraction [MVC]), and bench-press throw (50% 1RM) at baseline and after each training program. Total exercise volume was matched across the three groups.

RESULTS: MVC increased by 0.4% in the LL, 6.8% in the HL, and 5.3% in the SLR groups. Bench throw demonstrated higher improvement in the SLR compared to the LL and HL groups (SLR = 9.9%; LL = 1.1%; HL = 2.1%).

CONCLUSION: Results suggested that three weeks of SLR resistance training was effective in improving muscle strength and power for bench press exercise.

EFFECTS OF DIFFERENT EXERCISE DURATION ON SALIVARY IGA SECRETION AND SECRETORY REGULATING FACTOR

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INTRODUCTION: Prolonged exercise such as marathon induces a transient decrease in oral immune function through reduced salivary immunoglobulin A (IgA) secretion, leading to an increase in the risk of developing upper respiratory tract infections. Saliva flow rate decreased by sympathetic nervous activity is involved in the reduction of salivary IgA secretion rate after an acute exercise bout. However, the effects of different exercise duration on salivary IgA secretion and secretory regulating factor remain unclear. We aimed to investigate the changes in salivary IgA secretion and secretory regulating factor before and after an acute exercise bout at different exercise duration.

METHODS: Twelve healthy young males with no exercise habits participated in this study. Subjects performed three exercise durations in a randomized crossover order: moderate-intensity continuous cycle exercise (55% maximal oxygen uptake [VO2max]) for 30 min, 60 min, and 90 min. Saliva samples were collected at baseline, immediately after, and 60 min after each exercise duration. The salivary IgA secretion rate was calculated from saliva flow rate per minute and salivary IgA concentration measured by ELISA. As a regulating factor for the reduction of saliva flow rate by acute exercise, salivary levels of cortisol released via the regulation of the adrenocortical system was measured by ELISA. The effect of different exercise duration was determined by using two-way repeated measures ANOVA. The relationship between change in salivary IgA secretion and change in salivary cortisol concentration was determined using Pearson's correlation coefficient. A significance level in statistics set at $P < 0.05$.

RESULTS: The significant changes in saliva flow rate and salivary IgA concentration were observed as the main effect of time (respectively, $P < 0.05$). The change in salivary IgA secretion rate immediately after exercise in an exercise duration for 90 min was significantly lower than that of 30 min ($P < 0.05$). The change in salivary cortisol concentration did not change significantly at the time course of each exercise duration. However, there was a significant negative correlation between the change in saliva flow rate and the change in salivary cortisol concentration before and immediately after exercise ($r = -0.63$, $P < 0.01$).

CONCLUSION: These results suggest that the salivary IgA secretion rate is reduced by exercise at 55% VO2max exercise intensity for longer than 90 min, and hence the decreased saliva flow rate via the increase in cortisol secretion may be a related factor of the decrease in salivary IgA secretion rate.

DOES MENTAL FATIGUE AFFECT REACTION TIME IN ATHLETES?

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INTRODUCTION: Mental fatigue (MF) has been defined as a psychobiological state caused by prolonged periods of demanding cognitive activity and characterized by subjective sensations that are felt with the semantic expression of "fatigue" or "lack of energy" (Boksem & Tops, 2008; Van

Cutsem et al., 2017)). However, mental fatigue plays a role in endurance athletes (Meeusen et al., 2021), while the impact of mental fatigue in motor task as reaction time (RT) to visual stimuli remains largely unknown.

METHODS: For this aim, 45 athletes (age 29.18±3.25 y) took part in this study. MF was induced by a routine of 15 minutes of Stroop Task (PsyTool),

with 600 tasks and 5 different colors choice. Heart rate (HR) was recorded with Cardio-Polar H7 in pre-Stroop-Test, during Stroop-Test

(every 5'), post-Stroop-Test and 1', 3', and 5' after post Stroop-Test. While RT was evaluated in pre and post Stroop-Test with a Cognitive

Fun software. The variables considered were HR (bpm), RT on Pre-Stroop-Test (RTPR), RT on Post-Stroop-Test (RTPO). Univariate ANOVA

and Bonferroni Post-hoc were used to compare HR in-between conditions and t-test to compare the RT performance before/after StroopTest. The significance level was fixed at priori as $\alpha < 0.05$

RESULTS: Analysis of variance (ANOVA) for HR showed a Fischer value of 6.051 and $\eta 2 = 0.101$ with $p < 0.001$; while the post-hoc showed a significant

difference (p<0.05) during the Stroop-Test (HR was 36.58±5.40, 40.31±6.36 and 42.87±7.36 %HRMAX at the 1st 2nd 3rd point, respectively) compared to the other conditions. RTPR and RTPO was 310.29±38.34 and 334.12±38.79 ms, with p=0.0029, respectively

CONCLUSION: The present findings suggest that the parasympathetic branch of the autonomous nervous system functioning as a relaxation system tends

to be activated under increasing mental fatigue with a decreased performance (RT). Therefore, the athletes could use MF induced during

the training to improve the time delay related to the motor task.

These data have numerous implications. In the first place, it suggests how MF has a direct relationship to the RT and how its alteration can

become a determining factor in sports performance. Secondly, it suggests that the detection of HR can be used as a verification marker of

mental fatigue, in the absence of physical fatigue.

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DOES PRIOR MENTAL FATIGUE AFFECT SUBJECTIVE MEASURES DURING AND AFTER A CYCLING TIME TRIAL?

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INTRODUCTION: Mental fatigue (MF) can manifest itself in a subjective, physiological and a behaviorally manner, and can negatively impact physical performance [1]. A multitude of studies have investigated perceived effort during exercise in a mentally fatigued state [1]. However, investigating additional subjective measures of fatigue during exercise is essential to understand how MF affects performance. Therefore, we aim to examine how MF affects perceived effort, mental and physical fatigue during a 15-minute cycling time trial in a mentally fatigued state.

METHODS: Current results are part of an ongoing randomized cross-over trial. 51 participants (M/F=26/25; MeanAge =30 ± 8 y; BMI; 22.6 ± 2.5) visited the lab for three trials (familiarization, intervention and control). MF was induced with a 45-minute individualized STROOP task while the control trial consisted of watching a documentary. Directly after each condition, participants completed a 15-minute cycling time trial. The rate of perceived effort (0-100 RPE scale), physical fatigue and MF (0-100 scale) were monitored at the start, during (every 3 minutes) and at the end of the time trial. A two-way repeated measures (2x7) ANOVA was employed to test changes between conditions over time of each measure separately. Significant interaction effects were followed-up with paired T-tests.

RESULTS: For perceived MF, an interaction between condition and time (F=15.5, P<0.001, effect size=0.237) and a main effect of condition (F=19.4, P<0.001, effect size=0.280) were found. At the start of the time trial, perceived MF was significantly higher in the MF condition vs. control condition (MF=36.5 ± 23.9; CON = 18.4 ±15.3; t=5.664; P<0.001). Between the start and 12th minute, perceived MF decreased in the MF condition (MeanDifference= -7.29) whereas an increase was found in the control condition (MeanDifference = 7.22). Perceived physical fatigue and effort increased over time for both conditions, but only physical fatigue revealed a main effect of condition with higher scores in the MF condition (F=4.2, P=0.046, effect size=0.820).

CONCLUSION: Preliminary results show that a 45-min individualized Stroop task induced a higher MF perception before, during and after a 15-minute cycling time trial. In the MF condition, exercise decreased perceived MF over time, which reflects positive effects of exercise on MF. Physical fatigue was negatively affected by MF, possibly reflecting a separate working mechanism of MF on effort and physical fatigue perception. Future studies should further explore the underlying mechanisms of MF during exercise by relating subjective to physiological fatigue measures.

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DO GENDER DIFFERENCES IN PERFORMANCE FATIGABILITY EMERGE AFTER NEUROMODULATION WITH THETA BURST STIMULATION?

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INTRODUCTION: Sex-based differences in performance fatigability have been observed frequently, with females generally showing a greater fatigue resistance than males, but the responsible mechanisms are not completely understood. This study aimed to examine the events that might underlie the effect of biological sex on the neuromuscular components of

fatigue and corticospinal excitability elicited by elbow flexion task after different protocols of theta burst stimulation (TBS) applied on the motor cortex of the biceps brachii.

METHODS: During three experimental sessions, one for each TBS protocol (facilitatory, i.e. intermittent: iTBS; inhibitory, i.e. continuous: cTBS, and sham TBS), participants performed maximal and submaximal isometric contractions. Performance was measured with time to task failure (TTF). Changes in maximal voluntary contraction (MVC), voluntary activation (VA, central fatigue), and potentiated twitch force at rest (Qtw,pot, peripheral fatigue) from pre to post-exercise were determined via the interpolated twitch technique in thirty young healthy subjects (15 males; 15 females). Corticospinal excitability, reflected by the area and silent period (SP) of each motor-evoked potential (MEP), was assessed before and after both TBS, and the isometric sustained TTF (35% MVC).

RESULTS: More fatigue resistance in females than in males during the fatiguing task was detected (F:~233±40 vs M:~159±38 s; P<0.05), although the duration of TTF after the three TBS protocols changed equally in both groups (P>0.05) Moreover, after verifying the effectiveness of the three TBS protocols within each group, no sex differences were observed in VA, MEPs, and SPs (P>0.05). Similarly, MVC and Qtw,pot were not influenced by any TBS protocols, nor sex differences were observed (P>0.05).

CONCLUSION: Comparable alterations during the TTF emerged due to TBS protocols in both groups, although confirming greater fatigue resistance in females than males. Furthermore, iTBS and cTBS seem to influence central fatigue and corticospinal excitability, reducing and increasing them respectively, in males and females equally. Thus, this study suggests the possibility to alter fatigue and performance in both males and females, enhancing neuromuscular adaptations or offsetting them in both groups.

THE IMPACT OF EXHAUSTIVE EXERCISE ON BRAIN ACTIVATION AND EXECUTIVE FUNCTION

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INTRODUCTION: Elite athletes are thought to exhibit superior visual processing and executive control. To ensure high performance, athletes should have a high level of executive function such as attention, judgment, and information processing during exercise. However, little is known the effect of exercise-induced fatigue on brain function. The aim of the present study was to investigate the impact of exhaustive exercise on executive function and brain activation.

METHODS: Nineteen young men participated in this study (30 ± 3 yrs). The participants conducted incremental exercise until exhaustion. The brain activation during Stroop task using functional magnetic resonance imaging (fMRI) before and after exhaustive exercise. We evaluated the Stroop interference as an index of executive function. Visual analog scales (VAS) of fatigue and arousal as an index of subjective condition before, immediately after exhaustive exercise, and after MRI task. The participants were divided into two groups: impaired executive function with prolonged interference time group (impaired group) and enhanced executive function with shortened interference time group (enhanced group).

RESULTS: The Stroop interference time was significantly prolonged in the impaired group and shortened in the enhanced group. There is no difference in maximal oxygen consumption, ventilation, heart rate, and time to exhaustion during exercise between the impaired and enhanced group. The impaired group exhibited a significant increase activation of meddle frontal gyrus region, whereas brain activation did not change before and after the exhaustive exercise in enhanced group. The VAS of fatigue score increased immediately after exhaustive exercise in both groups and decreased after MRI task only in the enhanced group. The VAS of arousal score decreased after MRI task in the impaired group, whereas it did not change in the enhanced group.

CONCLUSION: We demonstrated that delay of fatigue recovery and decrease in arousal status induced by exhaustive exercise increased activities of the middle frontal gyrus and slowed executive response. The findings of the present study suggest that the changes in subjective conditions including fatigue and arousal status and brain activation pattern may be contributed to impair executive function.

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CP-AP07 Performance analyses in Sports

PERFORMANCE ANALYSIS OF AN ELITE-LEVEL E-CYCLING COMPETITION

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INTRODUCTION: E-cycling is an emerging discipline that became particularly popular during the COVID-19 pandemic [1]. Despite the increasing interest of national and international federations, the performance-specific characteristics of a high-level E-cycling competition remain to be elucidated. In the present study, we evaluated the performance and characteristics of athletes competing in the first French national championship of E-cycling.

METHODS: The competition took place in February 2023 in an indoor stadium with 46 participants, which was the largest face-to-face E-Cycling event ever organized. The event was performed on the Zwift platform (https://www.zwift.com). The

cyclists used their own bike and the same power trainer (Wahoo KICKR V6, Wahoo Fitness, Atlanta, United States). They were divided into categories A, B or C based on their past performance, and competed in two races (22 km and 21 km), separated by 15 min. For the present study, we analyzed the performance of seven male athletes competing in the first category (A, 66 ± 6 Kg, 1.75 ± 0.03 m, 31 ± 12 years old) and seven male athletes competing in the second category (B, 72 ± 5 Kg, 1.77 ± 0.05 m, 45 ± 11 years old). We compared personal best records of 15 s, 5 min and 20 min over the last 3 months (virtual) and the percentage of their personal bests during the races.

RESULTS: Personal best records normalized to body mass were greater for category A than category B athletes (15 s: 12.7 ± 2 vs. 9.8 ± 1.9 W/kg; 5 min: 5.5 ± 0.6 vs 4.6 ± 0.4 W/kg; 20 min: 4.8 ± 0.4 vs 4.1 ± 0.3 W/kg; all $p < 0.05$). Work was greater in race 1 (7.3 ± 0.7 kJ/kg) than race 2 (5.4 ± 1.6 kJ/kg, $p < 0.001$) and in category A (7.0 ± 1.0 kJ/kg) than category B (5.8 ± 1.7 kJ/kg, $p = 0.03$). Performance that was expressed as percentage of the personal best showed no effect of category for all time intervals considered. Lower performance was systematically observed in race 2 over a period of 5 min (95 ± 8% vs 85 ± 8%, $p = 0.004$) and 20 min (92 ± 9% vs 83 ± 6%, $p = 0.001$) but not 15 s (83 ± 14% vs 74 ± 11%, $p = 0.09$).

CONCLUSION: Overall, performance during the second competition was lower compared to the first one. This was probably due to the effect of fatigue cumulated in the first competition which can affect the ability to produce high levels of power output. Athletes in category A were younger and showed better performance than category B athletes, both in terms of personal bests and performance during the race (work). However, the two groups showed a similar performance during the races when expressed in percentage of their personal bests measured in similar conditions (E-cycling). These results could be useful to inform coaches and E-cycling race organizers.

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PERFORMANCE ANALYSIS OF WOMENS EPEE IN THE 2017-2019 WORLD FENCING CHAMPIONSHIPS

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INTRODUCTION: Various factors can impact how fencers score, including the use of techniques in different locations of the piste, and different rounds and status (leading, even, or losing) of the match. Performance analysis in sports, especially on elite players, could provide insights on how to win a match as well as how to design the training to improve the performance.

METHODS: This study examined the performance of elite female epee fencers during the matches from top 16 to final in 2017-2019 world fencing championships (including 1840 scoring events from 90 fencers in 45 matches) using notational analysis on videos downloaded from official website of the International Fencing Federation (FIE) in YouTube. Three- or two-way repeated measures ANOVAs were used to investigate the effects of aforementioned factors and their interactions, and three- or two- way mixed-design ANOVAs were used to further examine these effects of winners and losers respectively.

RESULTS: Fencers scored the most at the 2nd round during the match, replicating the previous findings. This might reflect that they became more aggressive only after they were familiar with the profile of the opponent that they obtained from the 1st round. When the winner was Whereas in the end area, attack, counterattack, and defensed were all used more often than other skills. Conversely, there were no specific techniques used at any area of the piste for loser no matter in leading or losing status. These results show that winners had their own strategies to use specific techniques on specific location of the piste for specific situations to achieve the final victory. leading in the match, the piste of her own side was the main area she moved and scored. Specifically, in the central area, attack was used more often than defense and other skills. In the middle area, attack and counterattack were used more often than defense and other skills.

CONCLUSION: In sum, our findings provide empirical evidence of how elite fencers manipulate their techniques on the piste to create and maintain leading status till the final victory. Such information could be useful to coaches for designing training program and giving suggestions to fencers during the match.

SINGLE AND MULTI-PUNCH PERFORMANCE ANALYSIS IN BOXING

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INTRODUCTION: Boxing is a combat sport where hitting the opponent with quality blows and demonstrating fight dominance is key to claiming victory. Research has shown that in boxing, though the total number of punches were similar, winners had a higher ratio of effective punches and a lower ratio of air punches than losers [1]. Attacks can be performed as a single- or a multi-punch combination. Due to the high fitness demand of the multi-punch combinations, we hypothesized that the number of multi-punch combinations would be reduced over the progression of the rounds, and winners would have more multi-punch combinations than the losers. The study was to examine the effects of the round and outcome of the bouts on the attacking performance.

METHODS: Eight bouts of the quarterfinals of the 71kg division from 2021 AIBA (Association Internationale de Boxe Amateur) Men's World Boxing Championships were analyzed. Two observers used the Simi Scout notational analysis system to record timing of all punches for each boxer. All recorded punches were further separated into single punch and multi-punch based on the recorded intervals between punches. Cohen's Kappa for the average inter- and intra-observer relia-

bility tests were 0.74 and 0.77. The total number of attacking movement, single punch, and multi-punch combinations were analyzed using round (3) × outcome (2) repeated measure ANOVA.

RESULTS: There was a significant round effect on the number of single punches $F(2,14)=4.05$, $p=.04$, with decreasing values over the 3 rounds, (24.19, 19.50, 18.88). The outcome effect on the number of single punches was not significant, $F(1,7)=7.48$, $p=.06$, with a lower mean value for the winners (17.2) than the losers (24.5). For the number of the multi-punch combinations, the outcome effect was not significant either, $F(1,7)=4.83$, $p=.06$, with a higher mean value of 22.2 than the loser's 17.3. The round effect was not significant, $F(2,14)=2.23$, $p=.14$. For the total number of attacking movement, although the effect of the round did not reach the significant level, $F(2,14)=3.10$, $p=.08$, the mean values showed a decreasing trend over the 3 rounds (44.3, 41.3, 36.3). There was no outcome effect on the total number of attacking movements, $F(1,7)=0.38$, $p=.56$.

CONCLUSION: Boxers performed fewer single punch attacks as rounds progressed, whereas multi-punch combinations did not vary significantly. Although the statistical analyses for the outcome variable did not quite reach the significant level (ps = 0.6), with the large effect size (partial eta squared ≥ 0.41), the results seem to suggest that winners had more multi-punches and less single punch attacks than losers. More data from boxing bouts should be recorded and analyzed to substantiate the current findings.

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DETECTING PUNCHES FROM MULTI-VIEWS VIDEOS DATA FOR PERFORMANCE ANALYSIS IN ELITE BOXING

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INTRODUCTION: The quantification of punches thrown and received by a boxer is a key performance indicator to assess boxing activity [1]. More than a scoring factor, hit quantification allows to evaluate the physical load endured, which is essential for injury prevention [2]. Manually counting punches is a tedious and time-consuming annotation workload. To overcome this challenge, we have developed an automatic method for punch recognition from videos.

METHODS: To build our training dataset, we recorded 21 rounds of 3 min between elite boxers with 11 synchronized and calibrated cameras (Qualisys Miqus 60 fps, Full HD) distributed around the ring. For each point of view, we used a 2D pose estimator [3] to extract the body joint positions of both boxers at each frame in image coordinate system. The 2D skeletons are tracked and triangulated to avoid 2D issues (i.e. occlusions, depth estimation). In addition, 2508 punches were manually annotated at the exact frame of impact. We designed a temporal Convolutional

Neural Network [4] with Long Short Term Memory architecture to integrate spatial and temporal features tied to the action. The model outputs a hit probability for each frame throughout the video which allows to identify punch events with a 25 frames buffering sequence.

RESULTS: We obtain an accuracy of 93.2% and an F1-score of 93.3% on our validation set. Our model's predictions showed a significant impact of parameters like the number of joints and the sequence length. For each boxer, our model creates a playlist containing video clips of all the detected punches. It can be used for a first analysis by coaches, and will help us to expand our dataset. Based on fist speed, we also identify which of the boxer's arms is used to deliver the punch which gives additional qualification of the punches (unknown beforehand).

CONCLUSION: Our model quantifies punches thrown and received by a boxer with a good accuracy from multi-views feed. However, some detection errors persist due to specific gestures such as feints and combinations. Future work will focus on enriching our analysis by performing strike classification (i.e feints, hooks, jabs, uppercut), improving the model accuracy and deploying this approach inside the French Boxing training center. We aim to couple this automatic strike detector with more features such as impact zone or fist acceleration magnitude.

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YOUNG PERFORMANCE DETERMINES THE ADULTHOOD PERFORMANCE ? A PARAMETRIC AND NON-PARAMETRIC MARKOVIAN MULTI-STATE DEVELOPMENT MODEL IN FRENCH ALPINE SKIING

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IRMES

INTRODUCTION: Estimating the potential of alpine skiers is an unresolved question, especially because of the complexity of sports performance. Yet, an unsolved question is : the best performers at young age will be the best ones when they get older ? Our study aims to objectify this problem and to determine the influence the rate of progression on skier's future performance.

METHODS: The population studied included all French alpine skiers having participated in at least one competition in Slalom (GS), between the age of 10 up to 30 from the 2004/2005 season up to the 2020/2021 season. We categorized the states of the model by five Performance Lanes (PL), defined as a categorisation of performances by age group .We modelled and estimated the probabilities of performance progression among French alpine skiers in slalom using parametric and non-parametric multi-state Markovian models and a time-inhomogeneous Markov chain to calculate future PL probability. , We calculated the rate of individual performance progression based on a Bayesian nonlinear mixed model and we estimated the impact of this rate of progression on the skiers future PL.

RESULTS: The probability to be the first PL (PL1, i.e highest performance by age) at 20 years old is rather similar among the skiers who were at the first or the last PL at 10 years old. These probabilities are more heterogeneous with age. The probability to reach the PL1 at 20 years old according the PL 1,2,3,4 and 5 at 15 years old are 0.13, 0.07, 0.04, 0.02, 0.01 respectively. At 12 years old, the rate of progression is a better estimator of future performance at 20 years old than the PL the skier is.

CONCLUSION: We show that at the youngest age , the probability difference for reaching the highest PL according to the starting PL are rather similarMeaning that performance at the youngest age are not a good predictor of future performance. Yet, such difference increases with age. We also showed that the rate of progression among the youngest is a better predictor of future performance than the skiers PL.

INFLUENCE OF NEUROMUSCULAR ACTIVITY AND TECHNICAL DETERMINANTS ON ROWING PERFORMANCE

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INTRODUCTION: Studies (1) have described the relationships between technical determinants and rowing performance (defined as cycle-average boat velocity and power transferred to the oar), as well as activation patterns of upper body muscles (2,3). However, the dependence of rowing performance to muscle coordination has not yet been investigated. Knowing how muscle activity influences rowing performance could provide valuable information to trainers. The purpose of this study was to correlate rowers' performance i) with the neuromuscular activation of upper body muscles and ii) with the main technical determinants of rowing on water.

METHODS: Eleven male rowers performed three bouts of 15 strokes on a single scull at their own competitive stroke rate (32.8±2.3spm). Boats were equipped with Peach system (Peach Innovations, UK), collecting oar's forces and angles as well as boat velocity. Subjects were equipped with surface EMG (Trigno, Delsys, USA) to measure 13 trunk and arm muscles. Normalized EMG RMS were calculated over eight equal intervals of the drive phase. Linear mixed effect models were fitted to investigate the effects (i.e. the amount of performance explained by the linear model using the group average value of the predictor) of technical determinants and the neuromuscular activity in each interval of the drive phase on the rowers' performance.

RESULTS: All intervals in the drive phase had at least one muscle whose activity was significantly correlated to boat velocity and oar power. For example, during the first interval after catch, 11 muscles had a significant effect on velocity (highest effect: 0.11m/s flexor carpi; average trunk flexors (TF): 0.08m/s; average trunk extensors (TE): 0.04m/s); and six with oar power (highest effect: 39.1W biceps brachii; TF: 22.6W; TE: not significant). For the interval between 50 and 62.5% of the drive phase, i.e. during the peak power interval, 8 muscles had a significant contribution to boat velocity (highest effect: 0.07m/s brachioradialis; TF: 0.06m/s; TE: -0.05m/s) and 9 to oar power (highest effect: 34.2W gluteus maximus; TF: -22.0W; TE:24.4W). The largest effects of technique on boat velocity were: 2.4 m/s for the oar stroke min-to-max angle; 1.0 m/s for oar power and -0.4 m/s for time to peak oar power.

CONCLUSION: We evaluated the relationship between muscle activity and boat velocity for 13 muscles in the upper body. Increased activations in arm muscles and trunk flexors immediately after catch had a positive effect on boat velocity and oar power, indicating a more efficient power transfer to the oars. On the other hand, at mid drive phase, increased trunk flexors and reduced extensors activations were associated to higher velocities, but lower oar powers. This might indicate that techniques that maximize power production might not be the ones that maximize velocity.

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CLASSIFICATION OF MIDDLE- AND LONG-DISTANCE RUNNERS BASED ON THEIR COMPETITION RESULTS

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INTRODUCTION: The scientific literature lacks consensus on classification of middle- and long-distance runners. Many terms are used to describe the proficiency level of athletes. This creates situations where the sample studied may not represent the target population and could produce misleading results. Thus, we present an approach for a data-driven classification of middle- and long-distance runners according to their competition results.

METHODS: The best annual results of middle- and long-distance track runners participating at major (Olympics, World and European Championships) and national championships (Denmark, Sweden, Finland, Norway) were gathered for the

2012–2018 period. The results were grouped accordingly. Quadratic discriminant analysis was applied to define the limits between the groups.

RESULTS: Three basic categories could be proposed for classification: world class, international and national. The performance-based approach for classification provide value necessary for population descriptions in scientific research and elsewhere. Classification provides a realistic overview on performance standards and the number of athletes for different categories in middle- and long-distance track running in real-world settings.

CONCLUSION: The developed classification has the potential to improve the quality of scientific research and has applications in the effective planning of anti-doping testing. The present classification may further require regular upgrades to meet the demands of the constantly changing sport.

PACE STRATEGY IN THE 1500M SWIMMING IN TOKYO 2021

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INTRODUCTION: The ideal pace strategy (PS) in competitive long-distance swimming is not widely known in the literature but in generally is represented by U-shaped curve(Lara and Del Coso, 2021), indicating that professional long-distance swimmers have a fast pace in the first 100m and again another fast pace in the final meters of the race, while most of the entire race they keep the speed constant with small fluctuations. Nevertheless, there is no agreement on how the pace strategy determines the winners in a 1500 m competition, thus, the aim of this study is to analyze the performance of Olympic Games finalists in the mens 1500-meter freestyle race over the last Olympic games in Tokyo 2021 and identify the pace strategy most used by the best swimmers in the 1500 m.

METHODS: The sample of the study was collected from public data files available at FINA (Fédération Internationale De Natation) website(www.fina.org). Lap times (every 50 m) of the athletes (n = 8) finalists of the Olympic Games Tokyo 2021 were used in this study. To evaluate the athletes pace strategies, descriptive statistical analysis of the laps was done (mean, standard deviation, coefficient of variation) together with boxplots of the laps. T-test evaluate the difference from the first third of the race to the second and final third of the race (500m splits), Wilcoxon-Signed Ranks test was performed when the data did not present a normal distribution. The times at each 250 m were also compared with the following split times (250, 500, 750,1000,1250, and 1500 m), to assess which sections of the race were statistically different. The Friedman test with Bonferroni post hoc correction was used for $p < 0.003$. These tests were run on SPSS 27 software.

RESULTS: The results found were a parabolic race strategy (U-shaped) performed by all athletes, where the partial velocities as a function of time show an acceleration at the beginning of the race (250 m) followed by a maintenance of the speed in the middle part of the race (250 to 1250 m) and finally an increase in their accelerations in the final part of the race (1250 to 1500 m) characterizing a final sprint.

CONCLUSION: From the data analyzed it was identified U-shaped curve pace strategy profile used by all the athletes analyzed in this study. Most likely the fast pace in the beginning is related to the use of starting Blocks (diving start). A plausible explanation for athletes to assume a slower rhythm after some meters is related to a model of tele-anticipation, where the swimmer wants to save energy so that afterwards a final sprint can be performed.

From the practical aspect the U-shape PS is the best strategy so far (as we know) and should be used in training to improve performance of young athletes.

Some limitations of the study, only finalist were analyzed, so maybe different PS can be adopted in other heats before the finals.

Stroke rate and stroke length was not measured, this may help to understand whats within the PS in long distance events.

Conventional Print Poster

CP-MH20 Health and Fitness II

LONGITUDINAL DATA ANALYSIS INVESTIGATING THE INTERELATIONSHIP BETWEEN AIR POLLUTION, LUNG FUNCTION, AND THE ROLE OF PHYSICAL ACTIVITY AND ASTHMA STATUS IN CHILDREN AGED 5 - 18 YEARS.

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INTRODUCTION: Children are more susceptible to air pollution due, at least in part, to their less developed respiratory systems and higher respiratory rates. Whilst the health benefits associated with physical activity are indisputable, there is considerable debate regarding whether the increased exposure to, and deeper inhalation of, air pollution while being physically active negates such health benefits. The purpose of this study was to explore the relationship between air pollution and lung function, and the role of asthma status and physical activity in this relationship, in children and adolescents across different seasons throughout the year.

METHODS: A 9-month longitudinal study was conducted with 18 children (7 boys), 6 with a history of asthma. Seven-day, device-based physical activity levels were measured alongside spirometry and 30 day air pollution levels. Specifically,

outdoor air Pollution data (PM2.5 - PM10, NO2, and O3) was gathered from the Automatic Urban and Rural Network (AURN) whilst indoor air pollution data was collected using Dylos monitors (PM2.5 - PM10). Time series analysis were used to assess the temporal associations between lung function, physical activity and air pollution.

RESULTS: Children's physical activity levels were greatest during rush-hour and break-times, therefore, amplifying their exposure to air pollutants. However, no relationship between air pollution and lung function was found, irrespective of physical activity levels or timing.

CONCLUSION: The current results contrast previous findings of a three day lag in the relationship between air pollution and lung function. This may indicate that the influence of air pollution is lower in youth populations, or that the exposure to air pollution in the current study was relatively low. The lack of influence of physical activity is encouraging, suggesting that the benefits of physical activity are unabated by air pollution exposure, at least in terms of lung health.

EFFECTS OF NORDIC WALKING TRAINING ON FUNCTIONAL STATUS, PERCEIVED FATIGUE, AND QUALITY OF LIFE IN PEOPLE WITH MULTIPLE SCLEROSIS

LIBERALI, G.1, PEYRÉ-TARTARUGA, L.A.2, CORREALE, L.1, MARTINIS, L.1, DELL'ANNA, S.1, PASSOS-MONTEIRO, E.3, FEIJÓ-MARTINS, V.2, MACHADO, F.A.4, TAVAZZI, E.5, BERGAMASCHI, R.5, BUZZACHERA, C.F.

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INTRODUCTION: Multiple sclerosis (MS) is a chronic neurologic disease of the central nervous system. The clinical manifestations of MS are well documented and include sensory, motor, cerebellar, or visual system abnormalities. Pharmacologic approaches are commonly used to manage such symptoms experienced by persons with MS. Non-pharmacologic interventions, such as exercise training, are also helpful as behavioral approaches for managing clinical manifestations of the disease with minimal side effects. Nordic Walking (NW) has recently emerged as a safe and effective non-pharmacologic intervention for patients with neurologic disease and consists of walking with hand-held poles. Despite their growing popularity, the effects of NW have not been examined in the MS population. Therefore, the aim of this study was to investigate the effects of an 8-week NW training intervention on measures of functional status, perceived fatigue, and quality of life in people with MS.

METHODS: A group of men (n = 4; mean age: 40 ± 10 yrs.; mean BMI: 22.9 ± 2.7 kg.m2) and women (n = 5; mean age: 38 ± 4 yrs.; mean BMI: 24.4 ± 2.7 kg.m2) with definite relapsing-remitting MS participated in this quasi-experimental study. Key eligibility criteria included age 18-60 yrs. and EDSS score <4. All participants trained twice a week for 8 weeks, and before and after the intervention period, measures of aerobic endurance (two-min walk test), upper- (handgrip) and lower-body (30-sec chair stand test) muscle strength, gait speed (10-m walk test), and overall functional mobility (timed up and go test) were tested. Fatigue perceived and quality of life were also assessed using the Italian versions of the Modified Fatigue Impact Scale (MFIS) and the MS Quality of Life Questionnaire (MSQOL-29). Data were analyzed using paired t tests with the alpha level set at 0.05.

RESULTS: All participants completed the training program, with an adherence rate > 80%. Following the NW training regimen, upper-body muscle strength, gait speed, and overall functional mobility remained unchanged from baseline values ($P > 0.05$). However, significant improvements were observed for both lower-body muscle strength ($t8 = -4.919$; $P < 0.01$) and aerobic endurance ($t8=-4.944$; $P < 0.01$). A trend for improved perceived fatigue was also noted ($P = 0.09$), while the quality of life did not change over time ($P > 0.05$).

CONCLUSION: According to the results of this study, it seems that an 8-week NW training intervention may have positive effects on aerobic endurance and lower-body muscle strength, with plausible benefits on perceived fatigue. Although preliminary, such findings might have important clinical implications for the management of MS.

EFFECTS OF 3-MONTH AEROBIC EXERCISE AND TAI-CHI CHUAN EXERCISE INTERVENTIONS ON MOTOR AND NON-MOTOR FUNCTIONS IN PARKINSONS DISEASE: A PRELIMINARY STUDY

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INTRODUCTION: Parkinson's disease (PD) is a progressive, neurodegenerative disease with the characteristic of movement disorder (e.g., balance and gait problems) and non-motor symptom (e.g., cognition impairment). Exercise plays an important role in PD management and the improvement in motor status and cognition function through physical activity has been highlighted in recent studies [1, 2]. The aim of this study was to compare the different effects of Tai-chi chuan and aerobic exercise on the clinical motor status and neurocognitive performance in patients with PD.

METHODS: Twenty-eight participants with early-stage PD were recruited and randomly divided into three groups: aerobic exercise (AE), Tai-chi chaun exercise (TE), and control (C) groups. During the 3 months of the intervention period, participants in the AE group attended three 30-minute exercise sessions per week, with the exercise intensity corresponding to 50-65% of the individual target heart rate reserve. The TE group were trained in a series of 60-minute sessions that took place two times per week. The C group maintained their sedentary lifestyle. Participants' clinical motor performance was examined using Unified Parkinson Disease Rating Scale (UPDRS). Neuropsychological [e.g., accuracy rate and reaction times (RTs)] and neurophysiological [e.g., event-related potential (ERP) P3 latency and amplitude] parameters were to assess their neurocognitive functions when performing a delay matched S1-S2 paradigm. To minimize the potential for a medication cycle bias, all assessments were performed during their "on" state.

RESULTS: Compared to the pre-test, the control group showed significantly smaller ERP P3 amplitude in the post-test (p=.04). Compared to pre-test, the TE group exhibited faster RTs (p=.02) while the AE group scored lower UPDRS scores (p=.006) after 3 months of exercise interventions. The ERP P3 amplitudes only approached pre- and post- intervention significance (p=.06) in the TE group.

CONCLUSION: The motor status and neuropsychological (e.g., RTs) performance could be enhanced through different regular exercise modes in patients with PD. However, the neurophysiological performance (e.g., ERP P3 amplitude) might be deteriorated when they maintained sedentary lifestyle. The present findings suggested that the neuroplasticity could still be ameliorated by chronic exercise interventions in patients with PD with stages I and II.

ASSESSMENT OF AEROBIC CAPACITY AND MUSCLE STRENGTH OF CHRONIC KIDNEY DISEASE, HEMODIALYSIS PATIENTS AND AFTER KIDNEY TRANSPLANT

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INTRODUCTION: Chronic kidney disease (CKD) is a disease process in which the function of the kidneys is impaired and leads to renal failure due to progressive nephrons destruction. The progression of this disease leads to end-stage renal disease (ESRD) and renal replacement therapy: hemodialysis (HD) or kidney transplant (KTX). The complicated clinical state of those patients strongly impacts their physical activity and exercise tolerance. Information about changes in physical capacity in CKD and KTX patients are limited, hence interventions to improve exercise tolerance are not standard care. Therefore there is a need to establish "easy to carry out" tests for health professionals and expand the knowledge of physical status in this group of patients. The study aimed to assess aerobic capacity and muscle strength in CKD and TKX patients with selected tests.

An additional aim of the study was to determine the dependence of the obtained results from the stage of kidney failure and after kidney transplantation in the examined patients.

METHODS: The study included 333 patients: 111 hemodialysis patients (stage V) - group 1; 120 patients with CKD in stages I–IV - group 2; 102 patients after a kidney transplant - group 3. The mean age was 54.7 +/- 15.6 years, divided into groups according to the stage of progression of the disease and patients after kidney transplant. In three groups, the following tests were performed: evaluation of physical activity tolerance using a six-minute walk test (6MWT), 2-Minute Step in Place Test (2MSPT), hand grip strength test (HG), sit-to-stand test (STS), timed up and go test (TUG), the assessment of subjective fatigue was determined by the Borg scale. Hemodynamic parameters were measured before and after those tests (6MWT, 2MSPT, STS, TUG). Statistical significance was determined at the level of $p<0.05$. The Statistica 13.1 was used.

RESULTS: Kidney transplant patients have a higher exercise tolerance than patients with end-stage renal disease. KTX patients have a lower tolerance for physical activity based on a 2-MSPT than patients with CKD in Stages I-IV, but contrary higher physical activity tolerance based on 6MWT. Patients in Stages I-IV of CKD have a higher tolerance for exercise than ESRD patients. There is a correlation between hand grip strength, lower limb strength and exercise tolerance in CKD and KTX patients. However, in HD patients, those results do not show any significant relationships.

CONCLUSION: A two-minute walk-in-place test can be used as an alternative to the six-minute walking test to assess exercise tolerance in CKD and KTX patients. In all groups (I, II, and III) the correlations of results of 2MSPT and 6MWT were statistically highly significant.

TEST-RETEST RELIABILITY OF CARDIOPULMONARY EXERCISE TESTING IN PATIENTS WITH ATRIAL FIBRILLATION

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INTRODUCTION: Cardiopulmonary exercise testing (CPET) is the gold-standard measure of cardiorespiratory fitness (CRF). In patients with cardiovascular disease, CPET has been used to assess the risk of morbidity and mortality, prescribe individually tailored exercise interventions, and determine the effectiveness of exercise interventions. In patients with atrial fibrillation (AF), however, the complex presentation of disabling AF-related symptoms (e.g., palpitations, dyspnea, and dizziness) combined with medications to control heart rate (HR) may influence day-to-day exercise performance. This study evaluated the test-retest reliability of symptom-limited CPET in patients with AF.

METHODS: A subset of patients with persistent and permanent AF completed two baseline CPETs on a cycle ergometer as part of a clinical trial (OPPORTUNITY). The first CPET (CPET1) was completed by cardiac stress technologists in the Department of Cardiac Imaging, whereas the second CPET (CPET2) was completed by the research team. The intraclass correlation coefficient (ICC) based on a two-way mixed-effects model was used to examine the degree of consistency between the two tests, and minimal detectable difference was calculated. The ICC was classified as follows: <0.5 as poor, ≥0.5 and <0.75 as moderate, ≥0.75 and <0.9 as good, and ≥0.9 as excellent. Paired t-tests were used to determine the systematic bias between the two CPETs.

RESULTS: Data from 27 individuals with diagnosed persistent or permanent AF (persistent: 44.4%, mean age: 69 ± 7 years, female sex: 29.6%, beta-blockers: 70.4%) were analyzed. CPETs were conducted on two separate occasions within 14 ± 11 days. The peak VO2 (VO2peak) were 18.5 ± 5.7 and 18.3 ± 5.4 mL/kg/min for CPET1 and CPET2, respectively (p=0.774). The ICC for VO2peak was excellent (ICC=0.907, 95% CI 0.792-0.958). The minimum detectable difference for VO2peak was 4.6

mL/kg/min. The ICC for peak power output (PPO, ICC=0.796, 95% CI 0.545-0.909) and highest rating of perceived exertion (RPE, ICC=0.795, 95% CI 0.389-0.931) were good but CPET2 showed significantly greater PPO (135 ± 37 vs. 174 ± 41 Watts, P<0.001) and RPE (16 ± 4 vs. 18 ± 2 points, p<0.001). Peak HR, power output and HR at ventilatory threshold showed poor ICC (i.e., <0.5).

CONCLUSION: Our result showing excellent ICC (i.e., > 0.9) of VO2peak supports the use of this measure to capture changes in CRF over time in patients with AF. When CPETs are completed by different testers, changes in CRF of 4.6 mL/kg/min may be needed to be 95% confident that observed changes in VO2peak is beyond test-retest variability. PPO is often used for exercise prescription. However, our results showed a significant difference between the two tests. Caution is warranted when prescribing exercise intensity to patients with AF based on PPO. The high variability in HR and RPE observed in this study may be due to a condition unique to AF.

EFFECTS OF INTRADIALYTIC COGNITIVE AND AEROBIC EXERCISE TRAINING IN HEMODIALYSIS PATIENTS: RANDOMIZED CONTOLLED STUDY

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INTRODUCTION: Hemodialysis (HD) patients have lower cognitive functioning and reduced physical fitness compared to age-matched healthy individuals [1,2]. Clinicians typically do not recognize the declining cognitive performance in these patients; therefore, cognitive impairment is greatly underestimated and not appropriately treated [3]. This study aimed to evaluate the impact of combining cognitive training with physical exercise on cognitive function and physical performance in HD patients.

METHODS: Using a randomized, single-blinded control design, forty-four HD patients were recruited from University Medical Centre Ljubljana. Participants were randomly assigned to either an intradialytic physical exercise and cognitive training program (EXP group; n = 22; age = 65.7 ± 9.7 years) or a standard care control group (CON group; n = 22; age = 67.2 ± 12.5 years). The EXP group performed intradialytic aerobic exercise (approximately 30 minutes of cycling) and cognitive training three days per week for 12 weeks. Cognitive training was performed on the CogniFit platform on tablets. The primary outcome of the study was performance on the Alertness subtest of the computerized Test of Attentional Performance. Secondary study outcomes were: Symbol Digit Modalities Test (SDMT), Montreal Cognitive Assessment (MoCA), 10-repetition sit-to-stand test (STS10), Timed Up and Go test (TUG), and TUG dual task.

RESULTS: At baseline, Alertness scores were 391.23 ± 117.39 ms in the EXP group and 424.41 ± 211.65 ms in the CON group (p=0.067). Alertness score decreased in the EXP group after 12 weeks (347.95 ± 93.5 ms) and increased in the CON group (454.86 ± 235.99 ms), with a significant group x time interaction (p=0.017). In addition, the results showed a significant interaction effect for SDMT (p < 0.001), MoCA (p < 0.001), TUG (p = 0.005), and TUG dual task (p = 0.006) in favor of the EXP group. Moreover, no interaction was observed for STS10 (p = 0.530).

CONCLUSION: Our findings suggest that incorporating intradialytic cognitive and physical exercise training could help to improve functional status of HD patients. The innovative, nonpharmacological, bimodal intervention is cost-effective, safe, and easy to implement during the intradialytic period and has a potential impact on patients quality of life and well-being.

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A SINGLE CHEMOTHERAPY ADMINISTRATION IS SUFFICIENT TO INDUCE MITOCHONDRIAL ALTERATIONS IN SKELETAL MUSCLE OF EARLY BREAST CANCER PATIENTS

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INTRODUCTION: Breast cancer is mainly treated with chemotherapy (CT). This treatment induces severe side effects including skeletal muscle deconditioning, characterized by structural and functional alterations that impair exercise capacity. In a recent study (1), we identified that mitochondrial homeostasis was severely impaired in patients after the whole CT treatment completion (~4 months). However, studies conducted in preclinical models also reported major acute alterations following only one CT administration (2). Identifying these acute muscle alterations in patients is necessary to provide tailored preventive strategies. Thus, this study aimed to investigate acute mitochondrial alterations in skeletal muscle of breast cancer patients after a single CT administration.

METHODS: Ten early breast cancer patients undergoing epirubicin-cyclophosphamide-based CT treatment were included. Muscle biopsies from the vastus lateralis muscle were performed before and four days after the first CT administration. Mitochondrial respiratory capacity recording and western blotting analyses were performed.

RESULTS: Four days after the first CT administration, a large decrease in mitochondrial content markers was observed, as evidenced by a decrease in both citrate synthase (-49%; p=0.04) and VDAC (-41%; p=0.02) protein levels. We also found alterations in key markers of mitochondrial dynamics. Indeed, we reported a decrease in OPA1 protein levels (-70%; p=0.02) as well as an increase in DRP1 protein levels (+139%; p=0.03), reflecting potential alterations in fusion and fission processes, respectively. We then explored the mitophagy process through the quantification of PINK1 and Parkin proteins and found substantial reductions in their expression (-63%; p=0.02 and -58%; p=0.02, respectively). As a possible consequence of these alterations, mitochondrial respiration capacity was also reduced, as evidenced by a reduction in the complex I (CI) linked substrate state (-32%; p=0.02), the oxidative phosphorylation by CI (-33%; p=0.04) and by CIV (-23%; p=0.02). Finally, apoptosis pathway might be upregulated as we documented a large increase in the Bax/Bcl-2 ratio (+3786%; p=0.03).

CONCLUSION: A single CT administration substantially decreased mitochondrial content and function in skeletal muscle of breast cancer patients. Our study emphasizes the need to implement specific preventive strategies early (i.e., from the initiation of the treatment), such as exercise training and/or nutritional supplementation.

(1) Mallard et al. Chemotherapy impairs skeletal muscle mitochondrial homeostasis in early breast cancer patients. J. Cachexia Sarcopenia Muscle (2022).

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EFFECT OF ACUTE AEROBIC EXERCISE BEFORE IMMUNOTHERAPY AND CHEMOTHERAPY INFUSION IN PATIENTS WITH METASTATIC NON-SMALL-CELL LUNG CANCER: ERICA FEASIBILITY TRIAL

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INTRODUCTION: Data suggest that exercise could improve immune responses against cancer cells by increase immune cell infiltration to the tumor and potentially having an impact on disease progression. Additionally, there are data to suggest that infiltration of T and NK cells into the tumor microenvironment is correlates with response to immune checkpoint inhibitors (immunotherapy) in patients. We have therefore initiated the clinical trial ERICA to investigate if an aerobic physical exercise performed just before immuno-chemotherapy can increase treatment efficacy in metastatic lung cancer patients.

METHODS: ERICA (NCT04676009) is a randomized controlled trial (30 patients, 2:1) for patients with metastatic non-small cell lung cancer. Patients in the intervention arm, receive a 3-month program consisting of a supervised acute physical exercise session less that 15min prior to immune-chemotherapy infusion, and an unsupervised home-based walking program with an activity tracker. All patients will also receive standard oncological treatments; checkpoint inhibitors combined with chemotherapy and physical activity and nutrition recommendations. Primary outcome is feasibility of this innovant pre-treatment physical exercise administration. Secondary outcome is muscular strength and aerobic capacity measured by VO2 sub-max test, physical activity levels and quality of life measured by questionnaires, clinical outcomes and immune, inflammatory, metabolic, oxidative stress biomarkers and molecular profiling.

RESULTS: For now, 24 patients with metastatic non-small cell lung cancer (age 63±9 years, men 71%) was included, 16 in exercise group and 8 in control group. Of the 15 patients who ended the pre-treatment exercise program, 46% (7/15) completed all the exercise session planed and 87% completed > 85% of the program. All the data will be available in April 2023 (clinical, physical and biological data).

CONCLUSION: The ERICA study will provide clinical and physiological insights into feasibility of acute exercise prior immune-chemotherapy infusion in exercise in patients with metastatic non-small cell lung cancer. Data from ERICA geared to be informative regarding immune cell mobilization after an acute physical exercise.

BREAST CANCER PATIENTS WITH CANCER-RELATED FATIGUE PRESENT SPECIFIC ELECTROMYOGRAPHIC FEATURES DURING A FATIGUING EXERCISE FROM THE TIME OF DIAGNOSIS

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INTRODUCTION: Cancer related fatigue (CRF) is one of the most burdensome symptoms along cancer treatments. From a clinical point of view, CRF management remains challenging. At diagnosis, CRF concern about 50 % of patients suffering from breast cancer. At this time, anticancer treatments cannot be responsible of this symptom, and other etiologies remain to identify. It was established that performance fatigability may be a determinant of CRF. Electromyographic (EMG) dynamic (i.e., evolution of temporal or frequency domains) during fatiguing exercise can provide useful information regarding possible neuromuscular etiology. For example, mental load at cancer diagnosis could reduce motivation and/or increased central limitations in muscle recruitment. Thus, this study investigated the effect of CRF at diagnosis on EMG content during repeated isometric contractions of plantar flexor muscles.

METHODS: Neuromuscular fatigability was quantified on maximal force decrease of right plantar flexor muscles along with EMG recording of Gastrocnemius Lasteralis, Medialis and Soleus. A 5-min all-out exercise were realized, composed of 60 4-s maximal isometric contractions interspersed by 1-s recovery. EMG signals were analyzed in the time-frequency domain using a continuous wavelet transformation (CWT). Each CWT matrix was normalized using the total activity of the

first contraction, allowing analysis frequency changes independently of the EMG amplitude modifications. The mean of the first (PRE) and last (POST) 3 contractions was performed. Then, CWT matrices PRE-POST differences, i.e. fatigability effect, were compared between CRF (FA12>22) and non-CRF patients (FA12≤22) using a 2-dimensional statistical non-parametrical mapping (SnPM) analysis.

RESULTS: The study included 54 patients at cancer diagnosis, before chemotherapy treatments. In those included, the prevalence of CRF was 50% at baseline. No difference of fatigability was observed between CRF and non-CRF groups (47±14 % vs. 49±12 %, respectively). The SnPM analysis of relative CWT matrices reveals differences between groups. Patients presenting CRF symptoms manifested less spectrum energy in the frequency band 50-120 Hz during the first second of contraction. It was associated with a significantly reduced instantaneous median frequency on the same time-period.

CONCLUSION: Results showed that despite no difference in plantar flexors fatigability, CRF patients presented specific EMG features. Time-frequency transformation reveals a relative decrease in the energy spectrum content in the first second of contraction. This, associated to the reduced instantaneous median frequency in the fatigued group, may suggest an impairment in muscle activity at the initiation of the contraction. These results participate in understanding etiology of CRF at different step of anticancer treatments which remains challenging and worst of investigation.

THE IMPACT OF NUTRITION-PHYSICAL INTERVENTION ON GUT MICROBIOTA IN CHILD CANCER SURVIVORS

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INTRODUCTION: The impact of changes in gut microbiota on etiology of acute lymphoblastic leukemia (ALL) in children has not been fully clarified. However, many researchers have dealt with this area in recent years. Considerable decrease in diversity of gut microbiota can last many years after the treatment is finished. The aim of this study was to evoke shift in gut microbiota in child cancer survivors by healthy diet, physical activity and supplementation of probiotics drinking fermented milk beverage with Lactobacillus Casei CNCM I-1518 and yogurt cultures and evaluate effectiveness of intervention.

METHODS: This study is focused on analysis of gut microbiota in child cancer survivors with ALL. Patients who participated in this study (n = 16) completed a program comprised of physical activity and nutritional changes lasting 8 weeks. The fecal microbiota was categorized using specific primers targeting the V3–V4 region of 16S rDNA.

RESULTS: We found a significant positive shift in the Shannon index ($p = 0.04$) after nutrition-physical intervention in child cancer survivors. Moreover, we evaluated a significant increase in relative abundance of genus Lactobacillus after drinking the milk beverage with probiotic cultures (Lactobacillus Casei CNCMI-1518).

CONCLUSION: The main findings from our study were positive changes in gut microbiota after 2-months exercise-nutrition intervention in child cancer survivors. We assume that the implementation of intervention can have a positive impact on the gut microbiota and the overall clinical state in child cancer survivors.

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INFLUENCE OF COACHING ON EFFECTIVENESS, PARTICIPATION, AND SAFETY OF AN EXERCISE PROGRAM FOR POSTMENOPAUSAL WOMEN WITH OSTEOPOROSIS: A RANDOMIZED TRIAL

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INTRODUCTION: We compared two different strategies providing professional coaching to administer an exercise program for women with postmenopausal osteoporosis (POP): individual training (IT) at home with trainers supervision provided by telephone contacts at regular time-intervals or group training (GT) with trainers live supervision. Our working hypothesis was that IT is a valid alternative to GT when GT is not feasible.

METHODS: This was a single-blind, randomized study. We recruited 52 women with POP, without significant comorbidity, and no participation in any structured exercise program within the previous 6 months. They were assigned randomly to IT or GT groups (n = 26 each). Distribution of age (IT: 68±4, GT: 67±8 years) and body mass index (IT: 23.0±2.5, GT: 21.4±5.1) was similar between groups. Each group performed the exercise program in two 1-hour sessions per week for 18 months. Primary outcome measure was Health-Related Quality of Life (HRQoL), as measured by the Short Osteoporosis Quality of Life Questionnaire. Secondary outcome measures focused on domains acknowledged to influence HRQoL (disability, fear of falling, weekly physical activity, physical function) or the effectiveness of the exercise program (retention, adherence, and safety). Significance level was set at $p < 0.05$.

RESULTS: No significant differences were observed between IT and GT groups for any domain. Retention, adherence, and safety were also similar. HRQoL, disability and fear of falling did not change between baseline and follow-up for either

group. However, for both groups, physical function (knee flexion, shoulder mobility) and functional capacity (6-minute walking test) improved. Weekly physical activity levels increased from moderate range at baseline to intense at final assessment for both groups.

CONCLUSION: IT and GT supervised exercise programs for women with POP provide similar effectiveness, participation and safety. Hence, both modalities should be considered for future translation in clinical practice of exercise recommendations for POP.

COMPARISON OF BODY COMPOSITION AND BONE MINERAL DENSITY IN UNTRAINED ELDERLY AND MASTER ENDURANCE RUNNERS

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INTRODUCTION: Age-related loss of lean mass and increase in adipose tissue lead not only to decline in strength and to functional limitations but also to inflammaging and immunosenescence. Changes in body composition (BC) and bone mineral density (BMD) may thus lead to the initiation of various bone conditions. Long-term exercise training could therefore reduce the risk outcomes of osteoporosis and other metabolic pathological processes. The purpose of this study was to assess multiple anthropometric variables in relation to the amount of physical activity in elderly men.

METHODS: Subjects were divided into two groups: a master endurance runners (MER) (n= 9, 68.58 ± 3.01 yrs, body mass index (BMI) 24.18± 2.56 kg.m-2) and 'active less than recommended' group (ALTR) (n= 8, 70.73 ± 3.13 yrs, BMI 28.19± 2.12 kg.m-2) according to their long-term sports history anamnesis. MER were defined by a training volume of minimum 150 minutes of running activity per week and active participation in endurance running competitions and ALTR were defined as individuals with no history of regular physical activity training and no more practice than 150 minutes of moderate or 75 minutes of vigorous intensity per week. All subjects underwent a dual energy X-ray absorptiometry (DXA) where all the necessary anthropometric BC and BMD variables were estimated. Group differences were calculated using Mann-Whitney U-tests with significance level of $p< 0.05$. All data are expressed as means ± SD.

RESULTS: Total body mass (71.73 ± 9.63 vs 84,73 ± 5,05 kg, $p< 0.05$), BMI (24.18 ± 2.56 vs 28.19 ± 2.12 kg.m-2, $p< 0.01$) and total fat mass percentage (22.76 ± 3.08 vs 28.74 ± 3.45 %, $p< 0.01$) were significantly lower in MER compared to ALTR. On the contrary, lean mass percentage was significantly higher in MER (73.59 ± 2.95 vs 68.13 ± 3.20 %, $p< 0.01$). No significant differences were found in android/gynoid ratio and when analysing BMD, in none of the two standardly evaluated body parts (neither in T-score nor in Z-score) were detected significant differences.

CONCLUSION: Even though no significance was found in between BMD variables, a higher prevalence of osteopenia threshold values were noticed in the ALTR. Additionally, MER showed significantly more favourable BC values within the healthy population range what indicates the positive effect of endurance running on musculoskeletal health.

The study was supported by the INTERREG V-A Slovakia—Austria (acronym CAA, ITMS2014 + 305041X157) and by the Slovak Research and Development Agency (Grant no. APVV-21-0164).

THE EUROPEAN "HAPPY BONES" PROJECT: HEALTH PROMOTION IN MENOPAUSAL WOMEN.

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INTRODUCTION: Menopause is a condition that can lead to several side effects such as a decrease in Bone Mass Density, muscle loss and fatigue which negatively affect the women's Quality of Life (QoL). Adapted exercise can provide psycho-physiological adaptations which improve bone health, mental health and prevent falls by improving lower limb strength and balance. In addition, Physical Activity (PA) increases cardiorespiratory fitness, strength, flexibility and QOL in PostMenopausal Women (PMW) [1]. Therefore, it is essential that PMW practice regularly PA to preserve bone, muscle, physical fitness and QoL. Unfortunately, PMW do not reach minimum PA levels recommended, thus it is necessary to implement strategies to promote regular PA in this population. The WorkPlace (WP) might be the better place to implement a healthy lifestyle in PMW, because it can reduce the typical barriers to the regular PA practice. therefore, firstly, study aims to compare if compliance and dropout rate to the "Happy Bones" (HB) protocol are the same when offered in the WP or in a Sports Centre (SC). Secondary, it aims to evaluate the effects of the protocol on womens bone health, QoL and fitness in PMW.

METHODS: 73 PMW were enrolled in 5 European countries (Italy, Romania, Bulgaria, Spain and Turkey) and performed 6 months of HB training, three times a week. The HB training protocol was structured to positively affect bone health. 39 women performed the protocol at the WP (Italy, Romania and Turkey) while 34 at the SC (Bulgaria, Romania and Spain). To monitor the compliance and drop-out of the HB intervention attendance registers were used; to assess the effect of the protocol on osteoporosis prevention and the risk of falls 1RM test, star balance test, single leg stance test, were performed; to evaluate women's QoL the QUALEFFO-41 questionnaire was administered.

RESULTS: 5 of the PMW trained at WP (12.8%) drop the program due to Covid-19 restrictions. While, 14 of the women exercised at SC (41.2%) did not complete the program for reasons unrelated to the protocol. This evidenced a lower dropout for PA practice at the WP comparing to SC. Results showed 47% of PMW trained at WP and 85% at the SC recorded high

compliance. At the end of 6 months of intervention, the whole group showed improvements in strength and balance. Greater cognitive functions, general health perception and ability to move independently were evidenced after the protocol.

CONCLUSION: The HB protocol, when it was proposed at the WP seems to demonstrate a lower dropout rate but less compliance when compared to SC. Results on strength and balance suggested the efficacy of this protocol in preventing osteoporosis and risk of falls, improving general health in PMW.

Refereces:

Sipilä, S.; Törmäkangas, T.; Sillanpää, E.; Aukee, P.; Kujala, U.M.; Kovanen, V.; Laakkonen, E.K. Muscle and bone mass in middle-aged women: role of menopausal status and physical activity. J Cachexia Sarcopenia Muscle. 2020;11(3):698-709. doi: 10.1002/jcsm.12547.

ATHLOME: GENETIC PREDISPOSITIONS TO OUTSTANDING ATHLETIC PERFORMANCE

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IGBMC

INTRODUCTION: There is a link between genetic predispositions, diseases and exceptional physiological and athletic abilities. As an example, a mutation of the HFE gene, encoding a protein involved in iron homeostasis, leads to hemochromatosis when present in two copies in the genome, while the presence of a single copy was found enriched in top-level athletes engaged in sports which require either a large capacity for oxygen transfer or high muscular performance. With the present ATHLOME project, we aim to discover new genes and genetic variants modifying neuromuscular and respiratory performances, that would be potential therapeutic targets for diseases affecting these physiological functions.

METHODS: A first international cohort of thirty-one freedivers with a national or international level was recruited based on their high abilities in comparison to the common population (more than 6 min static apnea for women and 7 min for men, lung vital capacity >110%). Physiological (lung vital capacity, glossopharyngeal respiration…) and biological (blood cell counts and protein levels) data were gathered. Saliva samples were collected allowing DNA extraction and genome sequencing after anonymization. Also, lung MRI was performed to decipher mechanisms of the glossopharyngeal breathing.

RESULTS: For the analysis of the DNA sequencing raw data, benchmarking of several in-house and commercial pipelines was performed before optimization of the most efficient pipeline. As a first approach, a list of candidate genes implicated in the physiology of breathing, oxygen transport and muscle function was screened and both novel genetic variants as well as known variants were found enriched in the freedivers cohort compared to the control population. A second approach aimed to screen for very rare variants with a high predicted impact on the encoded protein leading to a modification of its expression or function. Two hits with a statistically relevant frequency were found and require further functional investigations. Lung area and height evolution were measured during glossopharyngeal breathing from MRI data from one athlete, documenting a consequent lowering of the diaphragm during this process.

CONCLUSION: The study design and pipeline of analysis were validated by those first results as variants already reported linked to athletic performance were identified in our cohort. However, validation of implicated genes or genetic variants at the statistical and molecular levels may require a larger cohort. In addition, other athletes whose field necessitates resistance to hypoxia and high muscular performance may be recruited and investigated. Also, enrollment of families of athletes would be an asset allowing genetic segregation.

A STUDY ON THE RELATIONSHIP BETWEEN SOCIAL ADAPTATION AND FINE MOTOR SKILLS IN AUTISM

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INTRODUCTION: Autism spectrum disorders (ASD) is a kind of complex neurodevelopmental disorder. Previous studies have focused on social disorders. The aim of this study is to understand the relationship between social adaptation and fine motor development in children with autism, and to provide scientific direction for the follow-up intervention treatment.

METHODS: A retrospective study was conducted to collect data on social adaptability and developmental level of children with autism diagnosed in the Child Development Behavior Clinic, and the control group was children with normal developmental level.

RESULTS: The results showed that there was no significant difference in sex and age distribution between ASD Group and control group ($P > 0.05$),but there was significant difference in social adaptation and fine motor skills between ASD Group and control group ($P > 0.05$).There was a certain correlation between each dimension of childrens development level and social adaptation (fine motor $P< 0.006$, $OR = 3.98(1.5 \sim 10.54)$.

CONCLUSION: there is a certain relationship between the developmental level of autistic children and their social adaptation. In the course of intervention therapy, fine movement can be used as an important point of entry, and it is of great significance to improve their social adaptation.

THE CONVERGENT VALIDITY OF THE CALF CIRCUMFERENCE TO PREDICT MUSCLE MASS COMPARED TO A BIOELECTRICAL IMPEDANCE ANALYSIS IN ADULTS WITH INTELLECTUAL DISABILITIES.

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ERASMUS MC

INTRODUCTION: Intellectual disability (ID) is defined as a deficit in cognitive and adaptive functioning, originated before 22 years of age [1]. In people with ID there is a high prevalence of sarcopenia (14.3%), at a relatively young age [2]. Sarcopenia is characterized by the loss of muscle mass and strength, and a decrease in quality of the remaining tissue [3]. In the European consensus on the definition and diagnosis of sarcopenia, CC is proposed as a non-invasive measurement for muscle mass [3]. However, it is not certain if CC is a valid screening tool in adults with ID. The aim of this study was to investigate the convergent validity of CC compared to bioelectrical impedance analysis (BIA) in assessing muscle mass in adults with ID.

METHODS: Muscle mass was measured using CC (Seca 200, Seca, Hamburg, Germany) and BIA (Tanita Body Composition Analyzer MC-780, Tanita, Tokyo, Japan) in 27 adults (mean age 56.15 ± 12.9 SD) with mild to moderate ID and at least two cardiovascular risk factors, who participated in a Progressive Resistance Exercise Training study [4]. All measurements were conducted by the same researcher. We used the Spearman's rho correlation to estimate the association between CC and skeletal muscle mass (SMM), segmental muscle mass of the legs (SegMM), and skeletal muscle index (SMI; SMM/height2).

RESULTS: A moderate correlation was found between CC and SegMM (rs= 0.49, p= 0.01, 95% CI: 0.10-0.76), and between CC and SMI (rs= 0.55, p=0.006, 95% CI: 0.17-0.78). No statistical significant correlation was found between CC and SMM (rs= 0.30, p= 0.13, 95% CI: -0.11-0.62).

CONCLUSION: The moderate correlation for SegMM and SMI indicates that there is a relationship between CC and muscle mass in adults with ID. The CC might be used as a tool for assessing muscle mass in adults with ID, but further research is necessary. Firstly, to investigate the validity in a larger and more heterogeneous sample of adults with ID. Secondly, to investigate the reliability of using CC as a screening tool for sarcopenia in adults with ID.

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THE RELEVANCE OF TENSIOMYOGRAPHY-DERIVED SKELETAL MUSCLE CONTRACTILE PROPERTIES IN SARCOPENIC AND NON-SARCOPENIC PARTICIPANTS

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SCIENCE AND RESEARCH CENTRE KOPER

INTRODUCTION: The original operational definition of sarcopenia was based solely on low muscle mass; however, in 2010 European Working Group on Sarcopenia in Older People (EWGSOP) issued guidelines that classified sarcopenia based on three consecutive criteria: low muscle quantity; low muscle strength; and low muscle performance. In 2019 the same group revised the guidelines and rearranged the consecutiveness of criteria: low muscle strength; low muscle quantity or quality; low muscle performance. Important, in 2019 the EWGSOP recognised muscle quality as the primary biomarker to confirm sarcopenia where the muscle quality should be used to describe micro- and macroscopic aspects of muscle architecture and composition. Since muscle contractile properties estimated from tensiomyography (TMG) reflects muscle fibre type composition and muscle architecture we aimed to investigate the prevalence of sarcopenia according to latest EWGSOP protocol in Slovenian population and compare TMG-derived contractile parameters of three leg skeletal muscles between non-sarcopenic and (pre)sarcopenic participants.

METHODS: A randomized sample of 345 individuals (31 % males) aged over 60 was recruited through Slovenian health centres and assessed according to EWGSOP protocol (grip strength, gait speed, chair stand and timed-up-and-go tests) and classified into two groups: non-sarcopenic (nonSARC; n = 298), pre-sarcopenic or sarcopenic (preSARC; n = 47). TMG was used to assess contraction time (Tc) and response amplitude (Dm) in vastus lateralis (VL), biceps femoris (BF), and gastrocnemius medialis (GM). Non-parametric Mann-Whitney and Spearman correlation tests were used due to non-normality of data distributions.

RESULTS: Prevalence of pre- and sarcopenia among Slovenian population was 13.1 %. PreSARC have lower Dm in all three muscles ($p < .05$) and shorter Tc in GM ($p = .032$). BF Dm correlated with chair stand ($\rho = -.168$), grip strength ($\rho = 0.151$), timed-up-and-go ($\rho = -0.147$) and gait speed ($\rho = .125$). GM Tc correlated with chair stand ($\rho = -.150$). GM dm correlated with chair stand, timed-up-and-go and gait speed GM Dm correlated with chair stand ($\rho = -.292$), timed-up-and-go ($\rho = -.238$) and gait speed ($\rho = .174$). VL Tc correlated with chair stand ($\rho = .166$), timed-up-and-go ($\rho = .150$) and gait speed ($\rho = -.153$).VL Dm correlated with chair stand ($\rho = -.171$), grip strength ($\rho = .299$) and timed-up-and-go ($\rho = -.215$).

CONCLUSION: Preliminary results of our study confirmed sensitivity of TMG-derived skeletal muscle contractile parameters to sarcopenia groups and sarcopenia classification tests. Although the correlations are weak, TMG parameters are promising biomarkers to be used in sarcopenia classification. By investigating the contractile properties of skeletal muscle in older adults, this study aims to shed light on the mechanisms underlying sarcopenia and contribute to the development of more effective interventions to prevent or treat the condition.

THE COGNITIVE AND PHYSICAL DEMAND OF A COMMERCIAL HIGH-ALTITUDE EXPEDITION

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INTRODUCTION: Laboratory and field studies have demonstrated the detrimental effect of hypoxia on cognitive function. Commercial expeditions to high altitude are becoming more accessible to a wider variety of individuals resulting in greater health and performance risks. The combination of hypobaric hypoxia and the additional demand of an expedition may augment impairments in cognitive function and be associated with perceived and physiological markers of altitude illness in healthy, although relatively unprepared, visitors to high-altitude. This study aimed to understand the effect of a commercial high-altitude trek to Everest Base Camp on fatigue, cognitive function, acute mountain sickness (AMS) and optic nerve size in healthy sojourners.

METHODS: A total sample of 20 international athletes completed a 14-day return trek to Everest Base Camp interspersed with a battery of tests at four different altitudes: 1) 1400 m (day 1); 2) 3340 m (day 4); 3) 4240 m (day 7); 2860 m (day 12). Multiple cognitive domains were assessed including reaction time tests, spatial working memory and task load (n=10). Fatigue and AMS (n=18) were determined by surveys and optic nerve sheath diameter (n=20) was measured using ultrasound of the eye. Mixed model one-way ANOVA (four altitudes) with Tukey's test for multiple comparison was employed with a 0.05 alpha level.

RESULTS: During a high-altitude trek there were no changes in spatial working memory (P=0.783), simple reaction time (P=0.590) or formula reaction time (P=0.247). Focus reaction time did not change (P=0.115) but errors increased (P=0.033, from 1.5±2.4% at 1400 m to 28.3±26.6% at 2860 m; 8.34±7.1% at 3340 m, and; 12.0±15.5% at 4240 m). Task load parameters did not change except for perceived physical demand (P=0.025; from 18.5±23.9% at 1400 m to 43.3±30.5% at 2860 m, and 33.9±21.8% at 4240 m). There was no significant effect of altitude on fatigue (41±23 to 61±22, P=0.187) or AMS score (P=0.0618, although pairwise comparisons suggest greater AMS scores on day 7 and 12 compared with 4 and 1, respectively) and optic nerve sheath diameter was unchanged (to P=0.054).

CONCLUSION: Participant adherence in this applied study, in a remote and austere environment, was challenging and highlighted individual variation among athletes. Attrition was due to expedition evacuation on two occasions as well as expedition time-limits and participants' self-citing extreme fatigue. Participants maintained their reaction time but at the cost of accuracy during the focus reaction time task that involved distracting stimuli. Increased error rate at lower altitude, but later during the expedition, may indicate that fatigue had greater influence on performance than altitude. Further data analysis will explore the relationship between AMS, optic nerve diameter and task load index to explore whether monitoring trekkers with these tools may offer expedition providers information to determine high-risk participants prior to emergency evacuation for altitude illness.

Conventional Print Poster

CP-AP08 Statistics and Analyses

HOW CAN MACHINE LEARNING HELP PREVENT KNEE INJURIES OF EXPERIENCED ATHLETES?

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INTRODUCTION: Risk prediction of anterior cruciate ligament (ACL) injuries is highly multifactorial. As machine learning (ML) algorithms have the ability to understand complex relationships in large datasets, they seem appropriate to predict at-risk athletes based on a large number of features [1]. Thus, we compared two artificial intelligence models that can help prevent knee injuries including ACLs of experienced athletes.

METHODS: 50 athletes, 24 healthy and 26 with a medical history of severe knee injuries in the last 3 years took part in our experiment. They completed an informative questionnaire with physical, psychological (KOOS, SAS), and sports questions and performed a horizontal force-velocity test on a ballistic device [2]. From each push phase, we extracted a vector containing 60 biomechanical and psychological features (force peak, velocity, KOOS Pain score, …). Thus, we obtained a 519 vectors database. To train our machine learning algorithms to classify athletes correctly, we split the database into a train set of 405 vectors (39 athletes) and a test set of 114 vectors (11 athletes). For interpretability reasons, we chose to train nearest-neighbors (kNN) and decision tree (DT) classifiers with and without principal component analysis (PCA). Metrics used for model evaluation were accuracy and the area under the receiver operating characteristic curve (AUC).

RESULTS: The test of our models on the 114 test vectors led to an accuracy of 79% with an AUC of 0.77 for the kNN, while the DT accuracy was 64% with an AUC of 0.61. With the use of a PCA before training, the results were lower for the kNN

(accuracy of 72%, AUC of 0.71), but were higher for the DT (accuracy of 77%, AUC of 0.77). Finally, the first kNN classified correctly ten out of the eleven test athletes.

CONCLUSION: Unlike the kNN, the DT is sensitive to small variations in data which may explain the differences in performance as our features were highly person dependent. Our best model achieved an AUC of 0.77, surpassing the Jauhiainen model's [3]. The results of the PCA might be better as the size of our database would increase. Finally, the results suggested that ML could help identify at-risk athletes and be useful in predicting knee injury risk.

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INJURY PREDICTION USING MACHINE LEARNING BASED ON THE MONITORING OF SPRINTING ATHLETES' PERCEPTION OF PHYSICAL AND MENTAL STATES

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INTRODUCTION: To estimate the risk of sports injury occurrence is an important challenge in sport science and medicine [1]. Sports injuries are multi-faceted issues, as athletes can be considered as complex systems exposed to inter-related physical, psychological, and physiological influences [2]. From these observations, machine learning (ML) techniques offer an opportunity to identify patterns leading to injuries [3]. The aim of this study was to predict injury risk over time by monitoring athletes' perceptions of physical and mental states using ML models [3].

METHODS: A total of 122 athletes practicing sports involving repetitions of sprints from three sports federations (athletics, bobsleigh and rugby) were included in the study. 16 features corresponding to their perceptions of physical and mental states, were assessed throughout a mobile app each morning and evening. The injury status of the athlete (either injured or not) was collected in the evening. Two ML models (a logistic regression LR [4] and a Decision Tree DT [5]) were trained and then tested on collected data over a follow-up period of 532 days. Data were preprocessed in a time window of 1.5 days composed of successive evening - morning - evening data. An internal validation strategy was used to assess model performances [6]. The test set was composed of the last 30% days of each athlete monitoring data in order to keep a chronological timeline in the validation process.

RESULTS: On a total of 3688 time-window observations, 171 injuries were recorded. This constitutes a case of serious class imbalance between injured and uninjured. The model was validated on test set of cases unused during models training. The accuracy (mean (SD)) (LR:0.64 (0.02)), specificity (LR:0.65 (0.02) – DT:0.92 (0.008)), recall (LR:0.55 (0.06) – DT:0.17 (0.05)), precision (LR:0.06 (0.02) – DT:0.16 (0.05)) and ROC AUC (LR:0.63 (0.03) – DT:0.56 (0.02)) were computed over 50 runs.

CONCLUSION: This preliminary analysis highlights the ability of ML models to estimate injury risk by monitoring athletes' perceptions of physical and mental states which are usually not considered in ML models [3]. Our ML model gives a good estimation with high true negative rate. However, the precision (i.e., the ability to detect true injury) is low and could be improved by increasing the sample size and particularly if class imbalance can be mitigated, or by using ensemble methods [7,8]. Moreover, prediction performances could be improved ML techniques seem to be a promising tool to help athletes and stakeholders in the management of injury risk by adopting some preventive behaviors and should require further investigation on the data collection, and mathematical formulations to manage the imbalanced class problem [9].

THE EMERGING TRENDS AND KNOWLEDGE STRUCTURE OF SPORTS PERFORMANCE: A SCIENTOMETRICS ANALYSIS

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INTRODUCTION: Sports performance involves research in several fields and disciplines. As research in these areas advances rapidly, it is critical to keep abreast of emerging trends and critical turns in the development of collective knowledge. Not only because discoveries emerge from a diverse range of areas but also because new findings may fundamentally alter the collective knowledge as a whole. Scientometrics is a branch of informatics that quantitatively analyzes patterns in the scientific literature to understand emerging trends and the knowledge structure of a research field.

METHODS: The database selected for the scientometric analysis in this study was the Web of Science Core Collection. The search formula was TS=("sport* performance" OR "athletic performance" OR "exercise performance"). Citation indexing was limited to SCI-E and SSCI. The document types were Article or Review Article. The period was from the start to 31 December 2022. No language restrictions. Duplicates were eliminated with CiteSpace and the final 16,279 documents were obtained and imported into CiteSpace (5.7.R5) for analysis.

RESULTS: The most cited references were IOC Consensus Statement: Dietary Supplements and the High-Performance Athlete, Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance, ISSN exercise & sports nutrition review update: research & recommendations. The top 2 citations with the highest citation bursts were consistent with the top two most cited references. The 3 journals with the most references were The Journal of Strength and Conditioning Research, Journal of Sports Medicine and Physical Fitness, and Medicine and Science in Sports and Exercise. Medicine and Science in Sports and Exercise, Journal of

Applied Physiology and Sports Medicine were the top 3 most cited journals. The USA was the country with the most total publications and citation count, followed by the UK and Australia. The top 3 cited institutions were the University of California, Udic French Research Universities, and Universidade De Sao Paulo, which has the most recent and strongest citation burst. The institution with the most centrality was the University of Colorado. The top 3 most co-cited authors in the last 5 years were Anonymous, Cohen J, and Hopkins WG. The top 3 authors with the highest centrality were Beedie CJ, Amann M, and Burke LM.

CONCLUSION: This study identified the most influential references, journals, countries, institutions, and authors. The retrieved co-citation reference network describes coherent links between 31 different clusters and identifies three distinct major research trends, namely advances in disease prevention and treatment, improvements in sports performance, and enhancements in healthy diets and sleep quality. The last five years research trends were: dietary supplementation and performance enhancements. These findings can inform funding agencies and research groups' future directions.

INVESTIGATING THE TEACHING OF QUANTITATIVE DATA ANALYSIS IN UNDERGRADUATE SPORT AND EXERCISE SCIENCE-RELATED DEGREE PROGRAMMES IN UK UNIVERSITIES

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INTRODUCTION: A large proportion of research findings may be false [1]. Underpowered studies [2], inappropriate research designs, and questionable research practices are at the heart of the problem, including within sport [3]. Many researchers misunderstand fundamental aspects of statistics [4] and it is important to consider how this affects the teaching of undergraduates who will enter the academic or industry workforce.

METHODS: To examine this, we surveyed 94 academics from 60 UK institutions on aspects related to the teaching of research methods and statistics on undergraduate sport and exercise science courses.

RESULTS: Topics 'covered in depth' on average included null-hypothesis significance testing, p-values, statistical significance, and assumption checks. This was at the expense of 'not covered' topics such as the Neyman-Pearson approach, the Fisherian approach, Bayesian approaches, open science, pre-registration, and Registered Reports. Students were mostly assessed via written assessments (54%), although individual research projects (29%), multiple choice tests (29%), and computer-based assessments (27%) were also common. Most courses used SPSS (76%) and Microsoft Excel (64%), although there was evident use of open-source software such as JASP (20%) and JAMOVI (10%), as well as greater referral to online videos and tutorials (73%) than textbooks (68%) and journal articles (64%). The median response 'strongly agreed' that modules effectively developed the practical ability to conduct data analyses, 'agreed' they prepared students effectively for a dissertation and developed conceptual understanding, and 'slightly agreed' that they prepared students effectively for data analysis within both sporting and industry settings. Content analysis of open responses indicated that participants judge the effectiveness of their teaching based on aspects relating to feedback (students, other staff), assessment (formative, summative), industry (preparedness for work), and future study (preparedness for dissertations/postgrad). The usefulness of student module evaluations was debated. There were also contrasting views on relative effectiveness for students passing tests compared to developing conceptual understanding. There were some collaborative projects with industry, but responses generally suggested students weren't prepared to work in industry and that many participants weren't even sure what that would require.

CONCLUSION: Our study suggests that academics in our discipline are mostly taking a 'well-worn path' to teaching statistics. Although some alternative approaches are being used, staff are focussing on the 'doing' of statistics in preference to developing conceptual understanding. Our study also suggests that particular emphasis should be given to the constructive alignment between academia and industry.

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THE ASSOCIATION BETWEEN MENTAL HEALTH AND PARTICIPATORY SPORTS CONSUMPTION IN KOREANS: A CROSS-SECTIONAL STUDY

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INTRODUCTION: Mental wellness protects against aging and chronic physical conditions, while mental disorders increase the risk of diseases and injury. Participating in sports activities is an effective way to improve mental health. With the successful development of the sports industry, participatory sports consumption as the core of sports consumption has a higher proportion in our leisure expenditure. Although participatory sports consumption is a concept in sports economics, consumption may allow us to have a more comfortable experience when participating in sports activities. Studying the relationship between the emergence of participatory sports consumption and mental health is necessary and meaningful.

METHODS: In the Korea Health Panel Annual (KHPS) data provided by the Institute of Health and Social Affairs & National Health Insurance Service (2020), we included 11268 participants over 19 years old in the analysis for this study. We per-

formed a logistic regression analysis to evaluate the relationship between participatory sports consumption and mental health. Adjustments were made for sex, age, education level, household income, and chronic disease. Subgroup analyses were also conducted based on sex, age, and exercise habits.

RESULTS: In Korea, there are significant differences between participation in sports consumption and the various factors of the study subjects, including gender, age, education level, annual income, number of chronic diseases, depression, anxiety, suicidal thoughts, subjective health status, and regular exercise habits($p<0.05$). Furthermore, even without a consistent exercise habit, study subjects who had participated in sports consumption showed significantly better results in terms of suicidal thoughts and subjective health status compared to other groups($p<0.05$). The presence or absence of participation-based sports consumption had a significant impact on stress , anxiety , suicidal thoughts , and subjective health status . Subgroup analysis also showed that the impact of participating in sports consumption on "feeling stressed" was significantly higher for women, the elderly, and regular exercisers compared to other subgroups. Additionally, the elderly showed a significant difference in the impact of participating in sports consumption on feelings of anxiety and subjective health status compared to other age groups.

CONCLUSION: The emergence of participatory sports consumption can positively influence our mental wellness. Despite potential variations in impact based on factors such as age, gender, and athletic inclinations, however, access to sports is more accessible than any other intervention method, and the costs associated with it are relatively low. Furthermore, the advantages derived from sports activities extend beyond mere mental health benefits. Therefore, encouraging the growth of participatory sports consumption is crucial to enhancing mental health.

ARE GYMNASTICS COMPETITIONS A SELF-FULFILLING PROPHECY?

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INTRODUCTION: In artistic gymnastic international competitions, access to All Around, Apparatus and Team finals are established based on the qualification round results. For a nation who aims for medals in all three finals, the composition of the qualification round's team is a major strategic choice. Coaches may find themselves facing the following question: which gymnasts will maximize the chances of individual and/or team finals. The purpose of this study is to see if it is possible to predict gymnastic result.

METHODS: To answer this question, we collected results of international gymnast over a period of six months. Two predictions were calculated for each athlete: "Max", corresponding to his/her best score and "Mean" corresponding to the average of all the score collected over the 6-month window. Those 2 predictions were then compared to the results obtained on each apparatus during the 2022 European Championship at Munich. A total of 547 Junior and Senior competed in Women's and Men's Artistic Gymnastics (WAG and MAG). Several statistics were used to quantify the validity of our prediction: Pearson's Coefficient, RMSE, Paired Sample T-Test and Bland & Altman's Limits of Agreements.

RESULTS: Systematic error is higher for Max than for the Mean prediction. Junior WAG Floor (+0,055), Senior WAG Uneven Bar (0,015), Junior MAG Parallel (-0,037) and High Bar (-0,051), Senior MAG Parallel Bar (0,017) and Floor (-0,078) present the smallest bias while Senior Balance Beam (0,331) Junior and Senior Pommel Horse (0,286 and 0,304 respectively) are among the highest. Random errors are very similar between Max and Mean predictions. Junior and senior WAG Floor (0,447 and 0,360 respectively), Junior and Senior MAG Still Rings (0,382 and 0,651 respectively) display the smallest dispersion while Junior and Senior WAG Balance Beam (0,921 and 1,256 respectively) and Junior and Senior Pommel Horse (0,932 and 1,113) show the highest. RMSE results follow the same trend. All correlation between prediction and results are moderate, large, or very large ranging between 0,409 and 0,867. Larger correlations correspond to Senior WAG Floor (0,867), Senior MAG Vault (0,786), Junior MAG Still Rings (0,779) and Junior WAG Uneven Bars (0,757). Percentages of prediction contain within our Limits of Agreement range between 90,164% and 97,826% for every apparatus. Max predictions are systematically significantly superior to the event final score while mean prediction are significantly different on some apparatus.

CONCLUSION: Considering all our indicators, Junior WAG Vault, Junior MAG Floor and Senior MAG Still Rings seem to be predictable based on their high validity and small dispersion. Other apparatus such as Pommel Horse or Balance Beam seems harder to predict due to their high variability. The validity of our predictions are in agreement with previous study interested in inter-day apparatus reliability [1].

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EFFICACY OF PRESSURE MANIPULATION TECHNIQUES IN DARTS PLAYERS - AN EXPLORATORY STUDY

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ETH ZÜRICH

INTRODUCTION: Being able to perform at a top level is of major importance for professional athletes. Therefore, it is essential to prevent a performance decrease under the pressure of competition which often leads to an over-aroused state of the athlete. However, it is difficult to (i) simulate mental pressure in laboratory or training settings and (ii) provide objective markers of the athlete's arousal state. Previous research has shown that the activation of the locus coeruleus-noradrenergic (LC-NA) system, a key regulator of arousal in humans, causes the eye's pupil to dilate particularly in situations that are perceived as stressful. Here we assessed the effectiveness of pressure manipulation via self-reported state anxiety, performance, and pupil measures in skilled dart players. Based on previous studies, we hypothesized that exper-

imentally induced pressure will cause an increase in self-reported anxiety and pupil diameter and a reduction in darts performance.

METHODS: Skilled darts players (N=39) completed two counterbalanced rounds with 15 specific targets on the dartboard, one round without pressure and a second round with experimental pressure manipulation techniques. The techniques used were: audience, camera, fake ranking, and monetary incentive, which were all implemented simultaneously. In addition to darts performance (number of attempts), pupil size and self-reported state anxiety (questionnaire) were measured pre and post each round. The anxiety questionnaires were analyzed using linear mixed effects models including the factors pressure (non-pressure vs. pressure) and time (pre vs. post playing). For pupil size, a 2-way repeated measures ANOVA time series analysis with the factors pressure and time was applied. The performance was analyzed using a dependent t-test.

RESULTS: Participants reported significantly higher state-anxiety in the pressure than in the non-pressure rounds (pre non-pressure 25.41±13.55, post non-pressure 21.24±12.83, pre pressure 27.88±14.78, post pressure 30.35±17.62; pressure x time interaction $p<.05$). We also found a significant decrease of mean performance (M non-pressure = 88.13±28.94, M pressure = 96.28±30.02; $p<.05$) and a significant increase of mean pupil size from 3.45mm to 3.61mm (SPM1D pressure main effect $p=.005$, $F^*=9.97$) for the pressure compared to the non-pressure condition.

CONCLUSION: Our pressure manipulation had a significant effect on self-reported state anxiety. This was accompanied by a significant increase in pupil size which is considered a physiological marker of elevated arousal levels, and by a significant decrease in performance. Our results provide the basis for experimentally testing new mental strategies and interventions for coping with pressure and associated over-arousal. One particularly interesting strategy is to train athletes in self-regulating their arousal state by combining mental strategies with pupil-based neurofeedback which has been shown help participants with gaining volitional control of their LC-NA system.

DROPOUT AMONG FRENCH SWIMMERS: GENDER, RELATIVE AGE EFFECT AND PERFORMANCE LEVEL INFLUENCES

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INSEP

INTRODUCTION: Dropout can be seen as someone who had competed in one particular sport and stopped but has not completely stopped participating in sport in general . This study investigates the dropout rate among French swimmers according to performance levels, sex and relative age.

METHODS: Using data from 160 861 swimmers under the age of 21, the distribution of birth quarters as well as the dropout rate by performance level is studied. Chi-squared statistical tests will be performed to attest to the significant effect of birth quarter variables on performance level. In addition, to determine and analyze the impact of sex and relative age on dropout, Kaplan Meier survival curves are realized.

RESULTS: For female, the most likely age to dropout is 13 while for male, it is 17 years old. At these ages, there is a significant effect of birth quarters on performance levels: the proportion of first birth quarter increases with the level of performance. A significant effect of performance levels on dropout is also measured: dropout rate increases as the performance level decrease. The Kaplan Meier dropout curves as a function of age, with sex as a discriminant variable, show that the dropout trends for both sexes are similar before age 13. However, from this age onwards, the dropout rate increases more rapidly for females than for males, with a maximum difference (4.8%) at 17.89 years old. The maximum difference in dropout trends for swimmers born in the first and last quarters is 10% for females at 12.71 years and 8.1% for males at 14.67 years with the dropout rate increasing more rapidly for swimmers born in the last quarter.

CONCLUSION: This study shows the importance of sex, relative age and performance level on the dropout of French swimmers. Female swimmers' present higher dropout rate than their males' counterparts. The highest dropout rate occurs during respective puberty. Dropout is potentiated by the level of performance.

WHAT DO STRESS-ESTIMATION MODELS REALLY SHOW?

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SALZBURG RESEARCH

INTRODUCTION: Recent advancements in wearable technology have enabled continuous and non-invasive monitoring of physiological responses, providing opportunities to estimate stress levels.[1] Stress intensity plays a critical role in the ability to stay alert, focussed and enthusiastic.[2] However, it is important to distinguish between stress intensity and its perception ranging from positive eustress to negative distress[3]. In particular in sports, wearables shall not reduce stress intensity, but support a more positive perception. The aim of this study is to characterize the stress intensity and its perception based on the SWELL-dataset[4].

METHODS: Two male participants, approx. 30 years of age, wore a Movisens EcgMove4[5] device for seven consecutive days to measure heart-rate peaks. Concurrently, every two hours from 8 am to 10 pm, they completed brief self-report questionnaires assessing their stress intensity and perception on a 7-point Likert scale.

A multi-layer perceptron (MLP) was trained using the Movisens-dataset, which consists of 118 stress events and 12 generated heart-rate features based on 60-second frames. The MLP was trained for 120 epochs to map the selected features onto the normalized stress intensity and perception scores, obtained from the assessment. The models hyperparameters were optimized using a 10-fold cross-validation. Subsequently, the trained model was applied to data from the SWELL-

dataset, which contains similar heart-rate data from 25 participants, exposed to different stressors such as interruption, time pressure and no stress.

RESULTS: During the model's pre-training using the Movisens dataset, a root mean square error (RMSE) of 0.2288 for the stress intensity and 0.3009 for the stress perception was achieved. In the downstream task of estimating the stress intensity and perception for the SWELL-dataset, different intra-class means were found. The normalized differential vectors in the 2D-target space between the center of the no stress class and the interruption class was (0.9627, 0.2706), and the differential vector between the center of the no stress class and the time pressure class was (0.8108, 0.5853).

CONCLUSION: The results of this study approves an increase in estimated stress intensity for both stress conditions. The perception was more positive in the time pressure condition as well as (but lesser) in the interruption condition. The artificially induced stress situations in an experimental setting might led to a motivational and therefore positive stress response. The higher RMSE for the stress perception compared to the intensity may be due to the higher complexity of the first aspect. This insight is crucial for the design of future stress studies, particularly those that incorporate stress feedback from wearables in sports, where it is essential to distinguish between stress intensity and the perception of stress.

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Conventional Print Poster

CP-PN12 Nutrition II

LITERATURE SCREENING OF GENETIC VARIANTS WITH RELEVANCE FOR ERGOGENIC POTENTIAL OF NUTRITIONAL SUPPLEMENTS

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INTRODUCTION: Dietary supplements are frequently used in sports to enhance performance, yet a high interindividual variability in response exists that can be partly assigned to genetic factors. We screened the scientific literature for genetic variants that can or could influence the response to the five most commonly accepted ergogenic supplements (caffeine, creatine, beta-alanine, sodium bicarbonate and nitrate) in sports performance.

METHODS: We conducted a thorough literature search for common genetic variants demonstrated to affect one or more of the main processing steps in the human body: absorption, distribution, metabolization, physiological effect and excretion. We also explored whether they have been linked to exercise performance studies.

RESULTS: Common genetic variants in a total of 46 relevant genes were identified for the five ergogenic supplements. Seven genes were described for caffeine, mainly involved in the metabolization and physiological effect. The breakdown of caffeine into paraxanthine is crucial as this metabolite has a higher affinity for the adenosine receptor than caffeine and therefore, has a prominent biological use. The CYP1A2-gene is the most researched gene in sports performance since it regulates the essential metabolization step. The rs762551 SNP of this gene slows this step down and therefore, decreases the ergogenic aid of caffeine in athletic performance. Five genes code for key proteins engaged in the creatine distribution to the skeletal muscle, but it is currently unclear as to whether genetic variants in these genes affect responsiveness to creatine loading. Beta-alanine is the rate-limiting precursor of carnosine, a proton buffer, and eleven genes were defined to be involved in the carnosine distribution and metabolization in skeletal muscle. Regarding the plasma pH buffer, sodium bicarbonate, nine potential genes, mainly active in the absorption of this supplement, were noticed. The final supplement nitrate, with fourteen target genes, becomes functional after conversion to nitric oxide, so the metabolization proteins have probably the highest impact on the usage of nitrate.

CONCLUSION: Multiple genes code for proteins that control important steps of the accumulation and ergogenicity of dietary supplements, but very little is known about potential SNPs that can alter this and there is a lack of sport specific research, except for caffeine. Thus, our screening can steer and inspire more research, which is definitely required to identify genetic variants that can form the future basis for sport nutrigenetics.

ACUTE EFFECTS OF CAFFEINE ON PHYSICAL PERFORMANCE AND LEVEL OF TECHNICAL AND TACTICAL SKILLS IN ELITE JUDO ATHLETES

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INTRODUCTION: Several previous investigations assessed the effect of pre-exercise caffeine ingestion on judo-specific performance. However, the effects of caffeine on repeated technical-tactical skills and physical tests related to judo performances are unclear. Therefore, the aim of this study was to explore the effect of acute oral caffeine intake on physical performance tests and indicators of activeness, efficiency, and effectiveness of athletes during repeated judo combats.

METHODS: Nine elite judo athletes of the Polish national team (4 men and 5 women, age: 22 ± 4 years, body mass: 70.7 ± 11.7 kg) habituated to caffeine (2.2 mg/kg/day) participated in a randomized, crossover, placebo-controlled and double-blind experiment. Each participant performed two identical experimental sessions after ingestion of (a) 3 mg/kg body mass of caffeine (CAF); b) a placebo (PLAC). After 60 min for substance absorption, the athletes performed the following 4 sets of tests: a) maximal isometric handgrip strength test; b) countermovement jump (CMJ) which were separated by three 4 min judo combats, on the basis of which indicators of activeness, efficiency, and effectiveness of attack and defense of the athletes were assessed. Additionally, blood lactate (LA) concentration was also measured before the testing, after each combat, and 30 minutes after the testing.

RESULTS: A two-way repeated measures ANOVA indicated no significant substance × time interaction effect ($p=0.940$) as well as no main effect of a substance ($p=0.054$) but indicated a significant main effect of time ($p<0.001$) for LA concentration. Post-hoc analysis for time effect showed a significant increase in LA concentration at points II, III, and IV compared to points I and V ($p<0.02$ for all). No significant differences between a substance x time interaction effect, the main effect of a substance, and the main effect of time were observed in CMJ ($p=0.587$; $p=0.162$; $p=0.117$, respectively), handgrip test with the dominant hand ($p=0.684$; $p=0.150$; $p=0.295$, respectively) and with non-dominant hand ($p=0.242$; $p=0.324$; $p=0.479$, respectively). In addition, t-tests showed no differences in the Overall Activeness ($p=0.558$), Attack Activeness ($p=0.736$), Defense Activeness ($p=0.233$), and Final Effectiveness ($p=0.860$) between PLAC and CAF trials in judo combats. In turn, the Wilcoxon signed rank test showed no differences in the Attack Efficiency ($p=1.000$), Defense Efficiency ($p=0.779$), Attack Effectiveness ($p=0.575$), Defense Effectiveness ($p=0.326$) between PLAC and CAF trials.

CONCLUSION: The present study indicates that 3 mg/kg body mass of caffeine is not an effective dose to improve physical performance and indicators of activeness, efficiency, and effectiveness during repeated judo combats in elite judo athletes habituated to caffeine.

PRELIMINARY RESULTS CONCERNING EFFECTS OF ACUTE CAFFEINE SUPPLEMENTATION ON PHYSICAL PERFORMANCE AND SLEEP IN HANDBALL PLAYERS. DOES IT DO MORE HARM THAN GOOD?

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INTRODUCTION: Although acute caffeine intake may improve sports performance, its increases the likelihood of sleep disturbance, particularly when consumed in the evening. Therefore, the aim of this study was to analyze the effects of low and moderate caffeine doses ingested before late evening sessions on physical performance and sleep in male handball players

METHODS: Twelve male handball players (age: 21.6 ± 3.4; body mass: 87.3 ± 11.6 kg; height: 183 ± 6 cm; habitual caffeine intake: 1.1 ± 0.9 mg/kg/day) participated in a randomized, counterbalanced, and crossover experiment. Each athlete performed three identical trials after the ingestion of a) placebo (PLAC) b) 3 mg/kg of caffeine (CAF-3) and c) 6 mg/kg of caffeine (CAF- 6), administered 60 min before the evening session and completed: a) agility T-test; b) countermovement jump; c) isometric handgrip test; d) the throwing velocity test e) sprint test (5, 10, 20 m). Sleep was assessed using wrist actigraphy and a Karolinska Sleep Diary (KSD).

RESULTS: One-way ANOVA showed no significant differences between conditions in any physical tests ($p > 0.05$ for all, ES: PLAC – CAF-3: 0.00 – 0.35, ES: PLAC – CAF-6: 0.00 – 0.41). Significant differences were observed in the following sleep actigraphy sleep measures: a) time between substance intake and sleep onset between CAF-3 and CAF-6 (464 ± 76 vs 492 ± 80 min, respectively; $p = 0.03$, ES: 0.35) and b) sleep duration between PLAC and CAF-6 (439 ± 69 vs 357 ± 72 min, respectively; $p < 0.001$, ES: 1.16). Results of sleep assessment on KSD showed a statistically significant difference in sleep quality between PLAC and CAF-6 (4.0 ± 0.7 vs 3.2 ± 0.7, respectively; $p = 0.24$, ES: 1.14) and calm sleep between CAF-3 and CAF-6 condition (3.9 ± 0.5 vs 3.5 ± 0.8, respectively; $p = 0.04$, ES: 0.59. In addition, sleep duration (5 :56 ± 0:05 h:min) and sleep latency (33 ± 35 min) during the CAF-6 condition were shorter than sleep recommendations.

CONCLUSION: The present study indicates that acute caffeine intake of 3 and 6 mg/kg has no significant impact on physical tests associated with handball performance. However, acute caffeine intake substantially interferes with some objective and subjective sleep parameters. Thus, when considering caffeine use in the evening, athletes need an individual approach and estimate potential profits and losses. However, future studies using a larger sample size and including genetic analysis will be required to confirm these findings

EFFECT OF DIETARY NITRATE SUPPLEMENTATION ON SKELETAL MUSCLE MITOCHONDRIAL RESPIRATION PRIOR TO AND FOLLOWING SEVERE-INTENSITY EXERCISE IN HEALTHY ADULTS

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INTRODUCTION: Dietary supplementation with nitrate (NO_3^-), which can undergo a stepwise reduction to nitrite and then nitric oxide, has been reported to improve exercise economy and performance during continuous endurance exercise. While these effects might be linked to improved mitochondrial function, the extent to which NO_3^- supplementation can improve mitochondrial respiration in human skeletal muscle is currently conflicting. Moreover, all studies assessing the effect of NO_3^- supplementation on mitochondrial respiration to date have obtained resting skeletal muscle samples prior to exercise. There is evidence that acute exercise can modulate skeletal muscle respiratory variables, but the extent to

which such variables may be impacted after exercise following NO3- supplementation has yet to be investigated. The purpose of this study was to assess the effect of short-term NO3- supplementation on mitochondrial respiratory variables from skeletal muscle sampled prior to and following severe-intensity cycle exercise.

METHODS: In a randomised, double-blind, cross-over study design, 5 recreationally active adults males consumed NO3rich (BR, 13 mmol of NO3-) or NO3depleted (PL, <0.1 mmol of NO3-) beetroot juice for 7 consecutive days. Muscle biopsy samples were collected on day 7 of supplementation at rest (Pre) and after (Post) attaining 80% of task failure during a constant work rate severe-intensity cycling test, which was established during a preliminary severe- intensity performance test. Mitochondrial respiratory variables were assessed in permeabilised muscle fibre bundles. Specifically, uncoupled leak respiration through complex I (CIL), saturating adenosine diphosphate stimulated respiration through complex I (CIP) and complex I+II (CI+IIP), and maximal electron transfer system activity through complex I+II (CI+IIE), complex II (CIIE) and complex IV (CIVE) were assessed using high-resolution respirometry. In addition, coupling control ratio (CIL/CI+IIP; 1/RCR) was used as a marker of oxidative phosphorylation coupling efficiency. Data were analysed with two-way (supplement x time) repeated-measures ANOVAs.

RESULTS: There were main effects for time for CIL (PL-Pre: 4 ± 2, BR-Pre: 8 ± 3, PL-Post: 7 ± 2, BR- Post: 9 ± 5 pmol/s/mg), CIP (PL-Pre: 53 ± 11, BR-Pre: 58 ± 18, PL-Post: 66 ± 10, BR-Post: 70 ± 21 pmol/s/mg), CI+IIP (PL-Pre: 98 ± 21, BR-Pre: 100 ± 14, PL-Post: 115 ± 14, BR-Post: 114 ± 12 pmol/s/mg) and CI+IIE (PL-Pre: 106 ± 21, BR-Pre: 108 ± 15, PL-Post: 124 ± 13, BR-Post: 124 ± 13 pmol/s/mg; all $P<0.05$). There were no main effects for supplement ($P>0.05$) or no supplement x time interaction effects ($P>0.05$) on any of the mitochondrial respiratory variables.

CONCLUSION: Short-term NO3- supplementation did not alter skeletal muscle mitochondrial respiratory variables prior to or following severe-intensity cycle exercise in healthy adults.

ACUTE EFFECT OF BEETROOT JUICE ON PHYSIOLOGICAL RESPONSES OF WOMEN TO EXERCISE

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INTRODUCTION: Beetroot juice has emerged as a widespread ergogenic dietary supplement with its natural nitrate content playing a key role in modifying normal responses to exercise. Research on the effects of even a single dose of a beetroot supplement to exercise performance is ample in men but scarce in women, despite the biological sex differences that exist in nitric oxide metabolism (Wickham & Spriet, 2019). The purpose of this study was to examine the acute effect of beetroot juice on physiological exercise responses in young physically active women.

METHODS: Six young (24.2±5.7 yrs) physically active (VO2max 31.1±3.1 ml/kg/min) females participated in the study. The participants performed a protocol with three types of exercise (submaximal work, sprinting, and incremental exercise to exhaustion) in two conditions, conducted between mean luteal and the beginning of the next ovarian phase of their menstrual cycle, 150 minutes after ingesting an acute dose of: a) a beetroot juice containing 6-7 mmol nitrate, and b) a placebo drink of similar color and taste with beetroot juice. Blood pressure (at rest, before and after drink administration, and post-exercise), heart rate, oxygen consumption (VO2), and power output were measured. Statistical analysis was performed using paired t-test.

RESULTS: Resting mean blood pressure was maintained 150 min after the intake of beetroot juice, whereas it was marginally increased ($p=0.068$) after the placebo drink. The mean VO2 during submaximal work was similar after the ingestion of beetroot juice and placebo. Peak power at the sprint also did not differ significantly. In the exercise test of gradually increasing intensity to exhaustion, both maximal VO2 and maximal power output did not differ significantly between conditions, but maximal heart rate was higher after beetroot than after placebo ingestion ($p=0.015$). Post-exercise systolic blood pressure was lower at the 10th min of recovery in the beetroot compared to the placebo condition ($p=0.029$).

CONCLUSION: In the present study, no significant differences were found in oxygen consumption at submaximal and maximal work, as well as in power output produced at 10-sec maximal sprint and at VO2max. The effect of beetroot ingestion on maximal heart rate and on resting blood pressure values pre- and post-exercise could suggest a compensatory reaction of the body against a reduction of total peripheral resistance elicited by nitric oxide acting as a vasodilator. It is possible that beetroot ingestion led to improved baroreceptor sensitivity increasing the range of positive heart rate response during exercise (Wehrwein & Joyner, 2013).

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EFFECTS OF 12 WEEKS OF OMEGA-3 FATTY ACID SUPPLEMENTATION IN LONG-DISTANCE RUNNERS

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INTRODUCTION: Omega-3 index (O3I) has been recognized as the best marker of omega-3 PUFA status. O3I is positively associated with many health indicators and outcomes in the general population. However, it's relation with physical performance indicators in athletes is poorly understood. We determined the effects of 12 weeks of omega-3 PUFA supple-

mentation compared with medium-chain triglycerides (MCT) as placebo during endurance training on O3I and physical performance indicators in amateur runners.

METHODS: 40 participants were randomly assigned to OMEGA or MCT groups providing either omega-3 PUFA (2234 mg·d−1 of EPA and 916 mg·d−1 of DHA) or MCTs as placebo (4000 mg·d−1). All participants completed a 12-week progressive endurance training programme supervised by a track and field coach, consisting of 3 four-week phases, together with simultaneous supplementation. A graded exercise test to exhaustion with assessment of VO2 peak, running economy and a 1500-m run trial were carried out before and after completion of the exercise training programme.

RESULTS: From the 40 participants enrolled, 26 completed the entire study (14 in the OMEGA and 12 in the MCT group). Twelve weeks of omega-3 fatty acid supplementation during endurance training increased O3I in the OMEGA group to the target range (from 5.8% to 11.6%, $P < 0.0001$) without significant changes in the MCT group. There was no significant difference between groups in change in VO2peak over the 12-week intervention period ($P = 0.6764$). However, a significant increase in VO2peak from pre- to post intervention in OMEGA group was observed (from 53.6 ± 4.4 to 56.0 ± 3.7 mL·kg−1·min−1, $P = 0.0219$) with no significant change in MCT group (from 54.7 ± 6.8 to 56.4 ± 5.9 mL·kg−1·min−1, $P = 0.1308$). Increase in VO2peak was seen in 13 (93%) out of 14 participants in the OMEGA group, whereas in the MCT group, improvements were visible in 9 (75%) out of 12 runners. When results pre- and post- 12-week intervention from all participants were combined, correlation highlighted the relationship between O3I and oxygen cost of submaximal running ($P = 0.0338$). No difference between groups in completion of the 1500-m run trial was seen (pre- to post-intervention between groups, $P > 0.9999$).

CONCLUSION: Twelve weeks of omega-3 PUFA supplementation at a dose of 2234 mg of EPA and 916 mg of DHA daily during endurance training resulted in the improvement of O3I and running economy and increased VO2peak without improvement in the 1500-m run trial time in amateur runners. Compared with previous studies in which performance indicators were assessed, our supplementation protocol was a higher dose over a longer supplementation period. However, what values of O3I are sufficient for amateur and competitive athletes to optimize athletic performance remains a question to be answered in future studies.

INCREASED SKELETAL MUSCLE NITRATE CONCENTRATION FOLLOWING 3 DAYS OF NITRATE SUPPLEMENTATION IS NOT INFLUENCED BY PRIOR NITRATE AVAILABILITY

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INTRODUCTION: Skeletal muscle nitrate (NO_3^-) concentration is increased following NO_3^- ingestion, and its decline during exercise is associated with enhanced performance. Rodent models have shown that muscle [NO_3^-] can be augmented by consuming NO_3^- following a period of low dietary NO_3^- availability, i.e., there is a 'supercompensation' response. The purpose of the current study was to assess whether, in humans, muscle [NO_3^-] was increased and exercise performance was improved to a greater extent following NO_3^- supplementation when preceded by 7-d low compared to 7-d normal dietary NO_3^- intake.

METHODS: Nine participants (8 males1 female; age: 22 ± 1 y; body mass: 76.2 ± 8.8 kg) were assigned in a randomized, crossover design to a calorie and macronutrient matched: i) 7-d low (<50 mg NO_3^- per day), or; ii) 7-d normal (~180 mg NO_3^- per day) NO_3^- diet, that was immediately followed by 3-d high NO_3^- intake. At baseline (i.e., prior to the 7-d prescribed diet), and at completion of the dietary interventions, participants completed a 10-s all-out sprint and a ramp incremental cycle test. Saliva, plasma and skeletal muscle samples were collected for determination of [NO_3^-] and nitrite ([NO_2^-]) using ozone-based chemiluminescence.

RESULTS: Saliva, plasma, and skeletal muscle [NO_3^-] and [NO_2^-] were not different between diets at baseline. Skeletal muscle [NO_3^-] was significantly increased when high NO_3^- intake was preceded by both the 7-d normal or 7-d low NO_3^- diets, but no difference was observed in the absolute or percentage increase between the conditions. Skeletal muscle [NO_2^-] was not changed from baseline for either diet. Ramp incremental exercise performance and 10-s sprint performance were not changed from baseline and were not different between conditions. No significant correlations were observed between absolute or percentage change in skeletal muscle [NO_3^-] and absolute or percentage changes in exercise performance variables.

CONCLUSION: This study shows, for the first time, that skeletal muscle [NO_3^-] is increased to a similar extent following 3-d high NO_3^- intake irrespective of dietary NO_3^- availability during the previous 7-d, i.e., there was no 'supercompensation' response. Under the conditions of the present study, neither ramp incremental nor 10-s sprint performance were enhanced.

EFFECT OF ARGININE-CITRULLINE SUPPLEMENT ON SKIN-GAS NITRIC OXIDE CONCENTRATION AND PERFORMANCE FOLLOWING MAXIMAL RUNNING EXERCISE

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INTRODUCTION: The combination of oral L-arginine and L-citrulline immediately and synergistically increases plasma arginine and nitrite/nitrate (NOx) concentrations more than either citrulline or arginine alone (1,2). Nitric oxide (NO) is the most important endothelium-derived relaxing factor, which plays a pivotal role in modulating smooth muscle tone (3). During exercise, increasing NO production facilitate blood flow in muscle tissues, muscle energy metabolism, and mitochondrial respiration, therefore previous human study has reported that oral arginine-citrulline supplement improved exercise performance due to increased NO bioavailability (1). However, there is no data concerning with the effect of arginine-citrulline supplement on skin-gas NO concentration during exercise. The present study examined to confirm the effect of arginine-citrulline supplement on skin-gas NO concentration and performance following maximal running exercise.

METHODS: A double-blind randomized placebo-controlled 2-way crossover study was employed. Ten healthy male students (23.0 ± 1.5 years; mean ± SD) consumed arginine-citrulline supplement (VELOX Charge: Kyowa Kirin Co., Ltd., Japan) or placebo orally 1 h before incremental maximal running exercise exhausting within 30 min. The skin-gas samples were obtained from the dominant hand by covering with a polyethylene bag in which pure nitrogen gas (250mL) was introduced for 100 sec, and collected in a sampling bag at rest and 0, 5, 10, 15, 30 min recovery of the exercise. The skin-gas NO concentration was measured by a chemiluminescence analyzer (Pico-Device Co., Ltd., Japan). Blood flow measured using a laser tissue blood flow meter from the non-dominant index finger belly and leg thigh skin surface (Omegaflo, Omega Wave, Japan).

RESULTS: The arginine-citrulline supplement significantly ($p<0.05$) increased running time and distance compared to the placebo. Maximal exercise in this study significantly increased skin-gas NO concentration ($p<0.05$) and blood flow ($p<0.001$) after the exercise compared to the resting values. Significant higher levels were observed in skin-gas NO concentration ($p<0.001$) and blood flow ($p<0.001$), thus there was a significant interaction in skin-gas NO concentration ($p<0.05$) and blood flow ($p<0.001$) between the arginine-citrulline supplement and the placebo.

CONCLUSION: Significantly higher levels of skin-gas NO concentration has indicated that the arginine-citrulline supplement increased NO production and NO bioavailability in the whole body during the maximal exercise. As a result, blood flow in muscle tissues, muscle energy metabolism, and mitochondrial respiration during exercise facilitated by the arginine-citrulline supplement, consequently improved exercise performance (1).

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INFLUENCE OF MUSCLE SIZE GROUP ON THE ERGOGENIC EFFECT OF CAFFEINE ON MUSCULAR STRENGTH, POWER AND ENDURANCE

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INTRODUCTION: There is a consensus that caffeine improves muscular strength-power-endurance performance; however, we did not entirely understand the mechanism of action of this substance. If the caffeine ergogenic effect occurs in the CNS, a higher increase in force production should occur in larger muscle groups by eliciting a higher increase in motor unit recruitment and firing rates than in small muscle groups. While if caffeine has a direct effect on muscle, the ergogenic effect of this substance should occur to a similar extent across muscle groups. Previous studies support the central effect hypothesis by observing a more pronounced improvement in mean isokinetic peak torque of larger than smaller muscle groups. However, the ergogenic effect of caffeine according to muscle size group has been scarcely investigated in isotonic exercises. Thus, this study aimed to examine the effects of acute caffeine intake on upper and lower-body muscular strength-power-endurance performance at different loads.

METHODS: Twenty resistance-trained athletes (male/female: 10/10; age: 23±4 yr; body mass: 71±15 kg) participated in a double-blind, placebo-controlled, cross-over and randomized study. Participants were provided with either 3 mg/kg of body mass of caffeine or maltodextrin (placebo). Sixty minutes after ingestion, they performed muscular strength and power assessment for bench press and back squat exercises at 25%, 50%, 75% and 90% 1-repetition-maximum (1RM), performing 3, 2, 1 and 1 repetitions, respectively. Then, muscular endurance was assessed for both exercises at 65% and 85% 1RM performing one set until task failure.

RESULTS: Compared to placebo, caffeine improved mean velocity (Vmean, ANOVA effect, P=0.045), mean power (Wmean, ANOVA effect, P=0.049) and rate of force development (RFD, ANOVA effect, P=0.032) in muscular strength and power test, particularly in back squat exercise at 75% and 90% 1RM where Vmean increased by 5-7% (P=0.48-0.038), Wmean by 6-8% (P=0.050-0.032) and RFD by 17-97% (P=0.042-0.046). No differences were found in the bench press exercise. In muscular endurance, caffeine improved the number of repetitions in all exercises and loads (ANOVA effect, P=0.003), but only

in back squat exercise at 85% 1RM, caffeine increased Vmean and Vpeak (8-9%, P=0.006-0.004), Wmean and Wpeak (10-13%, P=0.006-0.003) and force peak (3%, P=0.009).

CONCLUSION: This study compared back squat and bench press exercises, where the quadriceps and pectoralis are the main muscles involved, respectively. The results show a more pronounced ergogenic effect of low doses of caffeine on muscular strength-power-endurance performance by increasing Vmean, Wmean and RFD according to muscle size group. Therefore, this study reinforces the central effect hypothesis that caffeine improves force and power production by stimulating the CNS through increasing motor unit recruitment and firing rates in isotonic tasks.

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CO-SUPPLEMENTATION WITH NITRATE AND RESVERATROL PREVENTS HIGH-FAT-DIET MEDIATED REDUCTIONS IN BRAIN BLOOD FLOW, BUT SURPRISINGLY DECREASES MITOCHONDRIAL RESPIRATORY CAPACITY IN THE CORTEX OF MALE MICE

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INTRODUCTION: Mitochondrial biology affects neurological health, as oxidative phosphorylation (OXPHOS) influences action potential conductance and dendritic growth, while excessive reactive oxygen species (ROS) production has been linked to atrophy. Dietary nitrate (NIT) and resveratrol (RSV) are two nutraceuticals that may optimize mitochondrial biology within the brain as they can cross the blood-brain barrier and coordinate blood flow. In the present work, we aimed to characterize the effects of a high-fat diet (HFD) on mitochondrial bioenergetics within the cortex, as well as determine if supplementation with NIT and RSV could prevent HFD-mediated changes in blood flow and mitochondrial biology within this region of the brain in an independent and/or additive manner.

METHODS: C57Bl/6N male mice consumed a low-fat diet (LFD; 10% fat) or a HFD (60% fat) for eight weeks (n=9-10/group). Blood flow to the brain was measured via carotid ultrasonography and following the intervention period, the cortex was permeabilized to determined mitochondrial respiratory capacity, and homogenized for analysis of various protein targets. These experiments were repeated with nutraceutical interventions where mice consumed one of four HFD variations (n=12/group): un-supplemented (HFD), supplemented with +NIT (4mM sodium nitrate via drinking water), + RSV (172mg RSV/kg diet), or combined +NIT+RSV.

RESULTS: Compared to the LFD group, HFD feeding decreased blood flow to the brain as indicated by reduced carotid diameter, aortic velocity time integral (VTI), and carotid flow rate. Concurrently, HFD-fed mice also displayed strong trend for a decrease in VEGF protein content ($p = 0.0565$) in the cortex. Despite the reduction in blood flow, HFD-feeding did not alter mitochondrial content, nor maximal ADP, complex I- and complex II-supported mitochondrial respiration. Supplementation with +NIT+RSV prevented HFD-mediated decreases in carotid diameter, VTI and carotid flow rate in conjunction with an increase in VEGF protein content in the cortex. While combined treatment did not alter markers of mitochondrial content, despite the preservation of blood flow, +NIT+RSV supplementation decreased maximal complex I- and complex II-supported mitochondrial respiration.

CONCLUSION: While combined +NIT+RSV treatment prevented HFD-mediated decreases in blood flow to the brain, this occurred alongside reduced maximal mitochondrial respiration. Taken together, future research is required to integrate the effects of increased blow flow and reduced OXPHOS to understand in vivo biology, and to determine the effect on redox biology.

Conventional Print Poster

CP-PN13 Thermoregulation II

GREATER POST-EXERCISE HYPOTENSION IN HEALTHY UNTRAINED MEN AFTER EXERCISING IN THE HEAT

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INTRODUCTION: Mean arterial pressure (MAP) is lowered for approximately 2 h after physical exercise; a phenomenon called post-exercise hypotension (PEH). Whether exercising in the heat increases PEH compared to exercise in temperate conditions is unclear [1,2]. This study compared changes in MAP in healthy young untrained men after an acute bout of exercise in a temperate and hot environment. We hypothesized that exercise in a hot environment would elicit greater PEH than in a temperate environment.

METHODS: Twelve participants completed two experimental conditions, 40-min leg-cycling exercise at the intensity of 60% of maximal oxygen uptake in 23°C (CON) and 35°C (HOT). After exercise, they rested in the supine position for 60 min at 23°C. Blood pressure, skin blood flow at chest (CVC), and cardiac baroreflex sensitivity (cBRS) were assessed pre-exercise and after 10, 20, 30, 40, 50, 60 min of exercise.

RESULTS: Post-exercise hypotension was greater after exercising in a hot than temperate environment as indicated by a lower mean arterial pressure (MAP) at 60 min recovery (CON 83 ± 5 mmHg, HOT 78 ± 5 mmHg, Mean difference [95% confidence interval], Δ−5 [−8, −3] mmHg). Throughout the 60 min recovery CVC was higher and cBRS was lower after

exercising in a hot compared to temperate environment (P < 0.001). Sweat loss was greater on HOT than CON (P < 0.001). After exercising in the heat changes in MAP were associated with changes in sweat loss (r > 0.66, P = 0.02) and CVC (r > 0.64, P = 0.03). In contrast, no relationships were observed between changes in cBRS and MAP (P > 0.05).

CONCLUSION: A single bout of exercise in a hot environment elicited greater hypotension during recovery than in a temperate environment Greater PEH in HOT of the present study was consistent with a previous study completed in an inactive untrained population [1]; however, it contrasts the findings of another study completed in an endurance trained population [2]. Collectively, these studies suggest after exercising in the heat inactive and untrained people suffer greater PEH than endurance trained people. As PEH is related to risk of syncope this suggests inactive and untrained people may be at increased risk of syncope and falls after exercising in hot conditions. Our correlative data (R square) identify that the relationship between changes in CVC and MAP explains 40% of the variance for PEH in HOT. In addition, the changes in CVC during recovery from baseline were related to the changes in MAP in the hot environment. These findings suggest that the changes in MAP during recovery, preceded by a single bout of exercise in a hot environment, were more passive to changes in cutaneous circulation and may help explain the increased risk for post-exercise syncope in hot environments.

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EFFECT OF HOT WATER IMMERSION ON TRAINING ADAPTATION FOLLOWING A 10-WEEK RESISTANCE TRAINING PROGRAMME

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INTRODUCTION: Hot water immersion (HWI) is a strategy that has been shown to influence acute physiological responses following resistance exercise. However, the impact of regular HWI following resistance exercise on adaptation following a period of training is yet to be determined. This study investigated the effect of regular post-exercise HWI on markers of training adaptation following a resistance training programme.

METHODS: Sixteen trained males performed resistance training twice per week for 10 weeks, with either 10 min of HWI or passive recovery (PAS) after each session. Anthropometric variables of body mass, body fat percentage, as well as lower limb fat mass and fat free mass were measured pre- and post-resistance training programme using dual energy x-ray absorptiometry. Performance measures of one-repetition max (1RM), six-repetition max (6RM), maximal voluntary isometric contraction (MVIC) and isometric squat peak force were assessed before and after the training intervention.

RESULTS: As a result of the training programme, there was a significant increase in lean tissue in the lower limbs ($F(1, 14) = 9.082$, $P = 0.009$), although there was no difference between groups. Post-training, there were significant increases in maximal strength, although there were no differences between groups (($F(1, 14) = 20.513$, $P = <0.001$) and ($F(1, 14) = 50.871$, $P = <0.001$) for 1RM and 6RM respectively).

CONCLUSION: These data suggest that HWI does not appear to enhance maximal strength following a 10-week resistance training programme. However, further research is warranted to determine whether HWI can manipulate acute physiological responses, which over time may accumulate to contribute to small enhancements in strength in response to a training programme.

THE EFFECT OF PRE-EXERCISE HYPERHYDRATION ON EXERCISE PERFORMANCE, PHYSIOLOGICAL OUTCOMES AND GASTROINTESTINAL SYMPTOMS: A SYSTEMATIC REVIEW

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INTRODUCTION: Fluid loss during prolonged exercise in hot conditions poses thermoregulatory and cardiovascular challenges that can impair performance. Pre-exercise hyperhydration, defined as an increase in total body water above normal levels, can be achieved using osmotic aids (e.g., glycerol, sodium). This strategy may prevent or delay the adverse effects of dehydration and attenuate the impact of heat stress on exercise performance. The aim of this systematic review was to determine the effect of pre-exercise hyperhydration strategies on performance in temperate and hot conditions, key physiological responses (i.e., heart rate, core temperature and changes in plasma volume) and gastrointestinal symptoms.

METHODS: Inclusion criteria comprised: English language, full-text articles published up to and including October 2022 that compared the intervention to a baseline or placebo condition. Exclusion criteria comprised: studies that involved concurrent interventions or an initial dehydration period and rehydration period prior to exercise. A quality assessment was conducted by two authors using the American Dietetic Association Quality Criteria Checklist.

RESULTS: Thirty-eight studies involving 375 participants (n = 339 males) were included in this review (n = 22 assessed exercise performance or capacity). Two studies reported an improvement in time-trial performance (range 5-11%), three studies reported an improvement in total work completed (kJ) (range 4-5%), and five studies reported an increase in exercise capacity (range 12.5-28%). During constant work rate exercise, eight studies reported a reduced mean heart rate

(range 3-9 beats·min-1), and nine studies reported a reduced mean core temperature (range 0.1-0.8°C). Eleven studies reported an increase in plasma volume (range 3.5-9.8%). At least one gastrointestinal symptom was reported in 26 studies, with severity depending on the hyperhydration strategy (i.e., treatment, dose, ingestion rate).

CONCLUSION: Pre-exercise hyperhydration may improve exercise capacity in trained athletes at a given work rate in association with a reduced heart rate and core temperature, likely stemming from an acute increase in plasma volume. Limitations within this research area include a lack of valid and reliable tools used to monitor gastrointestinal symptoms and lack of adequate blinding techniques to reduce the possibility of a placebo effect. The inclusion of female participants and the effect of the menstrual cycle on fluid retention and pre-exercise hyperhydration remains a key area of interest for future research.

EFFECT OF CRYOSTIMULATION AFTER EXERCISE IN A HOT ENVIRONMENT ON THE CARDIOVASCULAR SYSTEM AND BODY TEMPERATURE

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INTRODUCTION: Exercising in a hot environment causes hyperthermia, which reduces exercise performance (Gonzàlez-Alonso et al. 1999). Especially during standing exercise, the increase in skin blood flow due to elevated body temperature causes blood pooling in the lower limb and cutaneous vasculature (Rowell 1986). Cryostimulation of the whole body and lower limb after exercise reduces core temperature and eliminates blood pooling through peripheral vasoconstriction (Yamazaki et al. 2002), thereby restoring cardiovascular and thermoregulatory function. In this study, cryostimulation of the whole body and lower limb and sole after exercise in a hot environment was to examine the effect of cardiovascular and thermoregulatory function.

METHODS: Six trained subjects (age: 24 ± 2 years, height: 175.5 ± 4 cm, weight: 71.3 ± 5.8 kg) completed a submaximal (70% Vo_2max) constant load exercise test for 30 minutes in a hot environment (Ta 35°C, RH 60%). After exercise, the subjects were exposed to a whole-body (WBC) and lower limb to cryobath at -120°C and sole was cooling ice pack at -50°C for 2 minutes. Measurements were taken for esophageal temperature (Tes), skin temperature, heart rate (HR), cardio output (CO), stork volume (SV), forearm blood flow (FBF), muscle temperature.

RESULTS: There was a significant decrease in Tes(rest:38.50±0.48°C vs WBC:37.99±0.43°C, lower limb:38.18±0.50°C, sole:38.32±0.40°C P>0.05), HR(rest:130±14bpm vs WBC:117±15bpm, lower limb:118±17bpm, sole:121±15bpm P>0.05), muscle temperature(rest:38.72±0.72°C vs WBC:37.93±0.43°C, lower limb:38.10±0.60°C, sole:38.54±0.57°C P>0.05) and FBF(rest:13.07±3.19ml/min/100g vs WBC:8.92±1.23ml/min/100g, lower limb:9.88±4.16°C, sole:10.22±3.08°C P>0.05) and a significant increase in SV(rest:71±9ml vs WBC:82±7ml, lower limb:81±9°C, sole:75±8°C P>0.05) after cryostimulation compared to rest. Skin temperature decreased significantly in WBC and lower limb.

CONCLUSION: Cryostimulation for 2 minutes after exercise significantly decreased Tes and significantly increased SV in lower limb and sole. It is suggested that the cutaneous vasoconstriction caused by cryositimulation increased venous return and increased SV. Whole body cryostimulation showed a large decrease in temperature. But the same cooling effect as in the lower limb and WBC was obtained for all points except the mean skin temperature in sole, which has a smaller cooling area. The temperature was higher than that of the whole body and lower limb, but this result may have been due to through arteriovenous anastomoses in the sole. It was shown that there was no difference in cardiovascular function, although there was a large difference in temperature only due to the difference in the cryostimulation area.

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INTERMITTENT RUNNING IN THE HEAT ON SYNTHETIC GRASS INCREASES MARKERS OF HEAT STRESS COMPARED TO NATURAL GRASS

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INTRODUCTION: The surface temperature of synthetic grass sports surfaces becomes considerably hotter than natural grass when exposed to high levels of sunlight. Some data has also demonstrated that synthetic grass surfaces can increase the ambient and radiant temperature above the surface. However, it is unknown if a synthetic surface can increase human heat stress during exercise compared to natural grass. Therefore, this study aimed to determine if synthetic grass surfaces impose a thermal load that elicits physiological or perceptual changes in athletes during intermittent running, compared to natural grass.

METHODS: Thirteen recreational team-sport athletes performed a baseline 30-15 fitness test, and then, with a randomised and cross-over design, two separate 50-minute standardised intermittent running trials on a synthetic and natural grass surface, separated by one week, on hot days. Environmental parameters, core and skin temperature, heart rate, sweat rate, and perceptual ratings were measured.

RESULTS: There were no significant differences in wet-bulb-globe temperatures between the two trials (synthetic: 27.41 ± 0.12°C; natural: 26.65 ± 0.49°C; p >0.05). The change in mean core body temperature from baseline to the end of the

trials was not significantly different between surface types (synthetic: 1.31 ± 0.34°C; natural: 1.42 ± 0.54°C; p >0.05). Compared to baseline, there was a significant increase in mid-calf skin temperature for synthetic (7.12 ± 2.92°C) compared to natural (0.48 ± 0.90°C; p <0.001) and shoulder skin temperature for synthetic: (2.48 ± 2.16 °C) compared to natural (0.64 ± 1.26°C; p <0.001), at the end of the trial. The mean perception of thermal sensation across the protocol was significantly higher on synthetic (2.8 ± 0.4) compared to natural (2.4 ± 0.5; p = 0.013). Sweat rate was also higher on synthetic (1.53 ± 0.43 L/hr) compared to natural (1.23 ± 0 .31 L/hr; p = 0.017). There were no significant differences in mean heart rate, rate of perceived exertion, thermal comfort or chest skin temperature across the trials (p >0.05).

CONCLUSION: The findings demonstrate that running on a synthetic grass surface compared to natural grass on a hot day increases a range of markers of heat stress, including skin temperatures, sweat rate, and perceived thermal sensation. However, there was no difference in core body temperature. Sport's governing bodies, facility managers, and any individual organising or prescribing exercise or sport on a synthetic surface on hot days should consider this additional heat stress. More data is required to determine the implications for different sports in different environmental conditions and on different synthetic surfaces.

ICE INGESTION MAINTAINS COGNITIVE PERFORMANCE ON A REPEATED SPRINT PERFORMANCE IN THE HEAT

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INTRODUCTION: Environmental factors have a major influence on exercise performance. Notably, excessive exercise in the heat often results in increased physiological demands and reduced ability to deal with cognitive loads. This has been attributed to the elevation of core body temperature (Tc), which can subsequently impair exercise and cognitive performance. The elevation of Tc is a result of a disturbance in thermoregulation processes during exercise in the heat, which reduces the ability of the body to return to homeostasis. Hence, the body is unable to regulate its Tc within a normal range (36.5 – 37.5°C). Consequently, when Tc reaches 39°C, which is known

as a critical Tc threshold, it represents one of the key limiting factors to exercise tolerance in the heat, leading to reduced force output, cardiovascular strain, premature termination of exercise, and increased risk of heat illness. Of relevance, when Tc increases during exercise, particularly when performed in the heat, the temperature of arterial blood flow to the brain also increases, placing a thermal load on the brain, which in turn can result in central fatigue. Furthermore, an increase in Tc during exercise in the heat results in a concomitant reduction in cerebral blood flow to the brain due to the need for the body to direct blood flow to the

periphery for cooling purposes, with blood flow to the brain further compromised if dehydration, as a result of sweating, occurs.

METHODS: Nine males, non-acclimatised to heat (mean age: 28.2±2.7 y; height: 175.7±9.7 cm; body-mass: 76.9±10.6 kg) completed a 30 min bout of repeated sprint (36 sprint × 4 s) on a cycle ergometer. Crushed ice ingestion (7g·kg-1, -0.4°C, ICE) or no cooling (CON) interventions were completed at rest, 30 min prior to exercise in the heat chamber (35°C, 70% relative humidity). Working memory was assessed via Serial Seven Test (S7) and the Automated Operation Span Task (OSPAN) before cooling/no cooling, prior and after exercise. Core body temperature (Tc), forehead temperature (Th) and thermal sensation (TS) were assessed during the protocol.

RESULTS: Precooling significantly decreased Th (-0.59°C, p<0.001) and Tc (-0.67°C, p=0.005) in ICE compared to baseline but increased in CON (Th: +0.54°C, p<0.001, Tc: +0.17°C; p=0.01). Further, S7 and OSPAN scores significantly declined over time in CON compared to baseline, p<0.05. Although S7 and OSPAN were not different in ICE (p=0.94, p=0.84, respectively) compared to CON, ICE has been shown to preserve working memory by maintaining S7 between baseline (20±2.6) and min 27 (20±3.7,p>0.05) and OSPAN between baseline (65±5.4) and min 30 (66.8±4.2 p>0.05) compared to CON. In addition, thermal sensation was lower at baseline in ICE compared to CON (p<0.05).

CONCLUSION: Crushed ice ingestion significantly reduced Th and Tc and subsequently facilitated maintenance of cognitive performance responses during intermittent repeated sprint in the heat.

INTERVAL TRAINING AS A MEANS OF MAINTAINING A HIGH LEVEL OF PERFORMANCE OF ATHLETES IN CONDITIONS OF HIGH AMBIENT TEMPERATURE.

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INTRODUCTION: This study aimed to investigate the effects of hyperthermia on physiological parameters of a high-level athletes at rest and during exercise of varying intensity. The study was conducted in a laboratory setting and results were tested under real conditions of increased environmental temperature at training camps in Brazil. Physiological parameters were measured at rest, at the aerobic threshold, anaerobic threshold, maximal power output and during submaximal exercises. The results of this study have important implications for athletes competing in the upcoming Olympics in 2024 and 2028, as the ambient temperature during the competition will be high [1,2,3].

METHODS: 86 highly qualified team sports athletes were tested to determine VO2max and maximum alactic power. Testing was performed on Ergoline 200 and Monark 894E bicycle ergometers using a Cortex Metamax 3B gas analyzer. To simulate the conditions of hyperthermia, the subjects entered the sauna (t=90-95°C, humidity <10%) until the temperature of the core of the body increased to 38-38.5°C. The temperature was measured in the ear with the "TermoScan" device

(p<0.1°C). After that, the subjects performed a load on a bicycle ergometer at room conditions (tk = 25.3 °C) with a load of varying intensity. The results obtained were tested on 15 athletes of the countrys national rugby-7 team in Brazil at an ambient temperature of 33-35 °C during training and competitive exercises. Athletes were measured core body temperature, the concentration of lactic acid in capillary blood, the subjective state of the athlete was assessed, the intensity of the exercise was recorded using Catapults GPS performance tracking system monitors, measuring heart rate (HR) and heart rate variability (HRV).

RESULTS: When performing a load at the level of the aerobic threshold and below, the core temperature of the athletes body decreases. Performing a load at the level of the anaerobic threshold (AT) leads to a faster achievement of the maximum temperature of the body core (40-40.5 °C) and, as a result, reduces the duration of the load with the AT power by 40-50% and an increase in heart rate at the AT level by 30±4 bpm. With an increase in body temperature, the maximum duration of the exercise with submaximal power decreases by 15% (p<0.001), while the indicators of maximum strength and power increase by 7% (p<0.001).

CONCLUSION: The temperature of the core of the body after heating to 39 - 40 °C can be significantly reduced when performing work with a power below the aerobic threshold. Performing a rest interval with power at the level of anaerobic threshold and above leads to the accumulation of heat in the body of athletes. Therefore, the interval method of training with the performance of speed and speed-strength exercises and active rest intervals, with power below the aerobic threshold, will allow organizing effective training sessions in a hot climate, while maintaining the high performance.

EFFECTIVENESS OF MIXED METHOD PRECOOLING ON PERFORMANCE IN NATURALLY HEAT ACCLIMATISED TEAM-SPORT ATHLETES

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INTRODUCTION: Heat alleviation techniques, acclimatisation/acclimation and pre-cooling are often used to combat the negative effects heat and humidity have on exercise performance. Unsubstantiated claims suggest that pre-cooling may not add additional benefit to those already acclimatised/acclimated due to the reduced efficacy of precooling when the thermal stress experienced by an individual is low. This study aimed to determine if those who present as being naturally acclimatised to hot and humid environmental conditions benefit from precooling under differing thermal conditions.

METHODS: Ten male, team-sport athletes completed six experimental trials under three thermal conditions; (1) warm and humid (33˚C, 70% relative humidity [RH], 41˚C apparent temperature [AT]); (2) hot and dry (38˚C, 30% RH; 43˚C AT); (3) hot and humid (38˚C, 70% RH; 50˚C AT). All participants resided in Singapore and were naturally acclimatised to hot and humid thermal conditions. Each trial was completed twice in the three thermal conditions, once with 30 min of mixed-method (7 g·kg-1 BM of shaved ice plus ice jacket) pre-cooling (PC) and once without (CON). Following the PC or CON period, participants completed a repeat sprint exercise protocol on a cycle ergometer. The protocol consisted of 2 x 30 min halves, consisting of 30 x 4 s maximal sprints every minute interspersed with 56 s of exercise at varying intensities (25, 50, 75 and 100 Watts [W]). An additional six sprints were performed every 5 min, starting at 2.5 min. Separating the two halves was a 10 min break where during the PC trials, participants ingested 2.3 g·kg-1 BM of shaved ice and wore the cooling jacket whilst during the CON the equivalent in plain water was ingested. Water was consumed at the 15 min mark of each half (100 mL) and an additional 100 mL of a sports drink was consumed during half-time.

RESULTS: Overall mean power, and first and second half mean power were not different between the PC and CON trials within each of the same thermal conditions. Between the PC and CON trials within the same thermal conditions, core temperature was not different except at the start of the first half where participants started cooler in the PC trial (36.0 ± 0.7°C) compared to CON (36.9 ± 0.2°C) in the 50˚C AT condition (p<0.05). No differences were apparent between trials (PC vs CON) within each of the same thermal conditions for HR, RPE, thermal sensation or thermal comfort.

CONCLUSION: These results suggest that those who are naturally acclimatised to hot and humid environmental conditions did not benefit from precooling in either a warm dry, hot dry, or hot humid environment, when performing repeat-sprint exercise. This contributes to the evidence that precooling in male team-sport athletes who are naturally acclimatised to hot, humid conditions may not enhance repeat-sprint performance.

HEART RATE AS AN EARLY INDICATOR OF PREDICTED CORE TEMPERATURES DURING EXERTION IN THE HEAT

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INTRODUCTION: It is well documented that exercise in hot environments leads to higher core temperatures and associated decreased performances than cooler settings. (1) Heat illnesses constitute an array of conditions from exercise-associated collapse, heat intolerance to the most severe presentation of exertional heat stroke, of which one of the main clinical features include a core temperature greater than 40 degrees Celsius (˚C).(2) Identifying potentially susceptible individuals is of clinical value in certain settings. While finishing core temperature is often utilized as an outcome measure in heat tolerance tests, determining clinically relevant, easier to measure physiological factors, e.g. heart rate, could allow for improved monitoring during heat-stress related settings.

METHODS: Eight men and seven women regular runners performed four self-paced 10km treadmill time trials, one in cool (15˚C; 50% relative humidity(RH))and three in hot (32˚C; RH 50%) conditions in an environmental chamber, one week apart. Due to the complexity of thermoregulatory homeostasis, multiple physiological variables were recorded at regular inter-

vals, however, only finishing core temperature (Tc-fin), finishing time (Tmin-fin) and HR recorded at 10 and 20 minutes and finish were analysed and correlated in this analysis.

RESULTS: Significantly higher Tc-fin and HR were recorded in the hot trials compared to the cold trial ($p < 0.05$). No relationships were found in the cold trial measures between Tc-fin and HR. In the hot trials, relationships were found between Tc-fin and finishing % maximum HR in the male group only ($r=0.74$, $p< 0.05$). At both 10 and 20 minutes, relationships were found between Tc-fin and %maximum HR at these time points; ($r=0.82$, $p<0.05$);($r=0.83$, $p<0.05$) respectively, but again the male group only. In contrast, no relationship between finishing % max HR and Tmin-fin for the male group, but weaker correlations present in females ($r=0.68$, $p<0.05$).

CONCLUSION: While HR at 10 minutes of 40-60 minutes of running exercise can suggest which individuals are likely to finish with higher core temperatures and thus potentially at higher risk of heat-related conditions, this appears to only be of value for males, whereas females had higher HR associated with slower times. This is presumably related to previously documented differences in thermoregulation and performance between males and females of the general population such as sweat rates, pacing strategies and body surface to mass ratio differences. (3) Therefore in settings like the mining or military sector or individuals with underlying heat intolerance, where core temperature measurement may be challenging, heart rate monitoring with definition of norms for each population may be useful tool for identifying high risk individuals or guiding vulnerable individuals on how to manage themselves during certain physical activities in thermally challenging environments. 1. Ely BR et al. (2010) Med Sci Sports Exerc. 42(1):135-141; 2.Armstrong, LE et al (2007) Med Sci Sports Exerc. 39(3):556-5723.Iyoho AE et al. (2017) Mil Med. 182(S1):295-303

Conventional Print Poster

CP-BM07 Mechanics and Modelling

EFFECT OF KNEE ANGLE AND SUBMAXIMAL VOLUNTARY CONTRACTION INTENSITY ON VASTUS MEDIALIS AND VASTUS LATERALIS RIGIDITY

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UCBL , UNIL .

INTRODUCTION: Ultrasound shear wave elastography (SWE) provides a local and accurate assessment of muscle rigidity (i.e., an estimation of the Young's modulus calculated from shear wave velocity (Bercoff et al. 2004)) leading to a closer estimation of individual muscle tension (Hug et al. 2015). Few studies have reported an influence of joint angle on muscle rigidity during submaximal voluntary elbow, hip and plantar flexions (Zimmer et al. 2023, Lin et al. 2022, Kato et al. 2021). The aim of the present study was to investigate the effect of knee joint angle on the local mechanical properties of the vastus medialis (VM) and the vastus lateralis (VL) during isometric submaximal voluntary contractions from SWE mapping.

METHODS: Young's modulii of the VM and the VL were assessed using SWE at rest and during submaximal voluntary contractions for two knee angles in twelve subjects. The VM and the VL Young's modulii at rest and during constant isometric submaximal voluntary contractions (i.e., 25%, 50% and 75% of maximal voluntary contraction [MVC]) were evaluated for two knee angles (50° and 100° | knee fully extended = 0°) in twelve participants. Surface electromyographic (sEMG) signals for the VM and the VM were also recorded during the experiments. A paired Student's t-test was performed to assess the effect of knee angle on MVC torque. A three-way ANOVA (knee angle × muscle × contraction intensity) was used for sEMG and SWE parameters. Post-hoc analysis was conducted using Tukey HSD test when appropriate.

RESULTS: No significant difference was found in the VM Young's modulus among all torque levels and knee angles ($P > 0.05$). In contrast, VL Young's modulus was significantly higher at 25% MVC for a knee angle of 100° than for the other torque levels at the same knee angle and was greater at 25% MVC for a knee angle of 100° than for 50° ($P < 0.001$).

CONCLUSION: The SWE explorations reveal the local mechanical state of the muscle during isometric submaximal voluntary contractions. The relative contribution of the VL during isometric voluntary contraction appears dependent on the initial muscle length and the relative knee extension torque level as previously reported (Zimmer et al. 2023), in contrast to the VM. The influence of inhomogeneous intramuscular architecture changes and muscle tension during submaximal contractions needs to be further examined.

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CHARACTERISTICS OF ACUTE CARTILAGE DEFORMATION AFTER MECHANICAL LOADING IN PATIENTS WITH EARLY-MILD KNEE OSTEOARTHRITIS

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INTRODUCTION: Early cartilage degeneration in patients with knee osteoarthritis (KOA) is characterized by qualitative rather than quantitative change. As an indicator of cartilage quality, acute cartilage deformation after cyclic mechanical loading has attracted attention. Greater acute deformation, for example, is observed in young participants with arthroscopic cartilage damage following anterior cruciate ligament injury [1]. However, it is unknown whether acute cartilage deformation is associated with early cartilage degeneration in patients with KOA. This study aims to determine whether acute cartilage deformation differs between patients with KOA and healthy controls using an ultrasound imaging device.

METHODS: We recruited 56 women aged≥50 years with Kellgren-Lawrence grade (KLG)≤2 (age, 70.6±7.4y; height, 153.7±5.2cm; weight, 51.9±8.2kg). The knee symptom was assessed using the symptom section of the Knee Society Score (KSS). The scores range from 25 to 0, and lower scores indicate more severe knee pain and stiffness. We defined a score of 23 or more as asymptomatic. Based on KLG and KSS, participants were grouped into two groups: the control group (KLG≤1, asymptomatic, n=27) and the early-mild KOA group (KLG 1 and symptomatic, KLG 2, n=29). Medial femoral cartilage was assessed using an ultrasound imaging device. Longitudinal (corresponds to the tibiofemoral joint) and transverse (corresponds to the patellofemoral joint) B-mode images of the femoral cartilage were acquired three times before and after treadmill walking (15 minutes, 3.3 km/h), and measured cartilage thickness at each time point. On the ground, all participants measured the external knee moment impulse during the stance phase of gait at the same speed as treadmill walking using a motion capture system and force plates. Acute cartilage deformation was analyzed 2×2 (groups×time) repeated measures analysis of covariance with adjusted age, external knee moment impulse, steps during treadmill walking, and cartilage thickness at baseline. The statistical significance level was set at 5%.

RESULTS: A significant interaction was found on the longitudinal image, and cartilage thickness in the early-mild KOA group after walking was thinner than that in the control group (mean±standard error, control; 1.56±0.00→1.50±0.00mm, KOA; 1.56±0.00→1.44±0.01mm, p=0.002). On the transverse image, there was a significant main effect of time, but not an interaction(control; 1.58±0.00→1.53±0.02mm, KOA;1.58±0.00→1.52±0.02mm, p=0.802).

CONCLUSION: The femoral cartilage of the medial tibiofemoral joint deformed more in patients with early-mild KOA than in healthy controls. Our finding suggested that greater acute deformation was a feature of early cartilage degeneration in patients with early-mild KOA.

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CLARIFICATION OF SOFT TISSUES ASSOCIATED TO KNEE EXTENSION LIMITATION IN PATIENTS WITH KNEE OSTEOARTHRITIS

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INTRODUCTION: Patients with knee osteoarthritis (KOA) often exhibit knee extension limitation, which exacerbates knee symptoms and functional impairments. Although various tissues of the posterior knee would be associated with knee extension limitation, it remains to be determined which tissue is involved. It is probable that the tissue associated with knee extension limitation is stiffer. Ultrasound shear wave elastography (uSWE) could non-invasively quantify soft tissue stiffness in vivo. We aimed to clarify the relationship between knee extension limitation and tissue stiffness in patients with KOA using uSWE.

METHODS: Seventy-one women older than 50 years with a medial KOA grade ≥ 2 according to the Kellgren-Lawrence (KL) grading system participated in this study. The side with more severe radiographic KOA was selected for data acquisition. If the patient had equal radiographic KOA severity of knees, the more painful side was selected. After the evaluation of the maximum knee extension angle, shear wave velocity (SWV) of the following tissues was measured using uSWE: medial posterior capsule (PC), lateral PC, medial collateral ligament, popliteus muscle, biceps femoris short head, distal biceps femoris short head, medial gastrocnemius (GM), proximal medial GM, lateral GM, and proximal lateral GM. During the SWV measurement, patients lay in prone at 15° knee flexion, where each tissue was slightly stretched, and had their lower leg fixed in a neutral position using a self-made device. During measuring GM, the ankle joint was also fixed at 0° dorsiflexion in addition to the measurement position mentioned above. Three images of each tissue were measured, and the averaged SWV was used for further analysis. High SWV means that tissue is stiff. To clarify the associations of each tissue with knee extension limitation, we performed a single linear regression analysis with maximum knee extension angle as a dependent variable and SWV of each tissue as an independent variable. The level of statistical significance was set at 5%.

RESULTS: A total of 66 participants were included in this study (age: 72.9 ± 7.1 years, KL grade 2, n = 24; 3, n = 18; 4, n = 24; the maximum knee extension angle: -3.5 ± 4.6°). The maximum knee extension angle was significantly negatively associated with SWV of medial PC (R2 = 0.094, p = 0.012), indicating that patients with stiffer medial PC had more limited knee extension. On the other hand, the maximum knee extension angle was positively associated with the SWV of the proximal medial GM (R2 = 0.12, p = 0.004), indicating that patients with a softer proximal medial gastrocnemius had more limited knee extension. There were no associations between the other tissues and the maximum knee extension angle.

CONCLUSION: Given the assumption that stiffer tissue is associated with a more limited joint angle, our results suggest that the stiffness of the medial PC is associated with knee extension limitation in patients with KOA.

TISSUE COMPRESSION STIFFNESS OF LOWER LIMB MUSCLE GROUPS USING A LOW-COST DEVICE AND ITS RELATION TO OXYGEN COST WHILE RUNNING

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INTRODUCTION: Running economy is one of the main factors influencing endurance running and can be quantified as energy utilization at a given submaximal speed. Current research showed that a stiffer Achilles tendon [1] as well as triceps surae muscle [2] might be beneficial in terms of oxygen cost while running. Contrary, other studies showed that a more compliant quadriceps tendon [1] and muscle [2] might be in favor for running economy. Therefore, the aim of this study was to relate the tendon and muscle stiffness of the quadriceps and triceps surae muscle groups with respect to oxygen cost in a single running session to obtain an overall picture. For this purpose, a low-cost device (MyotonPro, Myoton Ltd., Estonia) was used for assessing resting tissue compression stiffness.

METHODS: 17 male trained runners/triathletes (age:29.6±6.0 yrs; weight:74.4±6.7 kg, height:181.8±3.7 cm) with a mean VO2max of 55.9±6.8 ml/kg/min and an average running distance of 44.1±12.8 km per week took part in the study. After a familiarization session (day 1), participants did an incremental test to determine VO2max (day 2). Prior to the running test, resting tissue compression stiffness of the patellar and Achilles tendon as well as the gastrocnemii and superficial quadriceps muscles was measured. On day 3, the athletes did a submaximal run for 15min at a velocity corresponding 70% of VO2max. The oxygen cost was estimated by averaging the steady-state V02 of the last 5 minutes during the 15min run.

RESULTS: The average speed of the 15min run was 11.3±1.2 km/h. Correlation analysis revealed a significant relationship between resting Achilles tendon stiffness to oxygen cost with a large effect size (rp=-0.52;CI(95%):-0.81 to -0.33;p=0.03). No further correlation was found for the other tested parameters (p>0.09).

CONCLUSION: Our analysis showed that recreational athletes with a stiffer resting Achilles tendon had a lower oxygen cost during running, whereas resting patellar tendon, quadriceps muscle and triceps surae muscle compression stiffness was not related to oxygen consumption during submaximal running. According to our findings, but also in accordance with previous studies [4], strategies to increase Achilles tendon stiffness could be part of daily training routines of endurance athletes, to decrease their oxygen cost during running. Our first results using a low-cost device to relate resting compression stiffness to running economy are well in line with previous research using classic tissue stiffness assessments. Further research is needed to see if such devices can be used in daily testing routines to track changes in resting stiffness and to obtain if these changes are related to a lower oxygen cost while running.

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STATIC STRETCHING OF THE PECTORALIS MAJOR MUSCLE FOR 7 WEEKS INCREASES MUSCLE FUNCTION BUT HAS NO EFFECTS ON MUSCLE STIFFNESS

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INTRODUCTION: The glenohumeral joint is the most flexible joint in the human body (Halder et al. 2000) and surrounded muscles and other connective tissues play a major role in joint positioning, function and performance (Kim et al. 2018). The aim of this study was to investigate the effects of a 7-weeks static stretching (SS) program of the pectoralis major (PMa) muscle on shoulder extension ROM and maximum voluntary isometric contraction (MVIC) peak torque of the PMa in two different elbow and shoulder joint positions (45°±5° or 90°±5° and 8°±8.6° or 31°±7.5°, respectively). The muscle stiffness of the PMa (pars clavicularis) was measured in the same positions as the force assessments pre and post the intervention.

METHODS: 38 physically active, healthy volunteers (23 males, 15 females) visited the laboratory for a familiarization, a pre- and a post-intervention session. The participants were randomly assigned to either the PMa-SS (7-weeks intervention, 3 times per week, 3 exercises with 5 min each) or the control group (CG). At the pre and post appointments the parameters PMa muscle stiffness, shoulder extension ROM and MVIC peak torque (similarly to an unilateral bench press movement - elbow angle at 45°±5° and 90°±5°) were measured at 45° shoulder abduction on a custom-made testing item. After checking for normal distribution, a repeated measures linear model and if permitted paired t-tests were done. For non-parametric data, a Wilcoxon test and if permitted a Mann-Whitney-U- test were done.

RESULTS: The baseline values (per parameter) were the same between the groups. Following the PMa-SS, shoulder extension ROM increased significantly by 6% (t(17)=-3.92, p<0.01), without a change in the CG (-1%;t(18)=0.48, p=0.64) (ANOVA time effect: F(35)=7.21, p =0.01; interaction effect: F(35)=10.97, p<0.01). Moreover, a significant increase was present in MVIC peak torque values at 45°±5° elbow joint angle in the PMa-SS (+11%, t(16)=-3.12, p<0.01), without a change in the CG (-1%, t(19)=0.14, p=0.89) (ANOVA time effect: F(35)=5.93, p=0.02; interaction effect: F(35)=6.81, p=0.01). No changes were

detected in MVIC peak torque with 90°±5° elbow joint angle (PMa-SS=+5%; CG=-5%) (ANOVA time effect: F(35)=0.79, p=0.38; interaction effect: F(35)=2.77, p=0.11). Furthermore, there were no changes detected in shear modulus in any group in 45° ± 5° (PMa-SS: Z(15)=-1.05, p=0.29, CG: Z(16)=-0.54, p=0.59) and 90° ± 5° elbow joint angle (PMa-SS: Z(15)=-0.91, p=0.36; CG: Z(16)=-0.63, p=0.53).

CONCLUSION: PMa muscle stretching increased shoulder extension ROM and additionally, our study showed an improved maximum force production at longer muscle length (45°±5° elbow joint angle), indicating possible changes in the force-length-relation of the sarcomere. It can be assumed that either pain tolerance and/or changes in stiffness of other structures than the muscles are responsible for the changes in ROM.

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EFFECTS OF A SOFT BACK EXOSKELETON ON LUMBAR LOADING DURING A MANUAL HANDLING TASK: A PILOT SIMULATION STUDY.

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INTRODUCTION: Back exoskeletons are wearable structures that provide an assistive torque to one or multiple joints and can prevent low back disorders during manual handling tasks (1). A previous study already reported a reduced low back muscle activity using the CORFOR® exoskeleton during stoop liftings (2), but the influence of this exoskeleton on lumbar loading hasn't been investigated yet. The aim of this study was thus to assess the effects of wearing such a soft back exoskeleton on lumbar compression force and flexion moment.

METHODS: Eight male participants (178.6 ± 2.6 cm, 72.9 ± 7.1 kg, 21.4 ± 2 years) performed 10 repetitions of a lifting task in the sagittal plane using the stoop technique (8 kg; 15 cycles / min). Participants were familiarized to the exoskeleton and to the task before starting the experiment. They carried out the task with (EXO) and without (FREE) wearing a CORFOR® soft back exoskeleton. This exoskeleton is made of a pair of elastic bands attached to shoulders and knees, stretched by hip flexion. The 3D trajectory of a full body marker set was recorded using an optoelectronic camera system (Arqus A12, Qualisys, Sweden) sampled at 200 Hz synchronized to 3D ground reaction forces and moments measured using force plates (BMS600900, AMTI, USA) sampled at 1000 Hz. These data were then imported in OpenSim 4.2 to estimate compression force and flexion moment at L5/S1 intervertebral joint. The OpenSim Lifting Full-Body model (3) was scaled to each participant anthropometric characteristics and completed by adding the exoskeleton. Exoskeleton elastic bands were modeled as springs. Related slack length and stiffness were measured at the end of each experiment and participant-specific spring path was obtained during EXO task using 16 markers taped on the exoskeleton. Lumbar compression force and flexion moment were estimated through an inverse dynamics-based static optimization procedure. Student's t-tests were finally performed to assess the effects of the exoskeleton by comparing EXO and FREE.

RESULTS: Statistical analyses showed that L5/S1 compression forces were significantly lower ($p = 0.02$, $d = 1$) in EXO (38.8 ± 3.3 N/Kg) than in FREE (41 ± 2.4 N/Kg). Flexion moments were also significantly lower ($p \leq 0.001$, $d = 2.8$) in EXO (1.8 ± 0.12 Nm/Kg) than in FREE (2.1 ± 0.08 Nm/Kg).

CONCLUSION: This study suggests that wearing the CORFOR® exoskeleton may reduce lumbar loading and thus contribute to prevent low back disorders. These results are consistent with the reduction of back neuromuscular activity observed while using this exoskeleton (2). Future experiments should focus on the effect of such an exoskeleton during other handling tasks (e.g. squat, asymmetric lifting). Simulating the effect of different stiffnesses and paths of the spring on lumbar loading may also help to optimize the exoskeleton design.

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POST-ACTIVATION-PERFORMANCE ENHANCEMENT: POSSIBLE CONTRIBUTING FACTORS

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INTRODUCTION: This study aimed to narrow down the possible mechanisms of Post-Activation-Performance Enhancement (PAPE) and especially if they are exclusively found in the muscle. It was therefore investigated whether the PAPE mechanism is influenced by spinal and supraspinal factors, if Post-Activation-Potentiation (PAP) influences PAPE, especially during the first minutes after the conditioning contraction (CC) and whether PAPE influences the muscle's EMG activity and frequency.

METHODS: Thirteen strength-trained participants (26.5 ± 3.16 years) took part in at least one of three interventions (PAP, PAPE-Electrical (PAPEE), and PAPE-Voluntary (PAPEV)). The task was to perform isometric leg extensions on an isokinetic device. The CC was either voluntarily or electrically stimulated. At baseline and after two seconds, four minutes, eight minutes, and twelve minutes of the CC, a maximum voluntary isometric contraction (MVIC) was performed for the PAPE

trials, to see if the peak torque, rate of force development (RFD), and the EMG amplitude and frequency of the quadriceps showed any significant changes.

RESULTS: Peak torque ($p < 0.001$) and RFD ($p = 0.005$) increased significantly during the PAP protocol immediately two seconds after the CC and decreased to near baseline values for the following time points. Peak torque and RFD showed no significant differences during PAPEE and PAPEV trials. Surface electromyography (EMG) measurements revealed significant differences concerning the amplitude of the EMG signal only for the PAPEE trial. EMG amplitude was significantly higher immediately two seconds after the conditioning contraction compared to the baseline measurement for all measured muscles. Concerning the frequency of the EMG signal, there was a significant difference in the M. rectus femoris and the M. vastus lateralis for the PAPEE trial. The mean frequency of those muscles was significantly lower immediately two seconds after the conditioning contraction compared to baseline measurement. For PAPEV, the mean frequency of the M. rectus femoris increased significantly ($p=0.007$) after four minutes compared to baseline.

CONCLUSION: Due to the lack of a visible PAPE effect, the question of whether PAPE depends on spinal or supraspinal mechanisms cannot be answered. The assumption that the PAP-mechanism influences PAPE cannot be confirmed for the same reason. However, it seems that PAPE, especially with an involuntary conditioning contraction, influences the EMG amplitude and frequency of the tested muscles.

THE EFFECTIVENESS OF A CAR-INTEGRATED MONITORING & INNOVATIVE COACHING SYSTEM ON LOWER BACK MUSCLE STIFFNESS, AND PERCEIVED DISCOMFORT AND FATIGUE DURING PROLONGED DRIVING

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HUMANFAB

INTRODUCTION: The prolonged fixed or poor position while driving may lead to high levels of low back soft tissue compression, early muscle fatigue and an important extent of discomfort resulting in low back pain. The development of posture monitoring systems based on different sensitive methods and posture recognition algorithms has dedicated large effort in the automotive industry and could be an interesting strategy to improve comfort, safety and health while driving.

The aim of this study was to evaluate the effects of a specific combination of massages delivered by the car-seat (backrest and cushion) and in-car exercises proposed by an embedded monitoring system, both inducing a passive and active mobilization of the driver, on perceived fatigue and discomfort, muscle function and stiffness of the low back fascia and muscle structures during and after a 4-hour driving session.

METHODS: 5/15 healthy car drivers (study in progress) have realized two counterbalanced 4-hours driving sessions separated by one week. During the "active" session drivers experienced a car-integrated coaching and monitoring system including a countermeasure (i.e., a massage or an exercise or a well-positioning advice) every 20 minutes while driving through a digital interface or the massage system embedded in the car-seat. The "passive" session consisted of 4 hours driving task without any countermeasure. Immediately after each countermeasure (or every 20 minutes), the body-segment comfort was assessed. Before, after two and four hours driving the low back fascia and muscle stiffness were evaluated quantitatively using shear-wave elastography. Moreover, functional capacities including back chain flexibility, reaction time, and upper limb muscle force and perceived fatigue were evaluated.

RESULTS: Preliminary results showed that subjective responses (fatigue and discomfort) were attenuated (by -14 and -27% after the entire task) when drivers experienced a car-integrated coaching and monitoring system compared to a traditional driving condition. While muscle quality (based on a low back stiffness) was increased after traditional driving by 10%, it was reduced (-10%) using the car-integrated coaching and monitoring system. Functional capacities (back chain flexibility, reaction time, and upper limb muscle force) were not different after driving between conditions.

CONCLUSION: Studies have shown that the constant low back mechanical constrain represented by higher stiffness or intra vertebral compression is strongly related to chronic back pain developed over months or years of driving. To monitor bad postures while driving and to deliver different types of countermeasures based on passive and active motion such as stretching exercises, backrest and cushion massages and well-positioning could be a good strategy to reduce discomfort, fatigue through a more compliant muscle (better choc or vibration dissipation) which would reduce pain experienced while driving.

RELATIONSHIP BETWEEN ANGULAR DISPLACEMENT OF SHOULDER JOINT AND FORCE ACTING ON THE POLE IN THE POLE VAULT

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INTRODUCTION: The bending of the pole is the one of the main factors determining the maximum height of the vaulters centre of gravity in the pole vault. The bending of the pole is caused by the conversion of the mechanical energy of the vaulter, in particular the translational energy, into the elastic energy of the pole (1)(2). Although it has been suggested that the action of the shoulder joint muscles was important in exerting force on the pole (3), the vaulters motion in relation to the force acting on the lower tip of the pole, the box reaction force, has not been elucidated. Therefore, the aim of this

study was to investigate the relationship between the angular displacement of the shoulder joint and the box reaction force.

METHODS: 14 Japanese male pole vaulters (season record = 5.22±0.19m) performed trials with run-up steps and poles identical to those used in competition. Three-dimensional body coordinates were obtained using a motion capture system (250 Hz) and the box reaction force was measured using a force platform (1000 Hz). The global coordinate system was defined as the Y axis in the direction of the progress of the run-up, the Z axis in the vertical upward direction, and the X axis as the cross product of the Y and Z axes. Several events were defined; pole plant (PP), take-off (TO), maximum vaulter's angular momentum (MAM) and maximum pole bending (MPB) (2). MAM was the instant when the vaulters swing motion was represented and was defined as the instant when the vaulters angular momentum peaked (2). The shoulder joint angle was defined as the angle between the long axis of the upper trunk and the long axis of the upper arm around the traverse axis of the upper trunk (flexion +/ extension -). The impulse of the box reaction force between each event was calculated using a fourth-order Runge-Kutta method. Pearsons correlation coefficient was used to analyse the relationships between the variables.

RESULTS: The results were summarised as follows:

1) The impulse of the Y-component of the box reaction force (Fy) from PP to MPB was negatively correlated with the elastic energy in the pole at MPB ($r=-0.57$, $p<0.05$).

2) The angular displacements of both shoulder joints from MAM to MPB were negatively correlated with the impulse of Fy from PP to MPB (upper: $r=-0.54$, $p<0.05$; lower: $r=-0.62$, $p<0.05$).

3) The average angular velocity of the shoulder joint on the lower grip side from MAM to MPB was negatively correlated with the impulse of Fy from PP to MPB ($r=-0.56$, $p<0.05$).

CONCLUSION: These results suggest that the phase from MAM to MPB is the important in causing the pole to bend. In addition, considering the muscle force-velocity relationship, there seems to be a specific vaulting technique and shoulder strength that leads to an increase in the box reaction force. The results of this study would have practical implications for pole vault training.

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CHANGES IN GASTROCNEMIUS MUSCLE ARCHITECTURE FOLLOWING STRETCHING TRAINING: A SYSTEMATIC REVIEW WITH META-ANALYSIS

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INTRODUCTION: Gastrocnemius muscle architecture (fascicle length and angle, and muscle thickness) is an important determinant of muscle function in athletes, clinical and aging populations. There is evidence to suggest that stretching training may alter muscle morphology (1, 2), however, the effect of static stretching training on gastrocnemii muscles remains unclear. This systematic review with meta-analysis aimed to examine the effect of static stretching training on gastrocnemius architecture in healthy participants.

METHODS: We searched PubMed Central, Web of Science, Scopus, and SPORTDiscus with a structured algorithm, and randomized controlled trials and controlled trials were included. Risk of bias was assessed using Cochrane RoB2 and ROBINS-I tools. Subgroup analyses and random-effects meta-regressions were also performed using stretching volume and intensity as covariates. Quality of evidence was determined by GRADE analysis.

RESULTS: From the 2946 records retrieved, 15 studies were included in the systematic review and meta-analysis (n = 375 participants). Risk of bias was low in 82.1% of all criteria. Confidence in cumulative evidence was high. Stretching training induced small increases in fascicle length at rest (SMD = 0.21; 95% CI = 0.03 to 0.40; p = 0.024) and during stretching (SMD = 0.48; 95% CI = 0.17 to 0.79; p = 0.002). No increases were observed in fascicle angle (p = 0.61), and trivial increases were found in muscle thickness (SMD = 0.17; 95% CI = 0.00 to 0.35; p = 0.046). Subgroup analyses showed that fascicle length increased when high stretching volumes and intensities were applied ($p < 0.001$), while no changes were found for low stretching volumes ($p > 0.15$; subgroup difference, $p < 0.014$). Also, high stretching volumes and intensities resulted in increased muscle thickness ($p < 0.04$). Meta-regression analyses showed that fascicle length was positively associated with stretching volume and intensity (p = 0.003 and p = 0.03, respectively).

CONCLUSION: Gastrocnemius muscle remodels its geometry in response to stretching training. High but not low stretching volumes and intensities induce longitudinal fascicle growth. Notably, long duration and high intensity stretching interventions increase muscle thickness. This strategy of remodeling may alter muscle contractile properties and thus, muscle mechanical function (3).

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INDOOR ENDURANCE EXERCISE PROVOKES HIGHER AEROSOL PARTICLE EMISSION AND POSES A HIGHER RISK OF INFECTION THAN RESISTANCE EXERCISE

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INTRODUCTION: Pathogens such as severe acute respiratory syndrome coronavirus type 2 (SARS-CoV-2), influenza, and rhinoviruses are transmitted by airborne aerosol respiratory particles that are exhaled by infectious subjects. We have previously reported that the emission of aerosol particles increases on average 132-fold from rest to maximal endurance exercise [1]. The aims of this study are to first measure aerosol particle emission during an isokinetic resistance exercise at 80% of the maximal voluntary contraction until exhaustion, second to compare aerosol particle emission during a typical spinning class session versus a three-set resistance training session. Finally, we then used this data to calculate the risk of infection during endurance and resistance exercise sessions with different mitigation strategies.

METHODS: We recruited 24 healthy participants (age: 21 to 37 years): eight of them for the endurance training session, eight for a resistance training, and eight for an isokinetic resistance training. In each training setting, we included four women and four men. The BMI of the participants ranged between 20.7 kg/m2 and 37 kg/m2 in the resistance exercise groups due to high muscle mass. In the endurance exercise group, the BMI ranged from 20.7 kg/m2 to 26.5 kg/m2. To measure ventilation and particle emission we coupled a spiroergometry device (Metalyzer; Cortex Medical™) with a particle counter (Palas Promo 3000 with Welas 2300 sensor, Palas GmbH) in a closed system. All measurements were performed in a clean air tent with reduced aerosol particle concentration (<150 particles/L compared to >30,000 particles/L in the ambient air). The airspace in the tent was flooded with cleaned air (H14 filter quality), and subjects directly inhale filtered air.

RESULTS: During a set of isokinetic resistance exercise, aerosol particle emission increased 10-fold from 5,400 ± 1,200 particles/min at rest to 59,000 ± 69,900 particles/min during a set of resistance exercise. We found that aerosol particle emission per minute is on average 4.9-times lower during a resistance training session than during a spinning class. Using this data, we determined that the simulated infection risk increase during an endurance exercise session was sixfold higher than during a resistance exercise session when assuming one infected participant in the class.

CONCLUSION: Collectively, this data helps to select mitigation measures for indoor resistance and endurance exercise classes at times where the risk of aerosol-transmitted infectious disease with severe outcomes is high. Even though exercise seems to impose a higher risk of getting infected, exercise holds many health benefits and should not simply be avoided. Thus, during periods with many consequential infections, the first focus should be to, for example, limit the number of people in endurance exercise classes, and increase the air exchange rate of the facility.

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EFFECTS OF A COMMUNITY INTERVENTION PROGRAM BASED ON CONDUCTED PHYSICAL EXERCISE AND SUPPORT NETWORKS ON THE QUALITY OF LIFE AND THE FEELING OF COMMUNITY IN ADULT WOMEN

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Introduction

The factors that condition the differences in the practice of physical activity prevent an increase in sports practice in Europe. Most recent studies are based on the theory of community participation (Long & Perkins, 2003; Vidal, 2001), however, from the point of view of the content of the interventions of physical exercise that enable the action of planning and managing community participation, everything seems to indicate that to date the content of the most effective exercise program that predicts the greatest benefits on QoL and the sense of belonging in the community is unknown in adult women. Therefore, the objective of this pre-experimental study was to make an exploratory contribution to find out if a conducted physical exercise program can influence quality of life (QoL) and the feeling of community (FoC) in adult women in an urban center, seek networks of collaboration between women and contribute to the social determinants of health in the urban nucleus.

Methods

A pre-experimental pre- and post-test study was designed, carried out by a multidisciplinary team made up of physical and social educators. A multicomponent program was designed consisting of supervised aerobic and functional physical exercise, activities aimed at self-knowledge of the body through movement, group bike rides and mutual support to promote autonomous, safe, and sustainable mobility. The program has a duration of 16 weeks. The QoL was measured

using the SF-36 v.2 instrument. (Ware Jr & Sherbourne, 1992). The FoC was measured through the community feeling scale (Vidal, 2001). The Wilcoxon technique was used for pre- and post-test comparisons. As an index of the effect size, eta squared was calculated for the Wilcoxon tests ($\eta 2 = Z2 / N$, where N is the number of observations). The values 0.01, 0.06, and 0.14 were used to interpret the effect size as small, medium, and large, respectively (Cohen, 1988). The significance level was set at 0.05.

Results

A better social function ($p = 0.007$; $\eta 2 = 0.38$) and the total mental health component of the QoL ($p = 0.007$; $\eta 2 = 0.38$) in the post-test of the QoL were localized. No significant improvement observed in FoC ($p > 0.05$).

Discussion

Numerous interventions have been proposed in different communities to favor the improvement of the social determinants of health (Bauer et al., 2014). However, our results were not in line with previous research, in which case they did find effects on their programs (Choi & Mutrie, 2020). An explanation could be found in the duration of the program. The most successful programs, in addition to having had a more continuous follow-up over time, require strong financing and support measures to be carried out, often due to a lack of available facilities and resources (Cereijo et al., 2019). The conducted physical exercise program could establish improvements in the QoL of adult women with barriers to the practice of physical activity and increase the exploration of other environm

PHYSICAL ACTIVITY, DAYTIME ACTIVITY AND SLEEP DURING A SPA STAY

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INTRODUCTION: Recently, the Spa stay, including facilities (e.g., swimming pools and gyms), and treatments, have been described as incrementing physical activity (PA), sleep quality, and, more generally, the quality of life [1, 2]. To date, no studies have investigated these aspects in sub-healthy subjects visiting Italian Spa; thus, the current study aims to shed light on leisure-time PA and sleep habits during a one-week stay at the Spa.

METHODS: Eighty-eight participants (M=30, 30%; 64.1±10.9yrs) staying one week at GB-Hotels (Abano Terme, Italy) and undergoing thermal treatments filled in the Godin-Shepard Leisure-Time Physical Activity Questionnaire (GSL-TPAQ) and the Mini Sleep Questionnaire (MSQ) at the beginning and the end of the spa stay. Actigraph Motion Watch 8 (CamNtech) monitored the daytime activity, whereas the daily PA was recorded through a diary. Comparisons were adjusted for age, BMI, and sex. The current study was funded by FORST.

RESULTS: During the Spa stay, the percentage of active subjects raised from 52% to 67% with a significant increase in the GSL-TPAQ score (before: 27.6±22.7 LSI; during: 40.3±30.1 LSI; $p<0.001$), indicating an increase of PA during the thermal stay. The percentage of participants with no sleep problems incremented from 32% to 48% during the Spa stay, with a significant decrease in the mean MSQ score (before: 30.3±10.3a.u.; during: 25.3±9.5 a.u.; $p=0.001$), indicative of better sleep quality. The questionnaires compiled at the end of the Spa stay showed that active and sufficiently active participants tend to report better MSQ values than inactive subjects and that those with no sleep problems practised more PA than participants with moderate and severe sleep problems (even though without significance). Regarding the actigraphic data, moderate daytime activity reached 30% of the monitored time, followed by low (17%) and vigorous (1%) daytime activities. From the daily diaries, the most reported physical activities were: walking, swimming, gym use, and thermal-water gymnastics, with 500.3±402.7 minutes of PA in a week.

CONCLUSION: A week of Spa stay and thermal treatments seemed to be effective in incrementing the PA and sleep quality. Participants reported reaching the recommended 300 minutes of physical activity in a week. Leisure-time PA could be favoured by the resorts' facilities, free time, and better predisposition of the participants to being active during the Spa stay. Sleep could improve thanks to the relaxing atmosphere, the effect of the hot water on body temperature and mud applications on cortisol's circadian rhythm regulation.

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LONG-TERM EFFECTIVENESS OF EXERCISE, COGNITIVE BEHAVIORAL THERAPY, AND PHARMACOTHERAPY ON IMPROVING SLEEP IN ADULTS WITH CHRONIC INSOMNIA: A SYSTEMATIC REVIEW AND NETWORK META-ANALYSIS

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INTRODUCTION: Despite the well-established treatment effectiveness of exercise, cognitive behavioral therapy for insomnia (CBT-I), and pharmacotherapy on improving sleep, there have been no studies to compare their long-term effectiveness, which is of clinical importance for sustainable management of chronic insomnia. This study aimed to compare the long-term effectiveness (≥ 6 months post-intervention follow-up) of exercise, CBT-I, and pharmacotherapy on improving sleep in adults with chronic insomnia.

METHODS: Data Sources: MEDLINE, PsycInfo, Embase, and SPORTDiscus were searched between January 1990 and January 2022.

Study Selection: We included randomized controlled trials investigating the long-term effectiveness of the three interventions on improving sleep in adults with chronic insomnia. The post-intervention follow-up (duration between the post-intervention measurement and the last follow-up measurement) of the trial had to be ≥ 6 months to be eligible.

Data Extraction: Study characteristics, quality, and data were assessed independently by two researchers. The primary outcome was the long-term effectiveness of the three interventions on improving sleep, which reflected the sleep-promoting effects of the interventions during the post-intervention follow-up period (time duration between the post-intervention measurement and the last follow-up measurement). The secondary outcome was the treatment effectiveness of the three interventions on improving sleep, which reflected the sleep-promoting effects of the interventions during the intervention period (time duration between the baseline measurement and the post-intervention measurement). A random-effects network meta-analysis was carried out using a frequentist approach.

RESULTS: Thirteen randomized controlled trials involving 1350 participants were included in the analysis. After an average post-intervention follow-up period of 10.3 months (95% confidence interval, 6.7 to 13.9), both exercise (standardized mean difference, -0.29; 95% confidence interval, -0.57 to -0.01) and CBT-I (-0.48; -0.68 to -0.28) showed superior long-term effectiveness on improving sleep compared with the control interventions. Temazepam was the only included pharmacotherapy and it demonstrated superior treatment effectiveness (-0.80; -1.25 to -0.36) but not long-term effectiveness (0.19; -0.32 to 0.69) on improving sleep compared with the control interventions.

CONCLUSION: The findings of our study support the use of both exercise and CBT-I for long-term management of chronic insomnia in adults, while temazepam may only be used for short-term insomnia treatment. The generalizability of the study findings was limited as temazepam was the only included pharmacotherapy.

EXERCISE AS TREATMENT FOR DRUG USE DISORDERS: A META-ANALYSIS

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INTRODUCTION: Drug addiction, which involves impulsive and compulsive factors and represents a dramatic dysregulation of motivational circuits, is a chronic relapsing disorder. It doesnt just lead to serious health consequences, even death, for the drug users themselves and serious damage to their families, but also affects social stability. In recent years, a number of reviews have been published on the effects of exercise on substance use disorders, including alcohol/tobacco use disorders. However, the effects of exercise interventions on drug dependence have not been assessed separately. While these descriptive reviews clearly advance the field, to our knowledge no meta-analysis has pooled data to consider the benefits of multiple trials and health outcomes. A review of randomised controlled trials is needed to determine whether these associations are causal. This meta-analysis aimed to provide an overview of the effectiveness of exercise interventions for drug dependence. This review enabled scientific societies to formulate exercise recommendations in their clinical guidelines by examining the effects of exercise interventions on drug-dependent individuals.

METHODS: We searched the following electronic databases for relevant literature Web of Science, PubMed, Embase, Ebsco, Cochrane Library. We also searched the online trials registry, ClinicalTrials.gov, to identify unpublished trials. There were no language restrictions, and we did not search for unpublished literature in English-language databases. The search period ended on 21 October 2022. As heterogeneity between studies was expected, we performed a random-effects meta-analysis using Review manager 5.3 software.

RESULTS: Seventeen studies were included in the analysis. The results showed that exercise was effective in reducing cravings [I2 = 0%, P = 0.84; SMD = -0.52, 95% CI (-0.74, -0.30), Z = 4.59, P＜0.00001] .Exercise also significantly reduced anxiety [I2 = 0%, P = 0.45; SMD = -0.43, 95% CI (-0.60, -0.26), Z = 5.02, P＜0.00001], depression[I2 = 14%, P = 0.31; SMD = -0.36, 95% CI (-0.53, -0.19), Z = 4.17, P＜0.0001]and improved quality of life[I2 = 68%, P ＜0.00001; SMD = 0.46, 95% CI (0.30, 0.61), Z = 5.72, P＜0.00001]. It had no significant effect on the physical fitness score [I2 = 85%, P < 0.00001, SMD = -0.02, 95% CI (-0.23, 0.19), Z = 0.16, P = 0.87] of drug-dependent individuals. Using the different physical fitness indices as grouping criteria, exercise was found to have a significant effect on improving pulse, vital capacity, body flexion, one leg stand with eye closed in drug-dependent individuals.

CONCLUSION: Exercise had a significant effect on drug-dependent people. For the main outcome (craving), we found that the current level of evidence for exercise intervention in drug-dependent people is high. For secondary outcomes, we found that exercise was beneficial for improving emotional state and quality of life in drug-dependent patients. More robust studies are needed to validate these findings, including long-term follow-up of a range of health outcomes.

DOES ESPORTS PARTICIPATION BRING ABOUT AN UNHEALTHIER LIFE?

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INTRODUCTION: This study is designed as a cross-sectional study to explore whether there are significant differences in health between eSports players and non-eSports players among young adults and aims to show the general health status of the eSports population compared with non-eSports players. This study collected detailed information on their eSports game participation (e. g. genres) to strictly distinguish eSports players from general video gamers.

METHODS: A total of 1549 responses were selected for the final data analysis (incomplete responses were excluded). They are identified as eSports players, general video gamers and non-eSports participants. The data on the health status of different categories of participants were also collected by means of an online questionnaire designed by the team. The whole questionnaire is divided into four sections: personal information (gender, age, education, etc.), gaming behavior (type of games, frequency of game, gaming habits), sports behavior (type, frequency, etc.), and health status (sleep duration, physical and mental health problems). Health problems were selected based on previous relevant studies where they were considered to be related to eSports or video gaming: physical health (hearing, vision, or musculoskeletal problems (e. g. neck, wrist, back pain or strain) and malnutrition), and mental health problems (anxiety, insomnia, depression).

RESULTS: It was found that participation in traditional sports was significantly higher among eSports participants (66%) than non-eSports participants (49.2%) ($p<0.001$). No significant difference in sleep duration, visual problems, hearing problems, neck, wrist, neck, upper or lower back pain or strain, or malnutrition was found between these two groups. The proportion of participants who reported having a mental issue (anxiety, depression, loneliness or insomnia)) is significantly higher among non-eSports participants (38.5%) than eSports players (30.3%) ($p<0.01$).

It was also found that participation in traditional sports is significantly more common among eSports players (66%) than among general video gamers (43%) ($p<0.001$). Significant differences were found in issues of visual impairment, myopia or dry eyes ($p<0.05$) and mental issues ($p<0.03$) between the two groups. 61.8% of video gamers reported having a visual impairment, myopia, or dry eye while 55.3% of eSports players reported it and a higher proportion of general video gamers reported having a mental issue than eSports participants ($p<0.05$).

CONCLUSION: eSports players did not reflect worse outcomes in terms of sports participation, and physical and mental health issues. Instead, we see higher levels of motivation in sport participation among eSports players. We also found that players who focused on their posture and proper rest during gameplay were less likely to suffer from muscle pain and strain, prompting us to think about exploring healthier ways to participate in eSports in the future.

COMBINED COGNITIVE AND PHYSICAL TRAINING FOR IMPROVED COGNITIVE AND PHYSICAL PERFORMANCE: PRELIMINARY FINDINGS FROM A RANDOMISED CONTROLLED TRIAL WITH YOUNG HEALTHY ADULTS.

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INTRODUCTION: Combining cognitive and physical exercise is gaining attention as a training modality by offering greater adaptations to both physical and cognitive performance. Research supports the benefits of concurrent training for improving cognition in older adults [1] but it is unclear if this applies to younger people [2]. This study sought to investigate the effectiveness of combined training for improving cognitive and physical performance in young healthy adults.

METHODS: At submission, 52 of the intended 93 participants (29 female, 27±6 years, baseline maximal oxygen uptake 34.9±9.4 mL/min/kg) were recruited for a 12-week, investigator blinded RCT. Participants were allocated to either physical training only (PAonly), concurrent cognitive and physical training (PACog) or separate cognitive and physical training (PA&Cog). Physical training involved stationary cycling at 70-80 % of maximum heartrate achieved during baseline fitness assessments. Cognitive training was administered using an adaptive, multidomain, computer program. Pre, mid, and post-intervention assessments included a maximal cardiorespiratory fitness (VO2peak) test, followed by a cognitive battery completed at rest. Pre- and post- intervention, participants also completed a dual task assessment (moderate intensity walking on inclined treadmill whilst wearing weighted vest and completing cognitive tests of inhibitory control and memory), followed immediately by a repeat of the cognitive battery.

RESULTS: Improvements during the fitness assessment showed no difference across groups in VO2peak (PACog: b = -2.4 mL/kg/min, 95%CI -8.8 to 3.9, PA&Cog: b = -0.5 mL/kg/min, 95%CI -6.6 to 5.6) or time to exhaustion (PACog: b = -36.6s, 95%CI -149.6 to 76.4, PA&Cog: b = 18.9s, 95%CI -89.0 to 126.8). Mean reaction time on a sustained attention task at rest improved mid-intervention (PACog: b = -28.9 ms, 95%CI - 54.9 to -3.3, PA&Cog: b = -36.1 ms, 95%CI -60.7 to -11.6) and post-intervention (PACog: b = -21.3 ms, 95%CI -47.0 to -4.4, PA&Cog: b = -29.8 ms, 95%CI -54.3 to -5.3). There was a significant group*time interaction for working memory performance (p = .018) suggesting PACog's maximal recall capacity reduced more than PA (b = - 0.4, 95%CI -1.0 to 0.2) while there was a greater improvement observed in PA&Cog (b = 0.4, 95%CI -0.2 to 1.0), however these estimates were non-significant.

CONCLUSION: Cardiorespiratory fitness improved in all groups, however, sustained attention and working memory – two key cognitive constructs for high performance [3] – improved to a greater extent in both groups receiving the cognitive training, with PA&Cog superior for maximal recall following the dual-task assessment. These findings suggest combined training may be a time efficient modality for improving cognitive performance with similar improvements in fitness to physical training only.

REFERENCES:

1. Gavelin (2021)

2. Nahleen (2021)

3. Albertella (2023)

CHANGES IN TRAINING LOAD ACROSS A 12-WEEK CONCURRENT COGNITIVE AND PHYSICAL TRAINING INTERVENTION IN YOUNG, HEALTHY ADULTS (PRELIMINARY FINDINGS)

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INTRODUCTION: Concurrent cognitive and physical training may offer an efficient training modality to provide both physical and cognitive benefits (Nahleen et al., 2021). The logistics and acceptability of delivering such training, however, is unclear and potentially complex. In particular, it is unclear how participants will respond to changes in training load and whether an effective progressive overload can be achieved for both cognitive and physical benefit.

METHODS: At time of submission, 42 healthy individuals (22 female, 27±6 years) had completed a 12-week training intervention. Participants were randomly allocated to either a control group (n=16), a concurrent training group (n=13), or a separate training group (n=13). All groups completed two 50-min bouts of stationary cycling at 65% heart rate peak per week. While cycling, the concurrent group conducted cognitive training on an adaptive, multi-domain platform. The separate group completed two cognitive training sessions seated at rest per week, in addition to cycling only. Measures of physical load (average power, average speed, and rating of perceived exertion (RPE)) were taken in weeks 3, 7, and 10. Cognitive assessments were completed within the cognitive training platform in weeks 1, 6, and 12 to examine whether the cognitive tasks (and associated load) were sufficient to provide cognitive benefits.

RESULTS: There were no significant group*time interactions for average power, average speed, or RPE. There was a significant time effect for mean power (B = 6.3 W, 95% CI: 1.1 to 11.6). There were no significant group effects for the cognitive training tasks; however, there were significant time effects for tasks involving reaction time (B = -196.8 ms, 95% CI: -256.1 to -139.0; B = -148.0 ms, 95% CI: -230.8 to -64.4) and working memory (B = 0.2 numbers, 95% CI: 0.1 to 0.4).

CONCLUSION: Mean power increased for all groups over the course of the intervention, which suggests that participants are experiencing progressive overload while cycling. Improvements observed across time in all groups on adaptive cognitive training tasks suggests an effective progressive overload can be achieved. Since there were no significant differences in physical and cognitive training load measures between the concurrent group and the separate group, concurrent training might be just as effective, and more efficient, as separate physical and cognitive training.

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FEASIBILITY, TOLERABILITY, AND PRELIMINARY EFFECTIVENESS OF A CONCURRENT COGNITIVE AND PHYSICAL TRAINING INTERVENTION IN YOUNG HEALTHY ADULTS

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INTRODUCTION: Concurrent cognitive and physical training has proved an effective and efficient method for improving cognitive [1], physical [2], and dual task performance [2]. However, much of this research lacks the application of basic training principles such as individualisation and progressive overload, and consideration of the participant experience. This study employed an individualised, adaptive concurrent training intervention in young healthy adults. We discuss preliminary effectiveness, feasibility, and tolerability.

METHODS: At submission, 52 of 93 participants (23 male, 27±6 yrs, baseline maximal oxygen uptake 35.0±9.3 mL/min/kg) had been recruited for a 12-week investigator blinded RCT. Participants were randomised to either physical training only (2 x 60 min stationary cycling sessions per week), concurrent cognitive and physical training (2 x cycling sessions whilst simultaneously completing cognitive training) or separate cognitive and physical training (2 x cycling sessions and 2 x cognitive training sessions at rest). Physical training was prescribed using heartrate during baseline fitness assessment. Cognitive training was administered using an adaptive multidomain computer program. Pre, mid, and post-intervention assessments included a maximal cardiorespiratory fitness test, a cognitive battery, and a cognitive and physical dual task. Throughout the intervention physical load was recorded alongside subjective workload and enjoyment as measures of tolerability. Feasibility outcomes included recruitment, dropout, and attendance. All participants randomised with baseline assessments were included in intention-to-treat analysis using linear mixed effects models.

RESULTS: Of the participants recruited, 50 were allocated to an intervention. Eight participants withdrew prior to completion (physical: 2 of 17, concurrent: 1 of 15, separate: 5 of 18), with no reports of adverse effects. Across groups, attendance was 94±6%. Maximal oxygen uptake increased across the intervention with no difference between groups, as was also observed for mean power of the physical training. Compared to physical only, mean reaction time on a sustained attention task was faster at mid (concurrent: b=-28.9 ms, 95% CI - 54.9 to -3.28, separate: b=-36.1 ms, 95% CI -60.7 to -11.6) and post assessment for concurrent and separate training (concurrent: b=-21.3 ms, 95% CI -47.0 to -4.4, separate: b=-29.8 ms, 95% CI -54.3 to -5.3). Response inhibition and memory at rest, and memory during the dual task improved over time with no group x time interaction. Subjective workload and enjoyment did not vary significantly across the intervention or between groups.

CONCLUSION: Our preliminary findings support concurrent and separate cognitive and physical training as effective and acceptable methods for improving cognitive, physical, and dual task performance in young healthy adults. For the reduced time impost, we recommend concurrent training as the preferred modality.

1. Lauenroth (2016)

2. Dallaway (2021)

ASSOCIATION OF BDNF RS6265 POLYMORPHISM WITH LITHUANIAN ELITE ATHLETES' STATUS

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INTRODUCTION: Regular physical activities lead to an increase in brain-derived neurotrophic factor (BDNF) and other myokines concentration level in the blood serum, which determines the general physical and psychological health of a person. BDNF (encoded by the BDNF gene) is present in the blood both at rest and during exercise training, and is derived from several tissue sources (such as skeletal muscle, brain, vascular endothelial cells, peripheral neurons, blood mononuclear cells, platelets etc.) known to produce and release neurotrophic factors into circulation in response to exercise. The single nucleotide polymorphism (SNP, rs6265, C>T, Val66Met) in the BDNF gene affect the intracellular distribution, packaging and release of BDNF protein, and can affect neuronal adaptation and response to exercise, as well as the ability to activate the appropriate muscles and generate more power. However, the influence of this SNP on the characteristics of elite athletes remains not clear. The purpose of this study was to investigate the relationship of the BDNF rs6265 genetic variant with elite Lithuanian athlete status.

METHODS: In the present study, BDNF rs6265 (C>T) polymorphism was investigated in 230 Lithuanian elite athletes representing three functional sports groups [endurance, N=59; sprint-power, N=87, and team sports, N=84], as well as in 230 control samples (non-athletes) from the Lithuanian population. Genotyping was performed using TaqMan Real-time polymerase chain reaction assay.

RESULTS: The results of the case-control analysis showed that the frequencies of BDNF genotypes were significantly different in the general group of athletes (CC/CT/TT: 58.1/33.5/0.0%, p = 0.01) and in sprint-power group (CC/CT/TT: 63.2/36.8/0.0%, p=0.03) compared to the control group (CC/CT/TT: 74.3/23.9/1.7%). The findings indicated that the heterozygous CT genotype is more prevalent in sprint-power athletes (36.8%) compared with endurance athletes (28.8%) and controls (23.9%). The logistic regression analysis suggests that the odds ratio (OR) of CT genotype (vs CC+TT) and being an elite athlete was 1.6 (95%CI: 1.06–2.41; p=0.02). OR of sprint-power athletes harboring the CT genotype was 1.85 (95%CI: 1.09–3.15; p=0.02). Our results suggest that BDNF CT heterozygous athletes have a higher sprint-power ability than homozygous.

CONCLUSION: Our findings provide support the hypothesis that the BDNF rs6265 polymorphism is associated with elite athletic status. The BDNF CT heterozygotes had a significantly higher prevalence among elite Lithuanian athletes (especially sprint-power oriented athletes) than in the control group. Possible explanations for heterozygote advantage of BDNF rs6265 variant for elite athletes are BDNF expression in brain and skeletal muscle (especially in the fast-twitch muscle fibers) during exercise training. Replication studies are needed to support our data and to fully understand the relationship between BDNF gene and physical performance of athletes.

Conventional Print Poster

CP-MH23 Physiotherapy II

EXERCISE-SPECIFIC EFFECTS ON THE MOTOR PERFORMANCE, GLYCAEMIA REGULATION AND MUSCLE HISTOLOGY OF A MOUSE MODEL OF LIMB-GIRDLE MUSCULAR DYSTROPHY R1 (CALPAINOPATHY)

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INTRODUCTION: Calpainopathy is one of the most common Limb-girdle Muscular dystrophies (LGMD R1) caused by the homozygous deletion of Calpain-3 gene and characterized by a symmetric and progressive weakness of the proximal muscles1. The absence of calcium-dependent-cysteine protease CAPN3 induced intracellular calcium dysregulation and sarcomere disorganization that generate sensitivity to exercise damages and avoid proper adaptation to aerobic training2. Thus, we questioned whether a non-lesional exercise performed in high-intensity could alleviate the disease progression in vivo in comparison to an eccentric exercise on a mouse model of calpainopathy.

METHODS: From 2 to 4 months of age, C57BL/6J CAPN3 KO mice were subjected to a 5 days-per-week 30 minutes training protocol performed either in an eccentric running condition (inclined treadmill -20°) at 16 m.min-1 or in a high intensity swimming condition (4 L.min-1), and were compared to untrained control and CAPN3 KO mice. Spontaneous activity (open field), muscles strength (grip strength), resistance to fatigue at low (grip test) or high (incremental test) intensity and glucose homeostasis were assessed once a month. The dystrophic process (HE staining) and muscular typology adaptations (immunofluorescence against-MyHC isoforms) were evaluated on antigravity muscles (psoas, deltoid, gluteus, soleus).

RESULTS: We noted a decrease of around 27.8% of the time of suspension and around 21.4 % in maximal aerobic performance in CAPN3 KO mice compared to controls throughout the studied ages, without any defect in spontaneous activity or muscle strength. Moreover, we observed a 9,3% increase in the area under the curve of the glucose tolerance test at 4 months of age. After exercises, we noted that only concentric swimming training increased the resistance to fatigue at low and high intensity (around 33.7% and 45.4%, respectively) compared to untrained CAPN3KO mice at 3 and 4 months of age. However, the swimming protocol failed in correcting glycaemic homeostasis while eccentric protocol restored the

area under the curve to control values at 4 months of age. At the muscle phenotype level, only eccentric protocol worsened the dystrophic processes in a muscle-specific manner in CAPN3KO mice at 4 months of age. Those muscular adaptations were accompanied by exercise- and muscle-specific adaptations of muscular typology.

CONCLUSION: Our study suggests that the muscular metabolic alteration of a calpainopathy model mouse could be positively or negatively modulated by adapted exercises. This opens new avenues in personalizing clinical care for this dystrophy.

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EFFECTS OF RESISTANCE TRAINING AS A BEHAVIOURAL PREVENTIVE MEASURE ON MUSCULOSKELETAL COMPLAINTS, MAXIMUM STRENGTH AND ERGONOMIC RISK IN DENTISTS AND DENTAL ASSISTANTS

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INTRODUCTION: For dental professionals, musculoskeletal disorders (MSD) are common health hazards. Resistance training programmes are promising approaches in the quest to decrease the pain intensity. Therefore, the aim of the current study was to investigate the effect of a trunk-oriented 10-week resistance training, especially designed for dental professionals, on the pain intensity, the maximum voluntary isometric contraction (MVIC) and the body posture during dental treatments.

METHODS: In total, 17 participants (3m / 14f) volunteered to take part in this study. Of these, 6 (0m / 6f) participants worked as dental assistants and 11 (3m / 8f) as dentists in Germany. The intervention programme consisted of 11 resistance training exercises where the participants trained for 10 weeks, 2 times a week, for one hour. Outcome values collected were the pain intensity (visual analogue scale (VAS) combined with a modified version of the Nordic Questionnaire), the MVIC and the rapid upper limb assessment (RULA) score (based on data from inertial motion units) during a standardised dental treatment protocol. In order to quantify the effects of the intervention on each outcome measure, the paired t-test and Wilcoxon signed-rank test were performed depending on the distribution. The significance level was set at $\alpha = 5\%$.

RESULTS: A significant reduction in pain intensity was found for each queried body region: the neck ($p < 0.001$), upper back ($p = 0.004$), lower back ($p < 0.001$) and the right ($p = 0.005$) and left ($p = 0.02$) shoulders. The MVIC improved significantly in all outcome measures: the flexion ($p = 0.001$), extension ($p = 0.004$), lateral flexion right ($p < 0.001$) and left ($p < 0.001$) and the rotation right ($p = 0.01$) and left ($p = 0.011$). The intervention had only marginal effects on the ergonomic risk, derived from a kinematic analysis; the neck showed a significant improvement ($p = 0.02$), however, the left upper arm revealed a significant worsening ($p = 0.018$). Correlation analyses revealed no relevant significances between the pain intensity and the MVIC and RULA scores.

CONCLUSION: A ten-week resistance training programme in dentists and dental assistants had significant effects on pain intensity reduction and on the MVIC of the musculature of the trunk and is, therefore, suitable as a behavioural preventive measure against MSD in dentistry. Since improvements in trunk force seem to have rather small effects on the body posture during dental treatments, the ergonomic risk is apparently determined predominantly by the arrangement of the dental treatment concept.

GASTROCNEMIUS VISCOELASTIC PROPERTIES, STRENGTH, FUNCTIONAL PERFORMANCE, AND PAIN FOLLOWING ECCENTRIC EXERCISE-INDUCED SORENESS: COMPARISON OF THE EFFECTS OF VIBRATION FOAM ROLLING AND FOAM ROLLING

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INTRODUCTION: The aim of this study was to investigate and compare the effect of vibrating and non-vibrating foam roller application on viscoelastic properties of the gastrocnemius muscle, plantar flexion strength, functional performance and pain after EIMS in healthy physically active individuals.

METHODS: Thirty healthy physically active individuals (15 Male, 15 Female, Age: 23.80±0.94 years, body mass index: 22.23±2.19 kg/m2) were included in the study. Participants' legs were randomly divided into two groups: vibration foam rolling (VFR) and foam rolling (FR). The participants performed a standardized eccentric calf muscle exercise on an inclined plane while wearing a weighted vest (approximately 25% of body weight). The tests were performed before and after the exercise protocol, 48 hours after the exercise protocol and immediately after foam rolling. Foam roller applications were done 48 hours after the exercise protocol. Visual analog scale was used to assess pain during resting, gastrocnemius stretching, isometric contraction and heel-rise. Muscle viscoelastic properties such as tonus, elasticity and stiffness were measured by using myotonometry. Plantar flexion isometric strength was measured by hand-held dynamometer. Weight bearing lunge test (WBLT) for ankle dorsiflexion range of motion and Y Balance test (YBT) with anterior, posteromedial and posterolateral reach directions were used for assessing functional performance. 2-way repeated measures of ANOVA (time by group) was used for statistical analysis.

RESULTS: There were no significant "time by group" interactions for pain in resting ($F(3,87)=1.73$, $p=0.17$), isometric contraction ($F(3,87)=1.73$, $p=0.17$), stretching ($F(3,87)=1.31$, $p=0.27$) and heel rise ($F(3,87)=0.23$, $p=0.87$). Pain gradually increased

after the exercise and decreased after foam roller applications (p<0.001). There were no significant time by group interactions for lateral and medial gastrocnemius tonus, elasticity and stiffness and plantar flexion strength (p>0.05). Gastrocnemius tonus and stiffness decreased and plantar flexion strength increased after foam rolling (p<0.001). Time by group interaction was significant for WBLT (F(3,87)=11.66, p<0.001). VFR increased ankle dorsiflexion ROM more than NVFR (p=0.01). Time by roller interaction was also significant for YBT_anterior (F(3,87)=3.72, p=0.01) and YBT_posteromedial (F(3,87)=2.62, p=0.04) directions. VFR increased YBT scores more than NVFR after exercise protocol (p=0.01).

CONCLUSION: Both foam rolling improved perceived pain, gastrocnemius tonus and stiffness, ankle dorsiflexion ROM, gastrocnemius strength and dynamic balance after eccentric exercise induced soreness. However, vibration foam roller is more effective than non-vibrated foam roller to improve ankle dorsiflexion ROM, plantar flexor strength and dynamic balance after eccentric exercise induced soreness. Thus, for functional recovery, vibration foam rollers can be selected after exercise induced fatigue and/or soreness.

BENEFICIAL EFFECTS OF POST-INJURY ICING ON SKELETAL MUSCLE REGENERATION IN A NEW INJURY MODEL WITH NECROSIS LIMITED TO A SMALL FRACTION OF MYOFIBERS IN RATS

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INTRODUCTION: Accumulating evidence from animal experiments has demonstrated that post-injury icing impairs the natural regenerative process of skeletal muscles. However, previous experimental models yielded massive necrotic myofibers, which contrasts with muscle damage upon human sports activities in which typically a small percentage (<10%) of myofibers necrotize. During muscle regeneration, macrophages accumulate in the damaged site and exhibit a pro-reparative profile, whereas they have cytotoxic potential on muscle cells dependent on inducible nitric oxide synthase (iNOS) expression. In this study, we established an animal injury model with necrosis limited to a small myofiber fraction and investigated the effect of icing on muscle regeneration with a focus on macrophage-related events.

METHODS: Eight-week-old male Wistar rats were divided into the non-icing and icing groups. Muscle injury was induced by crushing the extensor digitorum longus muscle for 30 s with forceps which a weight was attached as reported previously (1), but the attached weight was changed to 250 g (500 g in the previous study), causing necrosis in 4.0% ± 0.5% of myofibers as the initial damage. Animals in the icing group were given a session of ice pack application (three sets of 30 min each with 90-min intervals) beginning immediately and at 24 h and 48 h after injury. Injured muscles were harvested on post-injury days 1, 2, 3, 5, 7, and 14 (n = 5, respectively). The muscle cross sections were subjected to hematoxylin and eosin staining for morphological observation of the regenerative process and to immunofluorescence for detecting and quantifying the iNOS-expressing macrophages and activated satellite cells. The targeted protein expression was determined by western blot. Data comparison was conducted using the Student's t-test or two-way analysis of variance to determine statistical significance.

RESULTS: Icing after muscle injury resulted in an enlarged size of regenerating myofibers compared with those in untreated animals on days 7 and 14. During the regenerative process, icing reduced the iNOS-expressing macrophage invasion, suppressed the iNOS protein expression in the damaged muscle, and limited the expansion of injured area. Additionally, an early accumulation of activated satellite cells within the damaged/regenerating area was noted in the icing group. The protein expression level of MyoD and myogenin (myogenic regulatory factors) was not affected by icing.

CONCLUSION: Icing after skeletal muscle injury with necrosis in a small myofiber fraction could facilitate muscle regeneration. This phenomenon was associated with the attenuated iNOS-expressing macrophage invasion, limited muscle damage expansion, and accelerated accumulation of myogenic cells during icing-treated regenerative process. Our findings first unveil the benefits of post-injury icing for muscle regeneration provided that myofiber necrosis is not substantial following injury.

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THE EFFECT OF FUNCTIONAL EXERCISES PERFORMED ON SLIDING PLATFORM ON THIGH MUSCLE ACTIVATION AND HIP AND KNEE FLEXION ANGLES

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INTRODUCTION: "Sliding" exercises are very popular in work-out programs. They are thought to be very effective for improving core stability and muscle strengthening1,2. Slideboards are commonly used in the exercise programs but the information about how they affect muscle activities during exercises are limited. The aim of this study was to investigate the quadriceps and hamstring muscle activation levels and hip and knee flexion angles during functional exercises on a sliding platform and to compare them with normal ground.

METHODS: Thirty healthy individuals (age: 23.83±2.84 years, body mass index: 21.75±1.72 kg/m2) were included in the study. Single leg squat and lunge exercises were performed with forward, lateral and back reaching, and muscle activation levels of vastus medialis (VM), vastus lateralis (VL), biceps femoris (BF), semitendinosus (ST) were measured by surface electromyography. The exercises were performed randomly on the normal ground and on the slideboard. Exercises were performed at slow pace (60 beats/min). The phases of the exercises were analyzed with a video camera. Hip and knee

flexion angles/ratios were evaluated with 2D motion analysis. Repeated measures analysis of variance was used to analyze platform X exercise interaction, and paired samples t-test was used to determine the differences between hip and knee flexion angles.

RESULTS: In all exercises, VM and VL activation levels were greater during reaching and returning phases of the exercises on slideboard compared to normal ground ($p<0.05$). However, ST and BF activity were greater only during the returning phase of the forward lunge ($p<0.001$) and the returning phase of the back squat ($p=0.002$, $p=0.009$, resp.). Knee flexion angles were greater when forward lunge, back lunge, and lateral squat exercises were performed on the slideboard (respectively, $p<0.001$, $p=0.032$, $p=0.05$). Hip-to-knee flexion ratios were closer to 1 when the forward lunge ($p<0.001$), back lunge ($p=0.004$) and forward squat ($p=0.001$) exercises were performed on a slideboard.

CONCLUSION: Single leg squats and lunges provide more quadriceps-hamstring muscle activation when performed on a sliding platform. Therefore, sliding platforms can be used in exercise training of the knee muscles. Forward and back lunge and lateral squat exercises can be helpful for improving the balance between hip and knee flexion angles.

BENEFITS OF INSPIRATORY MUSCLE TRAINING IN IMPROVING THE PROGNOSIS OF HEART FAILURE PATIENTS WITH LEFT VENTRICULAR EJECTION FRACTION BELOW 50% - PILOT STUDY

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INTRODUCTION: The aim of the study was to evaluate the effect of attached 4-week inspiratory muscle training to standard phase II cardiac rehabilitation in post-myocardial infarction patients diagnosed with heart failure with a left ventricular ejection fraction below 50% on the respiratory muscle strength, exercise tolerance and physical capacity of these patients.

METHODS: Twenty-four post-myocardial infarction patients with established class II and III heart failure (EF< 50%) were enrolled in the study. Patients were randomized according to the distribution table into two groups by a cardiologist. Experimental group I - patients performing inspiratory muscle training up to 60% MIP (IMT group), control group II (sham-IMT group) - patients performing simulated training at a load level <1cm H2O.

The following tests were performed in each patient: somatic characteristics, assessment of maximum inspiratory pressure (MIP) and expiratory pressure (MEP), spiroergometric test on a treadmill according to the Bruce modified protocol.

The tests were performed 2 times: before the start of inspiratory muscle training and after 4 weeks. Jaegers Vyntus apparatus and the MicroRPM was used in examination.

The following were used to evaluate the effects of IMT training: test time [min]; VO2 peak oxygen consumption level, BP, HR and MET. A Threshold IMT breathing trainer was used for training. Training intensity was determined individually based on MIP. The initial training load was 30% of MIP. Then it gradually increased to a level of 60% of MIP. Training took place 7 times a week.

The control group performed sham inspiratory muscle training with a training load < 1 cm H2O - a placebo procedure. Stage II cardiac rehabilitation was performed in both groups according to standards (interval endurance training).

RESULTS: After the application of rehabilitation along with IMT training, a highly significant increase in MIP inspiratory muscle strength and MEP expiratory muscle strength was observed in group I. There was also a highly significant increase in patients peak oxygen consumption and MET energy expenditure. In Group II, significant changes at p less than 0.05 in Peak VO2 and MET were recorded after rehabilitation. Comparative analysis between groups showed the achievement of significantly higher inspiratory muscle strength, peak VO2 and MET values in Group I patients after 4 weeks of therapy.

CONCLUSION: 1.The use of inspiratory muscle training additionally in standard phase II cardiac rehabilitation in post-myocardial infarction patients with heart failure with a left ventricular ejection fraction below 50% highly significantly increased the values of physical performance parameters in the study subjects compared to those with standard rehabilitation.

2 The use of inspiratory muscle training in the second stage of cardiac rehabilitation of post-myocardial infarction patients with established heart failure with a left ventricular ejection fraction below 50% increases its effectiveness.

Conventional Print Poster

CP-BM08 Walking and running

DISCRIMINATION OF THE KINEMATICS FEATURES OF GAIT WITH THE POTENTIAL RISK OF TRIPPING BASED ON A MACHINE-LEARNING APPROACH

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INTRODUCTION: Tripping is a common cause of falls in older persons. Wearable-sensor systems that monitor walking in real-time are expected to be effective tools for detecting tripping; however, gait characteristics with an associated increased risk of trips remain unclear. Against this background, the present study determined foot kinematics with potential

risk of trips during level ground walking by applying a supervised machine-learning method to data acquired from a single inertial measurement unit (IMU).

METHODS: In 20 trials, 10 older adults and 4 young adults walked a distance of 10 m at their preferred walking speed. Translational accelerations along the three-dimensional (3D) axes of the foot and angular velocities around the 3D axes were measured by an IMU attached to their right shoe. A MoCap system was used to determine the minimum toe clearance (MTC) and event timings of toe-off, heel-strike, and MTC. Coefficients of variation of MTC (cvMTC) were calculated from all participants' strides. The group mean and SD of cvMTC were used to define those participants with potential tripping risk as well as those without risk, in which individual cvMTCs were larger than the mean+0.5SD and smaller than the mean-0.5SD, respectively. Supervised classification learnings were carried out using a Support Vector Machine (SVM) algorithm for time-series data of the IMU measurements during the swing phase between toe-off and MTC for each stride as predictor variables.

RESULTS: Leave-one-subject-out (LOSO) cross-validation tests showed that a linear regression model with translational acceleration along the anterior-posterior axis of the foot, as well as angular velocity around the lateral axis of the foot as a predictor, was most suitable for discriminating between the groups. The average discrimination accuracy of the LOSO tests was 70.0%. The trained linear regression model had larger beta coefficients at approximately 20–30% of the early swing phase between toe-off and MTC. This suggests that the difference in dorsiflexion at the ankle joint immediately after toe-off is a determinant of cvMTC magnitude.

CONCLUSION: Previous research hypothesized that the kinematic features of gait with potential risk of tripping would be included in individuals with smaller MTC and larger variations of MTC (Barrett et al. 2010, Gait & Posture). This motivated us to construct a discrimination model with cvMTC as a response variable. In conclusion, the present study has provided additional evidence demonstrating that a larger cvMTC may be a criterion for tripping risk during walking. Our findings are likely useful for the development of a system that predicts the occurrence of tripping in advance based on IMU measurements.

RELATION BETWEEN VISUAL EXPLORATION AND KINEMATIC SYNERGY CONTROLLING SWING FOOT WHILE CROSSING AN OBSTACLE

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INTRODUCTION: To step over obstacles of varying heights, two distinct ongoing streams of activities—visual exploration of the environment and gait adjustment— were required to occur concurrently without interfering with each other. Yet, it remains unclear whether and how the manner of embodied behavior of visual exploration is related to the synergistic control of foot trajectory to negotiate with the irregular terrain. Thus, we aimed to explore how the synergistic control of the vertical trajectory of the swing foot (i.e., obstacle clearance) crossing an obstacle is related to the manner of visual exploration of the environment during the approach.

METHODS: Twenty healthy young adults walked 15 times at their comfortable speed along a 7-m walkway with an obstacle of 8-cm height (depth: 1 cm, width: 60 cm), which was placed halfway down the walkway. An eye-tracker headgear was used to record the eye movements of each participant, and the visual exploration was evaluated as the amount of time spent fixating on the vicinity of the obstacle on the floor during the period from two to four steps prior to crossing the obstacle. Kinematic data during obstacle crossing were collected using a Motion Shadow inertial measurement unit (IMU)-based full-body motion capture system, and time normalized from right toe-off to right initial contact while crossing the obstacle. The strengths of kinematic synergy to control obstacle clearance were estimated using the uncontrolled manifold approach, and we partitioned the participants into higher and lower synergy groups (H-Synergy and L-Synergy) based on a median split of the kinematic synergy. To explore the relation between visual exploration and kinematic synergy, the total gaze duration was compared between H- and L-Synergy.

RESULTS: The time fixating on the vicinity of the obstacle in participants in L-Synergy was significantly longer than those in H-Synergy. Additionally, those in L-Synergy exhibited a greater amount of head flexion movement and larger variability of foot clearance compared to those in H-Synergy.

CONCLUSION: Kinematic synergy to control foot trajectory is essential for safe locomotion. The current study found that the participants who exhibited relatively weak synergy moved their heads more to fixate on the obstacle on the floor during the period critical to controlling the foot placement, implying that there are some kinds of trade-off between the strength of kinematic synergy to control the swing foot trajectory and the gaze behavior of look down at the obstacle. Adjustments of this complex relationship between exploratory activities (e.g. looking movement) and performative activities (e.g. adjustment of ground clearance) would be crucial to adapt to walking in a complex environment.

COGNITIVE-MOTOR INTERFERENCE DURING DUAL-TASK WALKING

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INTRODUCTION: In everyday life walking happens most of the time under dual-task (DT) conditions. Whether it is walking and talking on the phone or reading an advertisement at different signs along the street. Processing auditory or visual information as a secondary task is expected to interfere differently with the resources needed for the motor task. While young healthy adults can cope with the demands of dual-tasking well, other groups like older adults or hearing-impaired

people are more vulnerable and the risk of falling increases. However, it is important to investigate Cognitive-Motor-Interference (CMI) in the young population to understand better the interaction of performance, gait and brain activity measures. The Mobile Brain/Body Imaging approach (MoBI) allows for the parallel analysis of brain activity and body movement during unrestricted movement.

METHODS: Aiming for a sample size of 96 (48 healthy and 48 mildly hearing impaired) community-dwelling older adults (50–70 years) and 48 younger adults (20–30 years), the data of a first subset of thirty young participants has been collected so far. While the ongoing study has a multifactorial mixed-measure design comparing three groups, we present here only the analysis of the within-subject factors task complexity (sitting vs. walking) and cognitive task modality (visual vs. auditory) for the young participants. Stimuli of the auditory and visual discrimination task varied according to presentation side (left vs. right), and presentation-response compatibility (ipsilateral vs. contralateral). Gait parameters were captured with the OptoGait system and EEG activity was recorded using 64 active electrodes (LiveAmp, BrainProducts).

RESULTS: Cognitive-motor-interference (CMI) was analyzed by dependent variables of task performance (accuracy and response time) and gait parameters (Gait speed, step length, double support phase) as well as stimulus evoked brain potentials during single and dual task. Performance results showed that on average 80% (ST: 81%, DT: 79%) of the visual stimuli and 90%(ST: 88%, DT 92%) of the auditory stimuli were correctly discriminated. The rate of correct responses from all given responses was 88% and 95%, respectively, showing that dual task costs were represented similarly in misses and incorrect responses.

CONCLUSION: Cognitive-motor interference varied between task modalities. The stimulus-related brain activity shows the respective signatures known for the stimulus processing of the chosen modalities during sitting and walking. The gait parameters of the young population did not reveal the impact of dual-tasking, while the performance in the cognitive task demonstrated dual-task costs by misses and incorrect responses. These performance decrements can be associated with different cognitive-motor processes, i.e., stimulus input, resource allocation, and movement execution. The results allow first conclusions about task-specificity and general mechanisms of CMI (single task vs. dual-task overground walking).

EFFECTS OF LEG LENGTH DISCREPANCY ON SPATIOTEMPORAL AND DYNAMIC GAIT PARAMETERS DURING TREADMILL WALKING

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INTRODUCTION: Leg length discrepancy (LLD) is a common skeletal asymmetry usually manifested by joint misalignments of the lower extremities and lumbopelvic region as well as muscle imbalances. The uneven distribution of loads caused during standing and functional activities such as walking and running may contribute to clinical syndromes and osteoarthritis. Although many individuals experience some degree of LLD, the amount of difference between the legs that is considered clinically significant remains controversial. The purpose of the study was to investigate the effects of artificially induced LLD on gait symmetry during treadmill walking.

METHODS: Spatiotemporal (e.g., step length and time, cadence, stance and swing time) and dynamic parameters (e.g. force exerted during stance phase) of gait were recorded in 11 male and 15 female physically active uninjured college students, who required to walk for 150 sec at 5 km/h on an instrumented treadmill without (0 cm) and with artificially induced LLD of 1, 2 and 3 cm. LLD was artificially induced by means of a special pair of shoes, which was applied externally to the shoes each person normally worn for walking, with the sole of one shoe being 1, 2, or 3 cm thicker than the sole of the contralateral shoe. A two (long and short leg) by four (0, 1, 2 and 3 cm of LLD) way ANOVA was used to investigate possible effects of LLD on gait for all parameters measured.

RESULTS: Our findings revealed that step length increased, and step time decreased by up to 3% as LLD increased ($p<0.001$) when a step was performed from the long (stance) leg to the short (swing) leg during walking. The duration of stance phase was increased and swing phase was decreased by up to 3.1% and 2.7%, respectively in these steps as LLD increased ($p<0.001$). The opposite occurred when a step was performed from the short leg to the long leg. Step length decreased and step time increased by 1.1% and 4.9%, respectively while the duration of stance phase decreased, and the swing phase increased by up to 1.7% and 5.3% respectively ($p<0.001$). Cadence was not affected by LLD. The maximum force (MaxF) applied by the midfoot of both long and short limbs increased by up to 26.8% and 10.9%, respectively as the LLD increased ($p<0.001$). The MaxF applied by the heel of the long leg was not affected but the MaxF applied by the heel of the short leg increased by up to 9.0% as LLD increased ($p<0.001$). The MaxF exerted by the forefoot of the longer limb significantly decreased by up to 7.8%, and the MaxF exerted by the forefoot of the short limb increased by up to 2.7% ($p<0.001$)

CONCLUSION: The asymmetry presented by the spatiotemporal parameters of gait in conjunction with the increased midfoot force applied during the stance phase of walking can justify to a certain extend the negative effects of LLD on body function, potentially leading to pain and increased risk injury, especially of the foot (Gurney et al 2000).

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THE PROTECTIVE FIRE BOOTS ACUTELY ALTER THE GAIT PATTERN OF FIREFIGHTERS.

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INTRODUCTION: Firefighting scenes are dangerous and chaotic with many hazards for firefighters to protect against. Thus, firefighters wear personal protective equipment including fire heavy boots. If these protective boots ensure the safety of firefighters during emergencies, they are generally worn all day at the fire station, even when firefighters are not confronted with dangers. However, the weight, size and stiffness of the boots could affect gait (Chiou et al. 2012; Park et al. 2019). Therefore, we assessed in firefighters the spatiotemporal parameters of walking with fire boots and compared it to usual sports shoes.

METHODS: Twenty-nine firefighters (25 males and 4 females, age: 37.1 ± 9.4 years, heigh: 175.7 ± 8.2 cm, weight: 76.3 ± 16.0 kg) were instructed to walk 100 m in a straight line at comfortable pace, with either sports shoes or fire boots, in a randomized order. The spatiotemporal parameters of walking were recorded and analyzed using connected insoles (Podosmart, Nancy, France). The recorded parameters were: the walking speed, the cadence, the cycle length (the length between two successive stances of the heel of the same foot), the ground contact time (the time during which the foot is in contact with the ground), the pronation/supination angles (the inclination in the transverse plane of the foot at four moments: heel and toe ground contact and heel and toe take-off), the step progression angle (the path and the orientation of the foot in the air) and the minimum toe heigh (the minimum height between the toes and the ground during foot oscillation).

RESULTS: Walking speed was similar between the two conditions, but fire boots increased stride length ($p < 0.001$), ground contact time ($p < 0.05$), and decreased cadence ($p < 0.001$). These changes were accompanied by an alteration in the angle toe's ground contact ($p < 0.001$), in the minimum toe heigh ($p < 0.001$), and in the step progression angle ($p < 0.01$).

CONCLUSION: The results of the present study revealed that fire boots alter the acute spatiotemporal parameters of firefighter walking compared to sports shoes. These results should encourage firefighters to change their practices and not systematically wear their fire boots when it is not necessary, such as in the fire station. Furthermore, future research should investigate the chronic impact of fire boots.

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THE JOINT ANGLE-TORQUE RELATION OF THE TOE FLEXORS IN UPRIGHT STANDING

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INTRODUCTION: The force-generating mechanism at the metatarsophalangeal(MTP) joints is one of important features to understanding the unique function of human bipedal locomotion. The intrinsic and extrinsic muscles and tendon complexes around the metatarsophalangeal joints help to support the foot arch and generate the plantar flexion torque at the MTP joint during walking (McKeon et al., 2015). As one of the unique function of the foot, changing the form of the foot arch in the standing increases the maximum force of the toe flexor muscles (Yamauchi and Koyama, 2019). Although the plantar flexion torque-angle relationships at the MTP joint was measured at the joint angle between 0-45 degrees in the sitting position (Goldmann and Bruggemann, 2012), there has been no study into how the MTP joint angle contribute to the plantar flexion torque when the MTP joint angle is changed with a wide range of joint motion between 0-90 degrees in the standing and whether these values are related to the toe flexor strength. The purpose of this study was to investigate the relation between the MTP joint angle and the maximum isometric torque of the toe flexor muscles in standing position and the relation between this plantar flexor torque at different MTP joint angles and the maximum toe flexor strength.

METHODS: The maximum isometric plantar flexion torque at the MTP joint and toe flexor strength were measured in the left and right feet of 55 healthy young individuals. The plantar flexion torque was measured at 10 different metatarsophalangeal joint angles between 0-90 degrees in the standing position using a specifically custom designed dynamometer . The maximal isometric toe flexor strength in the standing position was measured using a toe flexor dynamometer. For both measurements, subjects exerted maximum force for 3 seconds and the maximum value among three measurements for each foot was used for further analysis. Additionally, these values were further normalized by body mass.

RESULTS: The plantar flexion torque at the MTP joint exhibited a peak when the MTP joint angle was at dorsiflexed 20-50 degrees, and these values were correlated with the maximum toe flexor strength.

CONCLUSION: The result of this study suggests that there is an optimal position for maximum force generation at the MTP joint and thus limiting the movement of the MTP joint from this optimal position could impair force production of the toe flexor muscles and physical performance in bipedal locomotion.

CHANGES IN MEDIAL LONGITUDINAL ARCH AND PLANTAR LOAD DURING WALKING AT DIFFERENT SPEEDS

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INTRODUCTION: As one of the important foot functions, medial longitudinal arch (MLA) plays spring-like action for braking and accelerating especially in walking and running. During the stance phase, MLA changes in response to load, absorbing shock at foot contact and generating propulsive force during push-off phase [1]. Walking at different speeds make changes in the spatio-temporal variables and the plantar load. Walking at a faster speed increases the stiffness of the MLA by activating the plantar intrinsic muscles, which contributes to increased push-off against the ground during walking [2]. However, it has not been clear how much load is applied to deform the MLA during stance phase. Purpose of this study was to clarify the changes in the MLA and plantar load distribution during the stance phase of walking at different speeds.

METHODS: Eight healthy male subjects participated in this study (Age 20.8±3.4 years; Height 174.2±4.7 cm; Mass 69.9±5.6 kg). Plantar pressure measurement plate (Novel GmbH®, 100Hz), motion capture system (Oxford, 100Hz) and force plate (Kistler, 1KHz) were synchronized. Using this system, subjects performed 3 walking trial at 0.8 (Slow), 1.2 (Normal), 1.7 (Fast) m/s. Plantar load distribution was divided into five sub-area based on anatomical measurement points [3]. MLA angle was calculated as the angle between the distal first metatarsal, navicular tuberosity and calcaneus. In addition, the plantar load data were used to divide the stance phase into three phases: (1) from initial foot contact till medial and lateral forefoot ground contact (forefoot contact phase : FCP), (2) from medial and lateral forefoot ground contact till heel off (foot flat phase : FFP), (3) from heel off till last foot contact (forefoot push-off phase : FPOP).

RESULTS: In comparison with Slow, Fast showed a significant increase in MLA angle, medial and lateral rearfoot plantar loads from FCP to FFP. On the other hand in FPOP, there was no difference in the amount of change in MLA angle among different speed conditions despite the greater load applied to the medial forefoot. In comparison with Slow, Fast showed no difference in the amount of change in MLA angle, despite the greater load applied to the medial forefoot at FPOP. When more forceful push-off, it has reported that the abductor hallucis is more activated and produces a greater plantar flexion moment [2]. Therefore, it was suggested that activity of the plantar intrinsic muscles increased foot stiffness, remaining the constant MLA angle at push-off.

CONCLUSION: Increasing the plantar loads in medial foot as well as stiffening the MLA might be important roles during push-off phase in walking at fast speed.

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A LONGITUDINAL STUDY OF THREE-DIMENSIONAL PELVIC BEHAVIOR IN MAXIMAL SPRINT RUNNING.

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INTRODUCTION: Sprinting speed is determined by step frequency and step length, and there is an inverse relationship between step frequency and step length. It is important to increase step frequency while maintaining the large step length for achieving high sprinting speed. Improvement in the recovery of leg motion during sprinting results in an improvement in step frequency, and this motion is associated with the pelvis rotating to the free leg side (Sado et al., 2017). Sado et al. (2017) found that the pelvis rotates to the free leg side, which is associated with the greater free leg side lumbosacral joint torsional torque, assisting in the recovery of leg motion of the stance leg. Thus, it seems reasonable that the free leg side lumbosacral joint torsional torque during sprinting may have an important function in terms of achieving high sprinting speed. However, these findings were investigated cross-sectional in terms of the relationship between variables and differences in competition levels, and no longitudinal study has been reported to investigate changes in the factors influencing step frequency and step length with increasing sprinting speed. Therefore, the purpose of this study was conducted to investigate the longitudinal change in the kinematics and kinetics of the pelvis using data with the increasing sprinting speed.

METHODS: Nine male sprinters performed a 60 m sprint from a crouching start at maximal effort, which was conducted at twice in a 1-year period, and the data from the 2 tests were analyzed. Each participant was attached with 47 retroreflective markers to their trunk and limbs for motion capture. A 26-camera motion capture system at 250 Hz was used to record the three-dimensional coordinates of the position of each reflective marker. The ground reaction force at 1000 Hz was recorded using a force platform, and the values were synchronized with the motion data. After normality was confirmed, Student's paired t-test was applied to compare the statistical significance at $p < 0.05$.

RESULTS: During the test 2, the sprinting speed and step frequency were significantly higher compared to the test 1. The kinetics pattern of pelvic rotation indicated that the lumbosacral joint torsional torque toward the stance leg side was greater until the middle of the stance phase and that the lumbosacral joint torsion torque toward the free leg side was greater. The integrated contributory component of the lumbosacral joint torsion angular impulse during the total and stance phase were significantly greater in the test 2 than in the test 1.

CONCLUSION: It is important for achieving high sprinting speed to exert free leg side lumbosacral joint torsional torque from the middle of the stance phase to toe-off, resulting in the faster recovery leg motion and increasing step frequency.

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MECHANICAL PROPERTIES OF LOWER EXTREMITY MUSCLE CHANGED AFTER FATIGUE AND RECOVERY USING VIBRATIONAL INSTRUMENT IN ADULTS

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INTRODUCTION: Jogging is a getting popular aerobic exercise in the general population around the world. Lower extremity muscle strains and stiffness as well as knee pain are commonly observed sports injuries in the runners. Applying proper and sufficient muscle relaxation techniques to facilitate muscle recovery and maintain soft and flexible muscle properties after training are believed to have effects on preventing sports injuries. Many relaxion instruments are available in the market such as foam rollers and vibrational guns. However, to date only one study showed increased ankle dorsiflexion after 5 minutes application of vibrational gun on calf muscles in young males. The effects of using vibrational gun as the recovery intervention on mechanical property of the lower extremity muscle are still very limited. Therefore, this study aimed to investigate how the mechanical properties of quadriceps would be changed after fatigue and after recovery intervention using the vibrational gun in young adults.

METHODS: A total of 16 young adults who never receive regular running training and without any health concern participated in this study. All participants first received a pre-designed fatigue protocol to induce aerobic fatigue using power biking and followed by muscle fatigue using repeated jumping, hopping and stepping tasks. The recovery intervention was then delivered using the Hypervolt vibrational gun (Hyperice, California, United States) with 53 Hz on the middle and caudal one-third locations of the right rectus femoris (RF) for 2.5 minutes each location. Mechanical properties of right RF including tension, stiffness, elasticity, relaxation time and creep were assessed using the MyotonPro (Myoton AS, Tallinn, Estonia) immediately before, after designed fatigued protocol, and after relaxation intervention. Repeated ANOVAs were used for analyzing the differences of muscle mechanical properties among three time points. Post hoc with Bonferroni correction was done if indicated.

RESULTS: Both the tension and stiffness of the RF significantly increased after fatigue and decreased after recovery intervention. In contrast, the relaxation time and creep significantly decreased after fatigue and increased after intervention. However, all muscle proprieties did not return to the pre-fatigue level after recovery. The elasticity of the RF did not change in this study.

CONCLUSION: The current findings demonstrated that after a period of training or occurrence of a fatigue, the muscle became stiffer, with higher inner pressure, and more difficult to relax or deform. Applying vibrational gun on the targeted muscle as the recovery intervention was able to improve the mechanical properties and may have potential effects on preventing injuries.

KINEMATICS OF PELVIS DURING MAXIMAL SPRINT RUNNING: GENDER DIFFERENCES IN ITS RELATION TO RUNNING VELOCITY

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INTRODUCTION: Many studies have investigated the lower limb kinematics of maximal sprint running. However, few have focused on the pelvis; the root of the lower limb. As it plays a substantial role in lower limb movement, it is important to investigate the kinematics of pelvis during maximal sprint running and its influence on maximal running velocity. The aim of this study was to examine the relationship between pelvic kinematics and running velocity during maximal sprint running and its gender differences.

METHODS: Japanese track and field athletes (52 males and 52 females, including sprinters, hurdlers, long jumpers, decathletes and heptathletes) participated in this study. Their maximal sprint running was captured using a 250-Hz optical motion capture system. Kinematic parameters of the pelvis during the stance phase, e.g., 3-dimensional angles at toe-on and toe-off, angular displacements, and peak angular velocities, were obtained from two consecutive left and right steps of each athlete. Multiple regression analyses were performed separately for males and females, with each kinematic parameter as a dependent variable and running velocity, leg length, and step frequency as explanatory variables. Leg length and step frequency were included to standardize the influence of body dimensions and spatiotemporal characteristics of running. The relationships were determined based on the statistical significance (α=0.05) of the standardized partial regression coefficients (β).

RESULTS: All athletes showed a similar pattern of pelvic movement during maximal sprint running: the pelvis tilted anteriorly; tilted ipsilaterally to the stance side; and rotated slightly ipsilaterally, then counter-rotated contralaterally during the stance phase. In males, the kinematic parameters relevant to anterior tilt were only related to the running velocity (β = 0.373, 0.248, -0.295, -0.252, for the anterior tilt angle at toe-on, that at toe-off, anterior angular displacement, and peak anterior angular velocity, respectively). In females, however, the kinematic parameters relevant to late stance rotation

were only related to the running velocity (β = 0.288, 0.255, 0.353, for the maximum ipsilateral rotation angle, contralateral counter-rotation angular displacement, and peak contralateral counter-rotation angular velocity, respectively).

CONCLUSION: The current results suggest that pelvic kinematics have a substantial influence on maximal running velocity, and the underlying mechanisms may differ between males and females. A more anteriorly tilted and stabilized pelvic motion may contribute to running velocity in males, whereas a larger and faster rotational motion may contribute in females. Gender differences in shape of the pelvis, i.e., more vertical in males and wider in females, lead to a difference in its moment of inertia around each axis, which may result in the different pelvic movement requirements for higher maximal running velocity between males and females.

Conventional Print Poster

CP-PN14 Interval Training

ASSESSMENT OF HIGH-INTENSITY TRAINING LOAD AND EXERCISE-INDUCED LIPID PEROXIDATION IN PROFESSIONAL FOOTBALL PLAYERS

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INTRODUCTION: It is documented that intense periods of football can induce lipid peroxidation, the negative effects of which can lead to compromised performance. However, few studies have explored the potential association between exercise-induced lipid peroxidation and training load intensity. Therefore, the aim of the study was to quantify a biomarker of lipid peroxidation relative to objective indicators of high-intensity training load in a cohort of professional football players throughout different phases of a competitive in-season.

METHODS: Ten professional football players (age: 23 ± 2 yrs; body mass: 83.5 ± 6.2 kg; stature: 181.3 ± 5.3 cm; VO2max: 57.2 ± 6.7 mL·kg·min^{-1}) participated in the study. Training load was assessed at three time points throughout a competitive in-season (T1: early in-season [1st microcycle]; T2: mid-season [16th microcycle]; T3: end of in-season [32nd microcycle]) using Global Positioning System (GPS) and heart rate (HR) based methods to quantify high-intensity external training load (HETL) and high-intensity internal training load (HITL). Urine samples were collected at each time point and analysed for urinary malondialdehyde (MDA) as a biomarker of lipid peroxidation; data normalised to creatinine. Results presented as M ± SD.

RESULTS: High-intensity training load varied significantly throughout the competitive in-season and was significantly higher at T2 compared to T1 (HETL: 18.56 ± 7.30 m.min-1 vs. 6.71 ± 2.62 m.min-1, an increase of 11.84 m.min-1, 95% CI [4.33, 19.36], p = .004; HITL: 60 ± 34 %Time spent > 80% HRmax vs. 23 ± 14 %Time spent > 80% HRmax, an increase of 37 %Time > 80% HRmax, 95% CI [13, 60], p = .004; T2 vs. T1, respectively). Urinary MDA concentrations decreased significantly throughout the competitive in-season, x2(2) = 6.889; p = .032, (T1: 0.76 ± 0.90 µM.mmol-1 vs. T3: 0.18 ± 0.12 µM.mmol-1, Z = -2.192, r = .52, p = .028). No significant correlations were observed between indicators of high-intensity training load and MDA.

CONCLUSION: Participation in chronic football training appears to promote an adaptive response as lipid peroxidation was attenuated over the competitive in-season, irrespective of high-intensity training load. Monitoring urinary MDA may be a useful tool to provide sports scientists with an insight into adaptive or maladaptive responses throughout a competitive season in football.

KINETICS OF PERFORMANCE FATIGABILITY DURING A SINGLE SESSION OF 8X4-MIN HIGH-INTENSITY INTERVAL TRAINING

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INTRODUCTION: Performance fatigability—a decline in an objective measure of performance over a discrete period—reflects complex processes in the nervous and skeletal muscle systems in response to exercise. Studies have quantified performance fatigability during sprint interval exercise; however, to our knowledge, no studies have examined the kinetics of fatigability during a session of longer intervals, representative of high-intensity interval training (HIIT). The purpose of this study was to examine performance fatigability during a cycling HIIT session. We hypothesized that (i) successive intervals would cause smaller declines in maximal voluntary contraction (MVC) force and central and peripheral indices of fatigability, compared to the previous interval; and (ii) the session would cause greater peripheral fatigue than central fatigue.

METHODS: Healthy participants (n=8 males, n=7 females, age = 26±5 yrs., VO2max = 47±6 ml/kg/min) performed cycling trials to task failure to determine critical power (CP) followed by a HIIT trial consisting of 8x4-min intervals at 105% CP interspersed with 3 min at 15% CP. Neuromuscular function (NMF) tests, which consisted of femoral nerve electrical stimuli delivered during and after an MVC, were performed prior to and immediately after the 1st, 4th, and 8th intervals. From these tests, we measured overall fatigability (MVC), voluntary activation (VA), and low-frequency fatigue (LFF). Data were analyzed using one-way, repeated measures ANOVAs. Statistical significance was set at $p<0.05$, and effect sizes (ES) were estimated using Cohen's d for repeated measures.

RESULTS: After 8 intervals, MVC decreased by 26±11% (708±174 N vs. 528±154 N, p<0.01). The first interval (ES: -0.6, p<0.01) had a larger effect than intervals 2-4 (ES: -0.2, p=0.40) and intervals 5-8 (ES: -0.3, p=0.09). A 32±18% decline was observed for LFF after 8 intervals (0.98±0.18 vs. 0.65 ± 0.13, p<0.01), with most of the decline attributable to the first interval (ES: -0.7, p=0.22) and intervals 2-4 (ES: -1.0, p<0.01) as opposed to intervals 5-8 (ES: -0.1, p=0.99). We found a significant effect of time for VA, despite small changes after 8 intervals (87±5% vs 85±8%, p=0.04). VA showed larger effects of the final four intervals (ES: -0.3, p=0.69) compared to the first interval (ES: 0.2, p=0.97) or intervals 2-4 (ES: 0.1, p=0.99).

CONCLUSION: Over the course of an eight-interval exercise session, there was a notable decline in MVC, which was primarily attributable to substantial impairment in muscle contractile function (peripheral fatigue), with limited central fatigue. A large proportion of the total decline in MVC (~60%) was present after just one interval, and ~70% of this impairment was present after four intervals. These findings suggest that the common "4x4" high-intensity interval training protocol elicits muscle metabolic stress with diminishing returns for subsequent completed intervals.

TH17 CELLS PROTECT THE LEAKY GUT FROM HIGH-INTENSITY EXERCISE-INDUCED DAMAGE IN MICE

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INTRODUCTION: Moderate exercise has a beneficial effect on the immune system, but high-intensity exercise is known to reduce the number of lymphocytes in the blood during recovery, leading to the "open window" that is vulnerable to infection. A seminal study found that T cells are redistributed to peripheral tissues including the intestine following an even bout of high-intensity exercise (1). During high-intensity exercise, an intestine is temporarily damaged and leaky, allowing gut bacteria to enter the intestine (2). In defense of gut bacteria, T helper 17(Th17) cells play an important role in enhancing the tight junction between intestinal epithelial cells by inducing interleukin-17 (IL-17) and IL-22 (3, 4). This study aims to identify Th17 cells in the Peyer's patches (PPs) of the small intestine for immune surveillance following high-intensity exercise.

METHODS: Twenty male Balb/c 8 weeks of age mice were divided into normal group (N) and exercise group (EX). The EX mice were subjected to swimming until exhaustion, and blood and PPs were collected 1 h after the forced swimming test. For in vivo evaluation of gut permeability, serum levels of lipopolysaccharide (LPS) and FITC-conjugated dextran were analyzed. Specific subsets of immune cells were analyzed by fluorescent-labeled antibody staining of blood and PP cells using flow cytometry. Gene expression was analyzed by realtime-PCR. Data were analyzed by Student's t-test and expressed as mean ± SD.

RESULTS: The average time spent for swimming was 28±4 min. In the EX group, the levels of serum FITC-dextran (N: 1520.18±219.17, EX: 1907.79±234.66ng/ml, p=0.005) and LPS (N: 1.029 ± 0.096, EX: 1.148 ± 0.099 EU/ml, p = 0.011) increased respectively. In analysis of blood cells, the percentages of T cells (p=0.02), CD4(+) T cells (p=0.01), CD8(+) T cells (p=0.015), and B cells (p=0.001) decreased in the EX group, as previously reported in PP, the percentage of dendritic cells (DC) (CD11c+) (p=0.039), macrophages (F4/80+) (p=0.002), and Th17 cells (CD3+CD4+IL-17+) (p=0.021) increased in the EX group, indicating the redistribution of immune cells to the gut. In the PP of the EX group, the expression of CD80, a DC activation marker, increased in the EX group (p=0.041). Also, the expression of CD69, a T cell activation marker, increased in the EX group (p=0.036). Further, the upregulation of IL-23 and IL-22, which induce the expression of Th17-type cytokines, was observed in the EX group (p=0.001 for IL-23 and p=0.021 for IL-22).

CONCLUSION: This study demonstrated that high-intensity exercise stimulates various immune cells to migrate to the PP. The increased number of Th17 cells indicates that they may protect the leaky gut from exercise-induced damage.

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THE INFLUENCE OF DOMAIN-SPECIFIC EXERCISE INTENSITY PRESCRIPTION ON CHANGES IN GUT MICROBIOTA COMPOSITION IN HEALTHY HUMANS

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INTRODUCTION: The gut microbiota comprises all microbes inhabiting the intestines and has been implicated in a variety of health and disease states [1]. Cardiovascular exercise training has been shown to positively influence the gut microbiota by enriching bacterial diversity and increasing the abundance of health-associated bacteria and their metabolites, including butyrate [2]. The majority of research to date has focused on low- or moderate-intensity continuous exercise interventions, thus the influence of higher intensities of continuous (i.e., heavy domain) or intermittent (severe or extreme domains) exercise training on the gut microbiota remains unknown. The purpose of this study was to evaluate the influence of domain-specific exercise training on the gut microbiota.

METHODS: Sixty-seven (n=67) healthy young adults were randomized to 6 groups (5 exercise interventions, 1 control (CON)). Exercise interventions consisted of three groups performing continuous cycling in the 1) moderate (MOD)- (n=11), 2) lower heavy (HVY1)- (n=10), and 3) upper heavy-intensity (HVY2) domain (n=13) and two interval cycling groups including 4) high- intensity interval training (HIIT) in the severe-intensity domain (n=11) and 5) sprint interval training (SIT) in the extreme-

intensity domain (n=13). Exercise intervention groups, except SIT were work matched. Participants performed 3 training sessions per week for 6 weeks. Stool samples were collected immediately prior to and following the 6-week period for gut microbiota analysis via 16S rRNA sequencing.

RESULTS: Bacterial alpha diversity was unchanged by the exercise intervention in all groups except SIT, which showed a significant decrease in alpha diversity (inverse Simpson) post intervention. Bacterial relative abundance at the genus level was unchanged in CON and MOD, however, significant ($p<0.05$) changes were observed post intervention in HVY1, HVY2, HIIT, and SIT. In the continuous exercise groups, the abundance of Faecalibacterium, a beneficial butyrate producer, was reduced post-intervention in HVY1 and HVY2, while HVY2 also increased butyrate producing Anaerostipes. In the interval exercise groups, Agathobacter - another butyrate producer - was decreased and increased in HIIT and SIT, respectively, while SIT also showed a non-significant ($p=0.062$) increase in Faecalibacterium post intervention.

CONCLUSION: These results suggest that 6 weeks of cardiovascular exercise training influences gut microbiota alpha diversity and relative abundance in healthy humans, but there may be a minimum exercise intensity required to stimulate changes. Additionally, intermittent exercise in the extreme intensity domain may be the most optimal for increasing the abundance of beneficial bacteria.

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REPEATED SPRINT TRAINING IN HYPOXIA INDUCES SUPERIOR GLYCOLYTIC ADAPTATIONS THAN IN NORMOXIA THROUGH S100 PROTEIN SIGNALING

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INTRODUCTION: Athletes increasingly engage in repeated sprint training that consists of repeated short all-out effort (<10 s) interspersed by short recoveries (<60 s). When performed in hypoxia (repeated sprints in hypoxia, RSH), it may lead to greater training effect than in normoxia (RSN). The literature on the molecular response to RSH remains moot about the effects on muscle oxidative vs glycolytic activity. To clarify it, we studied the effects of RSH on these molecular pathways, in comparison to RSN.

METHODS: Two groups of healthy young men (randomized) performed three training sessions/week for three weeks. Each training session consisted in six series of six sprints (6 s effort / 24 s rest) in either normoxia (RSN, n = 7) or normobaric hypoxia (FiO_2 = ~13%, RSH, n = 9). Before and after the training period, vastus lateralis muscle biopsies, a repeated sprint ability (RSA) test and a Wingate test were performed. Metabolic muscle adaptations were studied with proteomics and western blotting.

RESULTS: RSN and RSH similarly improved power output ($p<0.05$) during the RSA test (RSN: +7.2±7.7% vs. RSH: +7.9±6.6%) and the Wingate test (RSN: +1.3±3.6% vs. RSH: +4.4±5.0%). Proteomics revealed a decrease in several processes involved in oxidative phosphorylation, confirmed by Western Blot with a reduction ($p<0.05$) in complexes I (-21%) and V (-18%) protein levels in response to both RSN and RSH. RSN and RSH increased ($p<0.05$) protein levels of the hypoxia inducible factor 1α (HIF-1α, +106%) and vascular endothelial growth factor A (VEGFa, +80%). Protein levels of the glycolytic enzyme hexokinase II increased (+80%, $p<0.05$) after both training types. Only RSH induced increased glucose transporter 4 (GLUT4, +31%, $p<0.05$) protein level, suggesting specific glycolytic adaptations in response to hypoxia, supported by proteomics data. This specific adaptation may be triggered through the signaling of S100 protein family as we observed an increased S100A13 protein level (+730%, $p<0.05$) as well as several other S100 proteins in proteomics.

CONCLUSION: To conclude, RSH did not result in greater performance improvement than RSN. However, it further improved the glycolytic phenotype compared to RSN, possibly through specific S100 proteins signaling. Thus, we suggest that the reported superiority of RSH to RSN in the literature may result from superior glycolytic adaptations.

EXERCISE MITIGATES REDUCTIONS IN GLUCOSE TOLERANCE, SKELETAL MUSCLE MITOCHONDRIAL FUNCTION AND PROTEIN SYNTHESIS, BUT NOT COGNITIVE FUNCTION, INDUCED BY SLEEP RESTRICTION.

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INTRODUCTION: Inadequate sleep is increasingly common and has been associated with reductions in glucose tolerance. While the factors underpinning this require further investigation, reduced mitochondrial function has been suggested as a candidate mechanism. Moreover, inadequate sleep is known to reduce mood state and decrease vigilance. Given that exercise can improve glucose tolerance and mitochondrial function and improve mood, we hypothesised that exercise may mitigate the detrimental effects associated with a period of sleep restriction.

METHODS: 24 healthy young males participated in an eight-night, laboratory-controlled sleep study. Participants were allocated into one of the three experimental groups: a Normal Sleep (NS) group (8 h time in bed (TIB) per night, for five nights), a Sleep Restriction (SR) group (4 h TIB per night, for five nights), and a Sleep Restriction and Exercise group (SR+EX) (4 h TIB per night, for five nights and three high-intensity interval exercise (HIIE) sessions). Glucose tolerance, skeletal mus-

cle protein synthesis (via deuterium oxide administration), mitochondrial respiratory function, transcriptomic responses, and measures of mood and vigilance were assessed pre- and post-intervention.

RESULTS: We report that the SR group had reduced glucose tolerance post-intervention (mean change ± SD, P value, SR glucose AUC: 149 ± 115 A.U., P = 0.002), which was also associated with reductions in mitochondrial respiratory function (SR: -15.9 ± 12.4 pmol O2.s-1.mg-1, P = 0.001), and a lower rate of sarcoplasmic protein synthesis (SarcPS, FSR%/day SR: 1.11 ± 0.25%, P < 0.001). These effects were not observed when incorporating three sessions of HIIE during this period (SR+EX: glucose AUC: 67 ± 57, P = 0.239, mitochondrial respiratory function: 0.6 ± 11.8 pmol O2.s-1.mg-1, P = 0.997, and SarcPS (FSR%/day): 1.77 ± 0.22%, P = 0.971). However, there were no differences in POMS total mood disturbance score or PVT-assessed reaction time (P < 0.05) between the SR and SR+EX groups.

CONCLUSION: We report that performing three sessions of HIIE throughout a period of sleep restriction can prevent the reductions in glucose tolerance, mitochondrial function, and skeletal muscle protein synthesis observed with sleep restriction alone. However, the reductions in mood state and vigilance with sleep restriction were not ameliorated by performing HIIE. Therefore, exercise may be a viable candidate to mitigate the detrimental metabolic consequences associated with sleep loss, although it's benefit for improving mood and alertness in this context requires further research.

RELATIONSHIPS BETWEEN CHANGES IN PERFORMANCE RELATED-MEASURES FOLLOWING HIGH-INTENSITY INTERVAL TRAINING IN ELITE ATHLETES DERIVED VIA META-REGRESSION ANALYSES

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INTRODUCTION: Elite athletes use high-intensity interval training (HIT) to enhance competition performance. Meta-analyses have shown that HIT is effective for improving various performance-related measures in various settings (Wiesinger et al. 2023). However, visualization of relationships between HIT-induced change scores in performance-related measures may provide a more nuanced and practical interpretation by revealing trends and patterns that were not apparent in the separate meta-analyses. Here, we have explored these relationships.

METHODS: The change scores were the study-estimates for the performance-related measures (sprint speed/power, repeated-sprint ability, time-trial speed/power, peak speed/power, threshold speed/power, VO2max, work economy) for the HIT and control groups in the previous study (Wiesinger et al. 2023). The linear relationships between change scores of pairs of measures were quantified with a meta-analytic mixed model. The fixed effects were the linear-numeric predictor variable and the intercept. The mean value of the dependent variable was estimated with the same mixed model omitting the predictor variable, and the corresponding mean value of the predictor was estimated from the slope (the coefficient of the predictor) and the intercept of the first model. A random effect provided an estimate of heterogeneity as the standard error of the estimate, which represented differences in the effect of HIT between settings that were not explained by the predictor.

RESULTS: The scatterplots revealed positive linear relationships between appropriate pairwise combinations of time-trial speed/power, peak speed/power, VO2max, and aerobic/anaerobic threshold. The mean changes in the subset of study estimates in each plot were similar, but the variation in each dependent variable left unexplained by the predictor (the standard error of the estimate) was 2.0 to 2.6%. Mean change in work economy showed a slightly negative relationship with time-trial speed/power and a stronger negative relationship with VO2max. Repeated-sprint ability had a weak positive relationship with sprint speed/power.

CONCLUSION: The wide variation in change in mean time-trial performance between settings for a given change in peak speed/power, VO2max, or threshold speed/power implies that these three test measures would not accurately reflect the effects of HIT on performance in endurance competitions. Therefore, time-trials should be implemented whenever possible to accurately assess the effect of HIT. The three test measures, along with work economy, might nevertheless identify strengths and weaknesses to customize further implementation of HIT or other training interventions of the individual athletes in a given setting. Sprints and repeated-sprinted ability are both important performance-related measures for team-sport athletes, and their poor relationship implies that both should be measured to assess the effect of HIT.

EFFECTS OF EXERCISE IN HYPOXIA BUT REST IN NORMOXIA DURING SPRINT INTERVAL TRAINING ON ACUTE PHYSIOLOGICAL RESPONSES AND PERFORMANCE

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INTRODUCTION: Exercise under hypoxia can induce arterial and tissue deoxygenation due to low oxygen availability. This arterial and tissue hypoxia can induce physiological adaptations through an oxygen-sensing signaling pathway. However, adding hypoxia to exercise can negatively impact training stimulus due to reducing absolute training intensity and/or volume. In this study, we tested our hypothesis that exercise in hypoxia but rest in normoxia during sprint interval training can induce larger arterial hypoxia during exercise with maintained absolute training intensity and volume compared to normoxic exercise.

METHODS: Seven male athletics sprinters volunteered to participate in this study. This study was conducted in a single-blinded, cross-over manner. All participants performed 4 × 30-sec all-out cycling sprints with 4.5-min rest in normobaric

hypoxia (12.7%O2, H), or normoxia (N), or exercise in normobaric hypoxia (12.7%O2) but rest in normoxia (HN) in a randomized order. Total work, arterial oxygen saturation, and blood lactate concentration were measured as performance and physiological variables.

RESULTS: Compared to N, total work was significantly decreased in H ($p<0.05$) but maintained in HN. Main effect of time ($p<0.001$), condition ($p<0.001$) and interaction ($p<0.001$) were observed for arterial oxygen saturation. Arterial oxygen saturation of HN significantly decreased only during exercise to the same level as H (SpO2: 85.4±2.6 vs 85.3±4.9%) but not different during rest compared to N (SpO2: 97.1±1.0 vs 97.6±1.4%). Blood lactate concentration significantly increased across repetition ($p<0.001$) but was not different between conditions.

CONCLUSION: In this study, compared to normoxic condition, exercise in hypoxia but rest in normoxia during sprint interval training induced large arterial hypoxia only during exercise with similar absolute training intensity and volume. Therefore, the hypoxic training protocol in this study could be a new potential training method to induce a large physiological training stimulus with the same mechanical training stimulus.

EFFECTS OF HIGH-INTENSITY INTERVAL TRAINING WITH BLOOD FLOW RESTRICTION ON CYCLING EFFICIENCY AND OXYGEN UPTAKE

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INTRODUCTION: Blood Flow Restriction (BFR) is known to increase both muscular strength and hypertrophy but has also shown improvements in maximal aerobic power (VO2max) when using low-intensity training [1]. However, the effects of low-volume high-intensity interval training (HIIT) combined with BFR (HIIT+BFR) are unclear and need further investigation. In addition, the effects of occlusion pressure during training on central cardiovascular and peripherical metabolic adaptations are poorly documented. Thus, this study aimed to investigate the effects of HIIT+BFR on VO2max and the effects of different occlusion pressures on central cardiovascular adaptations.

METHODS: 25 participants (11 females, 14 males; 19 ± 7 years; 175 ± 8 cm; 66.8 ± 7.9 kg; 17.3 ± 8.2 % of body fat; 9 ± 5 h of physical activity per week) were trained three times a week for four weeks with BFR at different levels of occlusion (G1 = 20 mmHg (SHAM); G2 = 40% Limb Occlusion Pressure (LOP); G3 = 60% LOP). Training consisted of 4 to 7 bouts of 90 seconds HIIT+BFR performed at 90% of VO2max on a cycle ergometer, interspersed with 2 min recovery bouts, where cuffs were deflated. Pre-and post-cardiorespiratory fitness was assessed. Groups and sessions were compared using mixed ANOVA

RESULTS: Training did not affect VO2max, but significantly improved maximum power attained at volitional exhaustion for all groups, with no difference between groups (269 ± 45 vs. 300 ± 51 watts, $p<0.05$). Training enhanced power at both Gas Exchange Threshold (GET) (175 ± 48 vs. 212 ± 48 watts, $p<0.05$) and Respiratory Compensation Point (RCP) (227 ± 43 vs. 265 ± 51 watts, $p<0.05$), for all groups but with no difference between groups.

CONCLUSION: 4 weeks of HIIT combined with BFR is not enough to improve the participants' VO2max. However, the increase in maximum wattage attained without any increase in VO2max shows a training-induced improvement of cycling efficiency, suggesting peripherical metabolic or/and neuromuscular adaptations [2]. With this training modality, the stress stimulus induced by blood flow restriction during exercise was insufficient to induce significantly higher central cardiovascular adaptations, but induced peripherical adaptations even with low peripherical resistance, implying that higher pressures are not needed.

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META-ANALYSES OF THE EFFECT OF HIGH-INTENSITY INTERVAL TRAINING ON PERFORMANCE-RELATED MEASURES IN ELITE ATHLETES

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INTRODUCTION: High-intensity interval training (HIT) enhances sprint and endurance performance, but its effect on elite athletes, who are already highly trained, could be limited by a ceiling effect. We have therefore meta-analysed the effects of HIT on such athletes.

METHODS: We followed the PRISMA guidelines. Studies were performed on endurance (mean VO2max: males ≥60 ml·min−1·kg−1, females ≥55 ml·min−1·kg−1) or other elite athletes. HIT consisted of ≥5 sessions and ≥1 session/wk at intensities ≥90% of HRmax or VO2max for intervals of ≤4 min or with all-out intervals of ≤90 s. Percent changes with HIT vs usual control training were derived via log-transformation from random-effects meta-regression with adjustment for one or more fixed-effect modifiers (sex, type of athlete, type of test, type of HIT, phase of training, training duration, whether HIT replaced some usual training, and relevant pre-test mean values). Separate analyses were performed for the following performance-related measures: sprint speed/power, repeated-sprint ability (RSA), time-trial speed/power, peak speed/power, threshold speed/power, VO2max, and work economy. Heterogeneity, representing unexplained real

differences between settings, was estimated from random effects for study- and sample-estimate identity. Level of evidence for effect magnitudes was evaluated via effect uncertainty and a smallest important change of 1%.

RESULTS: All performance-related measures except economy showed at least good evidence for enhancement in some subgroups and some settings, with effects ranging from 2.1% for 5-s sprints in male other athletes to 12.6% for threshold speed/power in female endurance athletes. Moderating effects of sex and type of athlete were inconclusive. Very good evidence was found for greater effects of HIT vs control on longer sprint and time trial. There was at least good evidence for reduced effects of more anaerobic types of HIT on VO2max and threshold speed/power, but its effects on other measures were inconclusive. Effects of other modifiers on the other measures, where they could be estimated, were also inconclusive. Heterogeneity of the effects of HIT ranged from small to moderate (SDs 1.1 to 2.3%) but was generally unclear.

CONCLUSION: On average, HIT works for endurance and other elite athletes across various performance demands, including short sprints, repeated sprints, and time trials, which relate closely to competition performance. The positive effects of HIT would hold for most sports, even if our already conservative estimate of the smallest important of 1% was doubled. However, when heterogeneity is taken into account, HIT could be ineffective for some measures in some settings. Additional research is required to address the uncertainty in the effects of HIT with female non-endurance athletes on some measures, the effect of HIT on economy, and the modifying effects of the duration of training, the phase of training, and type of HIT with most measures.

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Conventional Print Poster

CP-PN15 Cardiovascular Physiology I

AUSCULTATORY, PALPATORY, PHOTOPLETHYSMOGRAPHIC AND ELECTROCARDIOGRAPHIC HEART RATE RECORDING DIFFERENCES DURING REST AND SUPMAXIMAL AEROBIC AND RESISTANCE EXERCISE

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INTRODUCTION: Heart rate monitoring is important for determining acute and chronic exercise responses and adaptations during rest and exercise and can be used as a training stress measure for exercise participants. The present study aimed to compare different methodologies for heart rate measurement in three specific conditions: resting state, after submaximal aerobic exercise and after strength training.

METHODS: Thirty-seven female and male sports science students, aged 23.2+3 years, participated in the study. During their visit to the laboratory, their Heart Rate (HR) was assessed at rest in a supine position and after being previously rested for 5 minutes. The assessment was performed simultaneously by the following methods: auscultation, palpation, photoplethysmograph (PPG -hand finger pulse oximetry and wristwatch) and electrocardiographic activity (chest heart rate belt). The same recordings were followed after a three-minute sub-maximal running on a treadmill at zero inclination and 8km/hr speed. Finally, the same methodology was used to record HR after performing three deep leg squat sets of twelve reps, with an intensity at 70% of maximal strength (1 RM determined 15 min earlier using the multiple repetition method) and a 1 min break between sets. Data were analyzed using IBM SPSS Statistics v26 software. Data are described by measures of central tendency and variance (X±SD), and one-way ANOVA was applied to compare means. The level of significance (p) was set at 0.05.

RESULTS: The comparison of means revealed no statistically significant differences ($p>0.05$) between the different recording methods in each condition. However, it is noteworthy that the maximum differences between the methods of the individual conditions increased with increasing exercise intensity and particularly as the dynamic physiological demands increased. In particular, the greatest difference (6.7%) in resting HR was observed between the auscultatory 70.7±8.6 bpm and the electrocardiographic method (chest band): 75.1±11.8 bpm; after submaximal endurance exercise the difference increased to 9% and was recorded between the PPG method (wristwatch): 130.3±29.1 bpm and the palpatory method: 118.62±26.41 bpm. Following the strength training, the difference between the different methods became even greater (10.7%) and was recorded between the electrocardiographic method (chest band): 134.58±22.65 bpm and the PPG method (wristwatch): 120.15±23.28 bpm.

CONCLUSION: It is concluded that the methods of HR recording do not exhibit significant differences between them under different measurement conditions. However, a tendency for the differences to become more pronounced as the intensity and, therefore, the hemodynamic demands of the effort increase is apparent. The electrocardiographic method shows higher HR recordings compared to the other methods.

ACUTE EFFECTS OF DIFFERENT ANAEROBIC WORKLOADS ON PARAMETERS OF ARTERIAL STIFFNESS

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INTRODUCTION: High intensity interval training has been shown to improve cardiovascular health (1,2) and arterial stiffness (AS) (3,4). Additionally, AS after single and repeated Wingate bout(s) have been studied (5,6). However, there is limited evidence on the relationship between different anaerobic workloads and its impact on AS. The purpose of this study is to investigate the differences between low load (LL) and high load (HL) Wingate bouts and its effects on different AS parameters.

METHODS: Thirty participants (age: 21.5±2.24 years; females:males: 23:7) were randomly assigned to either the LL (7.5% of body weight; n=16) or HL (10% of body weight; n=14) group. Participants completed a baseline AS assessment, consisting of pulse wave analysis (PWA) and pulse wave velocity (PWV) using the SphygmoCor XCEL device. PWA measured augmentation index (AIx) which pertains to peripheral AS while PWV pertains to central AS. Next, participants completed a customized Wingate protocol consisting of a five-minute warm up followed by three bouts of ten second sprints with two minutes of rest between the first two bouts. After the third bout, participants immediately completed a second analysis of AS. PWA was conducted at the three-, eight-, and thirteen-minute mark while PWV was conducted at the five-, ten-, and fifteen-minute mark. Repeated measures ANOVA were used to examine the relationship between load across the respective time intervals for AIx and PWV.

RESULTS: A main effect (p=0.003) was found for AIx. There was a significant decrease between pre AIx and AIx at 13 minutes (p=0.005). Trends indicated lower AIx values in the HL group compared to the LL group across time, but not significant (LL AIx 3 min: 9.5%, HL AIx 3 min: 4.21%; LL AIx 8 min: 8.89%, HL AIx 8 min: 6.57%; LL AIx 13 min: 5.81%, HL AIx 13 min: 2.21%). PWV main effect was borderline significant (p=0.056). No group by time interactions were observed (AIx by load: p=0.400; PWV by load: p=0.886).

CONCLUSION: Similar AS responses occurred regardless of the load for repeated anaerobic bouts. AIx values decreased over time and were lower in the HL group compared to LL group. Further research is needed to understand the long-term effects of repeated anaerobic bouts using HL and its potential to decrease peripheral AS.

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ASSOCIATIONS BETWEEN ARTERIAL STIFFNESS AND VISCERAL ADIPOSE TISSUE IN PHYSICALLY ACTIVE YOUNG-ADULTS

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INTRODUCTION: Arterial stiffness (AS) and high body fat (BF) are known to play a role in cardiovascular and metabolic events (1,2). Studies show higher correlations between visceral fat (VF) and cardiovascular risk compared to subcutaneous fat (SF) (1,2). However, the relationship between VF% and AS is limited and previous studies have focused on obese and/or older age subjects (1,3,4). The purpose of this study is to investigate the association between AS and VF% in physically active young adults.

METHODS: Thirty subjects (age: 21.5±2.24 y.o.; females: 23, males: 7) were asked to refrain from food, water, alcohol, nicotine, and caffeine 12 hours before measurements. Dual-energy X-ray absorptiometry was performed prior to AS measurements. AS was measured using the SphygmoCor XCEL device and is composed of pulse wave velocity (PWV) and pulse wave analysis (PWA). PWV measures central AS and PWA measures blood pressure (BP) which is used for PWV. BP was taken after five minutes of rest in the supine position and was conducted twice to get the average BP. Pearson correlations were used to analyze PWV and VF% while Spearman rank correlations were used to analyze PWV against SF, BF%, and waist circumference (WC).

RESULTS: Pearson correlation shows a moderate association between PWV and VF% (r=0.469, p=0.008). Spearman rank correlations showed low associations for PWV and SF (r=0.202, p=0.285), PWV and BF% (r=0.084, p=0.660), and a moderate association between PWV and WC (r=0.571, p<0.001).

CONCLUSION: PWV is moderately correlated with VF% and WC in young adults while SF and BF% were not associated with PWV. Potentially, these findings could be used as a prescreening tool for young adults prior to starting exercise. Further research is needed to better understand the correlation between AS and VF and its role in cardiovascular risk prevention in physically active young adults.

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EFFECT OF ELECTRICAL MUSCLE STIMULATION TRAINING ON ARTERIAL FUNCTION IN HEALTHY YOUNG MEN

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INTRODUCTION: Reduced arterial function is an independent risk factor for cardiovascular disease, and regular exercise improves arterial function. In recent years, increasing attention has been paid to electrical muscle stimulation (EMS) as an alternative modality to voluntary exercise. Acute EMS to lower limbs induces passive muscle activity by stimulating motor unit activities, which increases local arterial blood flow and decreases arterial stiffness. This suggests that EMS may serve as a new exercise modality for cardiovascular disease prevention. Therefore, we investigated whether an 8-week EMS training program improved arterial function.

METHODS: We recruited 38 normotensive (<140/90 mmHg) healthy males without obesity. The participants were randomly assigned to the EMS training group (n = 20, age: 21.9 ± 1.7 years) or the control group (n = 18, age: 21.6 ± 1.9 years). The EMS training group performed EMS training on the lower limbs three times a week for 8 weeks. The EMS system (Myoelectoric Medicine EMS) was designed to simulate the motor unit activities during voluntary muscle contraction, where the stimulation frequency was gradually increased from 12 to 60 Hz. Maximal isometric knee extension torque (MVC), brachial-ankle pulse wave velocity (baPWV; an index of systemic arterial stiffness), and flow-mediated dilation (FMD; an index of endothelial function) of the brachial artery were measured before and after the intervention, and the changes were compared by two-way analysis of variance.

RESULTS: We observed a significant interaction in the MVC ($p < 0.01$). The MVC increased significantly in the EMS group (pre: 171.9 ± 42.8 Nm vs. post: 200.7 ± 46.5 Nm; $p < 0.01$) but not in the control group (pre: 164.5 ± 27.6 Nm vs. post: 167.1 ± 32.0 Nm; $p = 0.94$). There was also a significant interaction in the baPWV ($p = 0.04$). The baPWV decreased significantly in the EMS group (pre: 1118.8 ± 118.7 cm/s vs. post: 1062.3 ± 125.1 cm/s; $p = 0.01$) but not in the control group (pre: 1060.9 ± 146.4 cm/s vs. post: 1068.9 ± 164.1 cm/s; $p = 0.72$). Although there was a significant interaction in the FMD ($p = 0.03$), changes in the FMD were not statistically significant in either group (EMS group: pre: 5.8% ± 1.9% vs. post: 6.6% ± 2.8%; $p = 0.08$ and control group: pre: 6.2% ± 2.0% vs. post: 5.6% ± 2.2%, $p = 0.18$).

CONCLUSION: EMS confers beneficial effects on arterial function, as indicated by a decreased baPWV (4.8%) and increased FMD (19.8%). These results suggest that EMS training may improve arterial function.

EFFECTS OF HIGH-INTENSITY INTERVAL EXERCISE IN WATER ON RENAL ARTERIAL BLOOD FLOW.

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INTRODUCTION: Whereas renal arterial blood flow decreases with increased exercise intensity on land, the ability to increase the resting baseline in an underwater environment may allow for increased exercise intensity while decreasing renal stress. This study aimed to determine the effects of high-intensity interval exercise (HIIE) in water on renal arterial haemodynamics by comparing moderate-intensity continuous exercise (MICE) and land-based exercise.

METHODS: The study included nine healthy young adult males (aged 22.9 ± 1.3 years). The exercise was performed on a recumbent ergometer under two conditions: the H condition, in which 10 sets of 20 s submaximal exercise were performed with a 1 min interval for a total of 13 min 20 s; and the M condition, in which 13 min 20 s of the moderate continuous exercise was performed (room temperature: 26.9 ± 2.4°C). There were two environmental conditions: in water (water level: xiphoid process, water temperature: 31.3 ± 1.4°C) (W condition) and on land (L condition). Each of these conditions was combined into four distinct conditions (WH, LH, WM, and LM). As primary endpoints, right renal artery haemodynamics (time-averaged blood flow velocity: Vm) were measured before, immediately after, and 30 min after exercise. Secondary endpoints included oxygen uptake (VO2), heart rate (HR), cardiac parasympathetic nervous system activity (LnHF), and urine volume. The significance level was set at less than 5%.

RESULTS: VO2 and HR during exercise did not differ significantly between environmental conditions within the exercise intensity conditions, suggesting that exercise could be performed at the same intensity irrespective of the environment. Vm showed significant differences between phases, and the post hoc analysis showed a significant increase at rest on the ergometer compared to at rest on land. Vm significant ly decreased immediately after exercise compared to resting on the ergometer, with no distinctions between the four conditions. LnHF showed a significant interaction and was lower immediately after exercise than rest on land in the LH condition. There was no significant change in the other three conditions. In the WH condition, LnHF tended to increase, although not significantly, after entering the water, a trend that was not significantly different from the LM condition The WM condition demonstrated a significant increase in urine volume post-exercise relative to pre-exercise.

CONCLUSION: HIIE on a recumbent ergometer did not significantly affect renal artery haemodynamics under different environmental conditions. On the contrary, the underwater condition increased urine volume and induced post-exercise

LnHF activation, which showed an insignificant difference in trend compared to the LM condition. These findings indicate that HIIE in water can be performed at a renal load, and cardiac autonomic nervous system activity is not significantly different from MICE on land.

CAROTID CHEMOREFLEX TONICALLY CONTRIBUTES TO SKIN BLOOD FLOW REGULATION DURING EXERCISE IN MALES AND FEMALES

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INTRODUCTION: Skin blood flow (SBF) regulation is controlled by different reflex pathways to maintain thermoregulatory homeostasis during exercise. The carotid chemoreflex inhibition (via hyperoxia inhalation) at rest attenuates the cutaneous vasoconstrictor response to voluntary apnea, suggesting that SBF is partially controlled by the carotid chemoreflex (1). Importantly, humoral and neural signals related to exercise stimulate the carotid chemoreflex, modulating cardiovascular responses (e.g., HR, arterial blood flow) to exercise. However, it remains unclear if the tonic contribution of the carotid chemoreflex during exercise extends to the cutaneous circulation. Finally, the extent to which there might be sex differences in any potential carotid chemoreflex-mediated SBF regulation remains incompletely understood.

METHODS: Twelve healthy-young participants (6 females) performed steady-state moderate intensity exercise on a cycle ergometer (50% VO2peak). Once SBF stabilization was achieved (approx. 10 min of cycling), subjects inhaled, in random order: normoxia (21% O2, control) or hyperoxia (100% O2, carotid chemoreflex inhibition) for 2 min. Gas inhalations were separated by 10min (while exercise continued). Throughout the protocol, SBF was assessed using Laser-doppler flowmetry on the left ventral forearm and local skin temperature clamped at 33oC. Beat-by-beat mean arterial pressure (MAP) was obtained by photoplethysmography. Cutaneous vascular conductance (CVC) was calculated as SBF/MAP and expressed as a percentage of maximal cutaneous vasodilation (CVCmax) assessed via local skin heating following the exercise protocol. Additionally, core (Tcore) and skin (Tskin) temperatures were recorded. Two-way ANOVA was used to examine main effects and interactions of gases and sex. Significance was set at $P<0.05$. Data are presented as mean ± SE, as well as delta (Δ) between means.

RESULTS: Baseline data (i.e, prior gas inhalation) were similar between normoxia and hyperoxia for MAP (Δ = 0.8±1.8 mmHg; Pgas = 0.87), SBF (Δ: 6 ± 8 a.u; Pgas = 0.45) and CVC% (Δ: 1±2%; Pgas = 0.52), independent of sex. During gas inhalations, Tcore, Tskin and MAP showed similar values, independent of sex or gas. Compared to normoxia, hyperoxia increased SBF (167±16 vs 150 ± 15 a.u; Δ: 18±5 a.u; Pgas<0.01) and CVC% (53±7 vs 46±5%; Δ: 7 ± 2 %; Pgas < 0.01). SBF was lower in females vs males (Δ: -69±24 a.u; Psex = 0.02) and CVC% tended to be lower in females vs males (Δ: -21±11 %; Psex = 0.08), independent of the gas. There was no gas*sex interaction for SBF nor CVC%.

CONCLUSION: Carotid chemoreflex inhibition promoted cutaneous vasodilation, suggesting that the carotid chemoreflex contributes tonically to the control of the cutaneous circulation during exercise. Finally, the carotid chemoreflex contribution to SBF regulation occurs similarly in males and females.

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THE INFLUENCE OF MATURATION AND SEX ON INTRA-CRANIAL BLOOD FLOW VELOCITIES DURING EXERCISE IN CHILDREN

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INTRODUCTION: Cerebral blood velocity increases in response to moderate exercise in humans, but the magnitude of change is smaller in children compared to adults and post-pubertal adolescents. Whether biological sex differences exist in the anterior or posterior CBv response to exercise with across pubertal development remains to be determined.

METHODS: We assessed middle cerebral artery (MCAv) and posterior cerebral artery (PCAv) blood flow velocity via transcranial Doppler, alongside end-tidal carbon dioxide (PETCO2) and minute ventilation (VE). 39 pre-pubertal (18 male) and 48 post-pubertal (23 male) children completed an exercise test to exhaustion, with cerebrovascular and cardiorespiratory measures compared at baseline and ventilatory threshold.

RESULTS: At baseline, MCAv was greater in both sexes pre-puberty (pre- pubertal males; 71.8 ± 8.4 vs. post males; 61.6 ± 7.3cm.s-1 and pre- pubertal females; 78.2 ± 10.9cm.s-1 vs post- pubertal females; 67.8 ± 10.2cm.s-1). Main effect of maturation, biological sex, and exercise intensity were determined using a three-way repeated measures ANOVA. A two-way ANOVA was used to compared relative change from baseline to ventilatory threshold. Significant main effects and interaction effects were assessed using post-hoc analysis, with alpha set at 0.05 for all statistical analysis. Females demonstrated a higher MCAv ($P<0.001$) than their pubertal-matched male counterparts (pre- pubertal females; 78.2 ± 10.9cm.s-1 vs. pre- puberal males; 71.8 ± 8.4cm.s-1, and post- pubertal females; 67.8 ± 10.2cm.s-1 vs. post- pubertal males; 61.6 ± 7.3cm.s-1). PCAv was greater in pre- vs post-pubertal females (51.4 ± 8.9cm.s-1 vs. 45.1 ± 10.6cm.s-1), but there was no effect of sex in the posterior circulation. At ventilatory threshold, despite a greater PETCO2 ($P<0.001$) in post- vs. pre-pubertal children (post- pubertal 40.9 ± 3.6mmHg vs. pre- pubertal 36.4 ± 3.6mmHg), MCAv was greater in pre-pubertal (82.24 ± 11.95cm.s-1 compared to post-pubertal 77.18 ± 13.57 cm.s-1 ($P<0.001$).

CONCLUSION: Our findings suggest biological sex alters in the anterior cerebral circulation at rest is present in both pre- and post-pubertal groups, but in response to moderate exercise a sex difference was only present in our post-pubertal groups. Therefore, the CBv response to exercise is modified in both a sex- and maturation-specific manner.

PRESERVED ENDOTHELIAL FUNCTION IN RESPONSE TO ACUTE RESISTANCE EXERCISE IN STRENGTH-TRAINED MEN IS INDEPENDENT OF CATECHOLAMINE AND ENDOTHELIN-1 RELEASES

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INTRODUCTION: Acute resistance exercise impairs endothelial function in the sedentary individuals but not in the strength-trained individuals. However, the underlying mechanism(s) by which the vascular protection in the strength-trained individuals is still unclear. Herein, we compared catecholamine and endothelin-1 releases in response to acute resistance exercise between sedentary and strength-trained individuals.

METHODS: The untrained group comprised 12 male individuals with no regular training (age, 19.5 ± 1.1 years; height, 173.3 ± 5.3 cm; weight, 59.2 ± 5.1 kg; body mass index, 19.7 ± 1.4 kg/m2), and the strength-trained group comprised 12 male individuals (age, 19.6 ± 1.3 years; height, 171.3 ± 5.1 cm; weight, 71.5 ± 8.1 kg; body mass index, 23.9 ± 2.7 kg/m2). The strength-trained group participants had a 2-yr experience in resistance training at least. One repetition maximum (1RM) for chest press, lat pulldown and leg extension were initially determined in all participants using weight stack machine. At second visit, subjects performed a session of resistance exercise (chest press, lat pulldown and leg extension), which consisted of three sets of 10 repetitions at 75 % of 1RM (nine sets in total). During resistance exercise, heart rate and blood pressure were measured. Before and 10, 30 and 60 min after the resistance exercise, brachial artery flow mediated dilation (FMD), blood pressure, heart rate and blood collection were undertaken.

RESULTS: The 1RM for chest press, lat pulldown and leg extension were significantly higher in the strength-trained group (104.5 ± 23.1 kg, 75.9 ± 5.6 kg and 1425.0 ± 27.1 kg) than in the untrained group (68.9 ± 15.1 kg, 58.0 ± 10.8 kg and 114.7 ± 27.1 kg) ($P < 0.05$). There is no significant difference in baseline brachial artery FMD between the groups (7.8 ± 2.3 % in the untrained group vs. 6.0 ± 2.9 % in the strength-trained group) ($P > 0.05$). After the resistance exercise, brachial artery FMD was significantly reduced in the untrained group ($P < 0.05$) but it was prevented in the endurance-trained group. At 10, 30 and 60 min after the resistance exercise, there were significant differences in brachial artery ΔFMD from baseline between groups ($P < 0.05$). Blood pressure, plasma epinephrine, norepinephrine and serum endothelin-1 concentrations were significantly and similarly increased during and after the resistance exercise in both groups.

CONCLUSION: Consistent with previous studies, acute resistance exercise reduced FMD in the sedentary individuals but not in the strength-trained individuals. However, there were no differences in plasma catecholamine and serum endothelin-1 response between groups. In fact, blood pressure similarly elevated in response to acute resistance exercise in both groups. In conclusion, preserved endothelial function in response to acute resistance exercise in strength-trained men is independent of vasoconstriction factors.

THE ROLE OF FERROPTOSIS IN THE EFFECTS OF EXERCISE ON OBESITY-INDUCED CARDIAC FIBROSIS

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INTRODUCTION: Ferroptosis is a recently recognized type of cell death characterized by an iron-dependent and lipid peroxidation-mediated nonapoptotic cell death. Whether ferroptosis plays a role in exercise against obesity-induced cardiac fibrosis is still unknown. We, therefore, investigated the role of ferroptosis in that exercise affects cardiac fibrosis in obesity using an animal model mimicking high-fat diet-induced obesity.

METHODS: Eight-week-old male C57BL/6 mice were adopted in this study. Mice were randomly assigned to a normal diet combined with the sedentary (NDCON) or exercise (NDEXE) group and a high-fat diet combined with CON (HFDCON) or EXE (HFDEXE) group. These groups were randomly assigned to subgroups receiving either vehicle (Veh) or the glutathione peroxidase 4 inhibitor RSL3 (RSL3) for 14 consecutive days. At weeks 9-10, the NDEXE and HFDEXE mice were habituated to treadmill exercise at a speed of 5-10 m/min for 5 consecutive days. In the 11-20 weeks, the animals ran at a 70% maximal running speed on the treadmill, gradually increasing running time, beginning with 30 min/day and ending with 60 min/day.

RESULTS: Compared to the NDCON subgroup, the body weight was significantly increased in HFD subgroups from weeks 5-20, respectively ($p < 0.05$). Compared to the HFDCON subgroups, the body weight was significantly decreased in HFDEXE subgroups from weeks 15-20, respectively ($p < .05$). Maximum running speed was significantly higher in the NDEXE and HFDEXE subgroups after exercise training than in the pretest, respectively ($p < .05$). Compared to the NDCON subgroups, the myocardial fibrosis indexes of the HFDCON subgroups were significantly increased ($p < .05$), and the fibrosis indexes of the HFDEXE subgroups after exercise training were significantly lower than that in the HFDCON subgroups ($p < .05$). Compared with the Veh subgroup, the fibrosis indexes of the NDCON, NDEXE, HFDCON and HFDEXE groups were significantly higher than that of RSL3 subgroup, respectively ($p < .05$). Compared with the HFDCON+RSL3 subgroup, the fibrosis index of the exercise group was significantly decreased in the HFDEXE+RSL3 subgroup ($p < .05$). The results of histochemical staining of myocardial section showed that RSL3 may increase the concentration of myocardial iron ions in NDCON and HFDCON subgroups, and exercise training may also reduce the accumulation of myocardial iron ions caused by RSL3.

CONCLUSION: Our findings showed that a high-fat diet could increase myocardial fibrosis. Exercise training can reduce the effect of high-fat diet-induced myocardial fibrosis. In ferroptosis, inhibiting GPX4 can increase myocardial fibrosis and the concentration of myocardial iron ions. These results suggested that ferroptosis might play a role in high-fat diet-induced myocardial fibrosis. Exercise could reduce myocardial ferroptosis resulting in reducing myocardial fibrosis.

COMPARISON OF VASCULAR STRUCTURE AND FUNCTION BETWEEN HABITUAL OMNIVORES, VEGETARIANS AND VEGANS: AN OMNIPLANT PILOT STUDY

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INTRODUCTION: Studies assessing prognostic markers of cardiovascular disease demonstrate improved vascular function, assessed via flow-mediated dilation (FMD), and lower carotid artery intima media thickness (cIMT) in vegetarians compared with omnivores [1,2]. However, more recent studies have failed to replicate these findings in vegetarian and vegan populations [3, 4, 5]. Currently, it is unclear whether these discrepancies are the result of differences in study design/methodological approach or can be explained by potential changes in eating patterns over time. The aim of this study was to compare vascular structure and function between healthy, habitual vegans, vegetarians and omnivores.

METHODS: One hundred and fifteen participants aged between 18-79 years old were recruited between September 2020-February 2023 (omnivore, OMN=55, vegetarian, VEGT=15, vegan, VEG=45; men=59, women=56), in a cross-sectional observational design having followed their dietary pattern for > two years (VEGT=10.7yrs, VEG=7.2yrs). Dietary patterns were initially self-reported, confirmed using a food frequency questionnaire and a three-day weighed food diary. Food diaries were analysed using an online dietary analysis software (Nutritics, Ireland). Assessment of brachial artery FMD and cIMT were conducted using B-mode ultrasonography and analysed using automated edge-detection software. A cuff positioned around the forearm was manually inflated to 220 mmHg for 5-min following a 1-min measurement of baseline diameter (BD). Data were analysed using analysis of covariance (SPSS, version 28), controlling for physical activity (quantified via the Baecke questionnaire), sex and age.

RESULTS: VEG (43±12yrs) were older than OMN (31±14yrs) and VEGT (33±16yrs) and OMN (79.1±16.2kg) had higher body mass than VEG (70.0±12.8kg) ($P<0.05$). Mean daily cholesterol intake was lower in VEG (5.4±7.7mg/d) compared with OMN (273.5±179.0mg/d) and VEGT (167.8±157.4mg/d) and total fibre intake was higher in VEG (37.0±14.2g/d) compared with OMN (22.6±7.8g/d). There were no differences between diet groups for mean BD-adjusted FMD (2.75±1.35%; 2.68±1.48%; 3.02±2.71%), mean BD (3.70±0.68mm; 3.54±0.69mm; 3.25±0.49mm) or mean cIMT values (0.49±0.10mm; 0.53±0.12mm; 0.50±0.14mm) between OMN, VEG and VEGT, respectively.

CONCLUSION: There were no differences in brachial artery BD, FMD or cIMT between habitual OMN, VEG and VEGT in this study. Interestingly, there were differences for certain nutrient intakes reported to affect vascular structure and function, such as cholesterol and fibre. It is possible that changes in eating patterns over time, to include more processed/unhealthy foods [6], have suppressed the benefits to vascular health in VEG and VEGT reported in earlier studies.

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CP-BM09 Running

THE EFFECT OF OVERSPEED TRAINING ON LINEAR KINEMATICS IN TWO FEMALE ATHLETES – A PILOT STUDY

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INTRODUCTION: Linear kinematics, such as stride rate (SR) and stride length (SL), have been shown to be important for an individual's sprint [1]. Research has investigated modalities to improve sprint performance, such as assisted (overspeed) sprint training [2]. However, there is a paucity of evidence investigating the effects of overspeed treadmill training (OTT) on the aforementioned variables. The purpose of this pilot study is to evaluate the effect of OTT on linear kinematics in two female athletes.

METHODS: Two college-aged female athletes (control: 22 y/o, 62.3 kg, 154.9 cm; intervention: 23 y/o, 67.3 kg, 165 cm) completed OTT. Within the seven-week protocol, week one consisted of a familiarization session with the treadmill device (h/p/cosmos locomotion system). Week two was comprised of pre-measurements on the track (TRA) and treadmill (TRE) which were separated by at least 48 hours. During the TRA and TRE testing sessions, subjects were equipped with motion capture devices from the ultium portable biomechanics lab (Noraxon, USA) to acquire kinematic data. Measurements included step time right (STR), step time left (STL), SL, step length right (SLR), step length left (SLL), SR, and stride time (ST). The average velocity during TRA sessions was captured using a radar gun (Stalker ATS II). All TRE sessions used a pressurized harness system that allowed subjects to sprint at 80% of their body weight. During the protocol, the control trained at the average velocity from their best 40m time trial (100%), while the OTT participant trained slightly above the average velocity

of their best time trial (105%). For each subject, the velocity remained constant throughout the protocol. Weeks three and four consisted of three sprints at their respective speeds; week five consisted of four sprints and week six consisted of five sprints. Post-testing during week seven consisted of the same measurements on the TRA and TRE acquired during week two pre-testing. Descriptives were completed using Excel.

RESULTS: For the control subject, STR increased by 13.06%, STL decreased by 14.93%, SL decreased by 25.88%, SLR decreased by 27.92%, SLL decreased by 24.53%, SR decreased by 0.37%, and ST increased by 0.45%. For the OTT subject, STR decreased by 15.29%, STL increased by 18.65%, SL decreased by 2.41%, SLR decreased by 2.50%, SLL decreased by 2.08%, SR decreased by 1.31%, and ST increased by 1.35%.

CONCLUSION: STR and STL showed differences over four weeks of OTT. Interestingly, in both participants, the step time of one side increased while the other side decreased. These opposing findings suggest the athletes developed a dominance throughout the training protocol. A dominance could have occurred due to training at a higher velocity than attainable without assistance. Further research is needed to examine if the current findings translate to a larger sample size, a longer training program, and different athletes.

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CORRELATION BETWEEN RUNNING SAGITTAL KINEMATICS AND SPATIOTEMPORAL GAIT CHARACTERISTICS AND RUNNING ECONOMY

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INTRODUCTION: Biomechanical characteristics play a critical role in distance running performance; however, their relationship with running economy (RE) remains unclear. The purpose of this study was to investigate the relationship between RE and sagittal plane kinematics of the lower extremity hip, knee, and ankle joints, ground contact/flight time, duty factor, and stride frequency/stride length in recreational runners.

METHODS: Thirty male recreational runners (age: 21±1years, VO2max: 54.61±5.42ml/kg/min) underwent two separate tests. In the first session, the subjects body composition index and RE at running speeds of 10 and 12 km/h were measured; In the second session, sagittal plane kinematic indicators of the hip, knee, and ankle joints, and spatiotemporal gait indicators such as ground contact/flight time, and stride frequency/stride length were collected at speeds of 10 and 12 km/h.

RESULTS: Pearson's correlation coefficients analysis found that RE at 12km/h was moderately correlated with ankle dorsiflexion angle at foot strike (r=0.423, p=0.020), hip and knee flexion angle at toe-off (r=0.374, p=0.042; r=0.405, p=0.026) and peak hip flexion (r=0.381, p=0.038) during the support phase. The peak ankle dorsiflexion (r=0.397, p=0.030; r=0.383, p=0.037) during the support phase was moderately correlated with RE at 10 and 12 km/h. In the flight phase, the peak knee flexion (r=0.457, p=0.011) and knee extension range of motion (r=0.439, p=0.015) were moderately correlated with RE at 10 km/h. RE at 12km/h was moderately correlated with peak hip, knee, and ankle flexion (dorsiflexion) (r=0.367, p=0.046; r=0.416, p=0.022; r=0.389, p=0.034) during the flight phase. In terms of spatiotemporal gait characteristics, RE at 10 km/h was moderately correlated with the corresponding ground contact time (r=-0.405, p=0.027), flight time (r=0.405, p=0.027) and duty factor (r=-0.451, p=0.012).

CONCLUSION: Smaller ankle dorsiflexion angles at foot strike, smaller hip, and knee flexion angles at toe-off, lower peak hip and ankle flexion (dorsiflexion) during the support phase, reduced peak hip, knee, and ankle flexion (dorsiflexion) during the flight phase and smaller knee extension range of motion during the flight phase are beneficial to improving RE in recreational runners. Regarding spatiotemporal gait characteristics, longer ground contact times at low speeds and increasing the duty factor are probably effective strategies for recreational runners to improve RE.

EXAMINATION OF THE RUNNING PATTERN BELOW AND ABOVE THE VENTILATORY ANAEROBIC THRESHOLD

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INTRODUCTION: Endurance running performance is influenced by factors related to muscle recruitment and force production (Roche-Seruendo et al., 2018). Runners unconsciously adopt their self-optimizing running pattern (Moore, 2016), but little is known about how the increase in running speed and muscle fatigue compromise running patterns. This study aimed to analyze the effects of running above and below the second ventilatory threshold (VT2) speed on spatiotemporal variables.

METHODS: Twelve male runners (five recreational and seven trained) participated in the study. All subjects completed a graded exercise test (GXT) (HP Cosmos Pulsar, Germany). The test started at 10 km·h-1, and speed was increased 1 km·h-1 every minute until volitional exhaustion. Running kinematics data (contact time [CT], flight time [FT], stride frequency [SF], stride length [SL] and vertical oscillation [VO]) were collected throughout the GXT through a wearable device (Stryd® device [Stryd Power Meter, USA]). Each test was analyzed individually, and the VT2 speed was established (15.00 ± 1.22 and 18.29 ± 1.80 km·h-1 for the recreational and trained group, respectively). Lastly, we analyzed the percentages of change in running kinematics occurring 1 and 2 km·h-1 below and above their VT2 speed within and between groups.

RESULTS: The main effect for speed was significant in all the kinematics variables ($p < 0.05$) except for VO ($p=0.10$). Speed × group interaction was significant in VO ($p=0.03$) showing a greater decline in trained runners, while in recreational runners did not change it ($p>0.05$). CT ($p=0.29$) and SF ($p=0.68$) presented similar trends in trained and recreational runners. Although FT and SL did not reach statistical significance in speed × group interaction ($p=0.06$ in both cases), there were significant differences between groups in the percentage at 2 km·h-1 below and at 1 km·h-1 above their VT2 speed in FT, and at all speeds in SL.

CONCLUSION: Running kinematics changed (reduction in vertical force production and increase in horizontal force production which induces a lower displacement of the center of mass) from 2 km·h-1 below to 2 km·h-1 above VT2 speed in trained and recreational runners, although percentage changes with respect to the values at VT2 speed were different according to training status.

HOW DOES MAXIMAL STRENGTH SPRINT AND JUMP PERFORMANCE EFFECT RESISTED SPRINT KINEMATIC VARIABLES?

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INTRODUCTION: Sprint performance (SP) is an essential skill to target within many sports [1]. Resisted sprint training is believed to increase strength specific to sprinting [2]. It is well-known that an athlete's acute kinematics change with increasing resistance [3]. However, to our knowledge, there remains a lack of clarity on how maximal strength and jump performance influences resisted sprint (RS) kinematics. Therefore, this study aimed to examine the correlation between back squat (BS) and hip thrust (HT) maximum strength (1RM) and jump measures with SP and change in kinematics (Ch).

METHODS: 20 sprint and 23 team sport athletes were tested over three days. After one familiarization session 1RMs, vertical jumps (CMJ and DJ) and resisted sprints with a resistance of 0, 10, 20, 30%Vdec were conducted on day 2 and 3. Timing gates were set up at 5-meter intervals to measure sprint time over 40m and average velocity. Kinematics (knee, hip, trunk, ankle angle) were measured at touch-down and toe-off using high-speed cameras. Then the percentage change of the angles between loads was calculated. Jumps were completed on force platforms. Jump height (JH) was calculated using the impulse-momentum method and the RSI was taken as the maximal height the athlete reached during the DJ divided by the ground contact time [4]. Pearson's correlation coefficient (r) was used to investigate the relationship between levels of strength, jump, SP and kinematic variables at each resistance.

RESULTS: Significant negative correlations were found between 1RMs and Ch (hip, knee and trunk angle) for the different loading conditions. Furthermore, correlations were displayed between acceleration SP and Ch (for trunk, knee, ankle angle) and between resisted (RSP) and unresisted SP (USP). Significant correlations were observed between 1RM and 40m RSP (BS: r= -0.47 to -0.61; HT: r= -0.67 to -0.72). Moreover, 1RM and USP presented significant correlations (BS: r= 0.44-0.47; HT: r= 0.71-0.72). Lastly, significant correlations were observed between CT at 30% Vdec and 1RM (HT) during maxV phase. (r= -0.504, p=0.014).

CONCLUSION: Faster RS times were associated with Ch, indicating that faster athletes see less change at the knee under load. Stronger athletes displayed less change in knee and hip kinematics, more similar to URS kinematics. The higher HT strength seemed to allow to create force through hip and knee. Faster and stronger athletes were also faster under load. Maybe the knee and hip were driving velocity under loaded conditions. Moreover, the stronger athletes (HT) demonstrated shorter CTs under load during the maxV phase, suggesting that the hip may be a greater contributor to the force produced. It could be concluded that maximum strength and SP measures explain some of the responses of athletes during RS, suggesting that stronger and faster athletes might be able to handle a higher overload without displaying changes in kinematics.

LOWER-LIMB MOMENT OF INERTIA IN THE ANATOMICAL POSITION DOES NOT EXPLAIN THE INTER-INDIVIDUAL VARIATION IN O2 COST IN TRAINED ENDURANCE RUNNERS

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INTRODUCTION: Morphological characteristics theoretically influence O2 cost. A manoeuvrable lower limb (i.e., a low lower-limb moment of inertia around the hip: ILowerLimb) can reduce the energy (WLowerLimb) required for the leg swing, thereby reducing O2 cost. In 10.8 km/h running, the O2 cost in the swing phase was shown to contribute to 20% of its total [1]. Meanwhile, running kinematics vary between individuals [2]. As the moment of inertia is mechanically proportional to the square of the radius of gyration, ILowerLimb can be controlled by lower-limb kinematics during running. Thus, ILowerLimb in the anatomical position (i.e., with fully extended knee) might not explain the inter-individual variance in O2 cost. We tested the hypothesis that adequate control of leg swing can reduce O2 cost regardless of ILowerLimb in the anatomical position.

METHODS: We analysed fat- and water-weighted MRI of the lower limbs in 12 endurance runners (19 ± 1 years, 170.7 ± 5.8 cm, 56.25 ± 3.91 kg). We calculated inertial properties by identifying the tissue (fat, lean or bone) of each voxel with the literature value of each tissue density [3]. Ten out of the 12 runners completed three bouts of 4-min treadmill runs at speeds of 14, 16, and 18 km/h each separated by 2-min recovery period. We measured the expired gases and volume and the lower limb kinematics during each run stage. WLowerLimb were calculated by combining the kinematic and MRI-based inertial data. O2 cost was assessed by oxygen uptake (VO2) measured during the last 1 min of each run stage. Pearson's correlation coefficients were calculated between ILowerLimb, WLowerLimb and VO2.

RESULTS: WLowerLimb was positivelly correlated with VO2 regardless of run speeds (r = 0.71–0.85 p ≤ 0.01). However, lLowerLimb (1.84 ± 0.26 kg.m2) in the anatomical position did not explain the inter-individual variance of WLowerLimb (14 km/h: 1.64 ± 0.18, 16 km/h: 2.03 ± 0.28, and 2.52 ± 0.39 J/kg; |r| = 0.08-0.36, p = 0.33-0.80) and of VO2 (14 km/h: 46.54 ± 3.41, 16 km/h: 55.04 ± 4.27, and 61.59 ± 4.72 ml/kg/min; |r| = 0.08-0.33, p = 0.29-0.82) at all speeds.

CONCLUSION: The adequate lower-limb kinematics during running can reduce lLowerLimb, and thereby the required WLowerLimb for swing execution. Thus, we speculate that even if lLowerLimb is large in the anatomical position, WLowerLimb can be reduced by adequate control of leg swing. WLowerLimb explained the individual variance in O2 cost, whereas lLowerLimb, that theoretically influences WLowerLimb did not explain the variance in WLowerLimb and VO2. We suggest that kinematic factors rather than morphological characteristics play a key role for reducing O2 cost.

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COMPARISON OF GROUND REACTION FORCES CHARACTERISTICS BETWEEN TWO 180-DEGREE CHANGE OF DIRECTION TECHNIQUES IN FEMALE CRICKETERS

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INTRODUCTION: Change of direction (COD) is one of the important factors for cricket performance. Batter requires running and turning 180 degrees between the wickets to score points. Half-half (HH) or side-lunge turning is a common technique performed by many cricketers (1). Presently, some cricketers perform a 180-degree turn by slightly jumping at the turn and landing in the sprinting position (2) to maximize sprinting speed, which is so-called sprinting technique (SP). The aim of this study was to compare ground reaction forces (GRF) characteristics including ground contact time via penultimate (PEN) and final (FINAL) foot contact between two 180-degree COD techniques.

METHODS: Nine Thai national female cricketers performed 2 different 180-degree turn techniques while holding a standard bat on force platforms. Three trials of each COD were collected and analyzed. GRF parameters including ground contact time (GCT), normalized peak and average GRFs and impulse (IMP) were compared between two techniques. Two successive decelerated foot contacts, penultimate (PEN) and final foot contact (FINAL) during deceleration phase were analyzed. Additionally, GRF foot contact ratios between FINAL and PEN (FINAL/PEN) were investigated in both vertical (vRatio) and horizaontal (hRatio) directions. Normality of data was examined by the Shapiro-Wilk test. Dependent t-test was employed for normality data.

RESULTS: Peak and average GRFs of HH were significantly greater than SP on both vertical and horizontal directions in PEN. HH showed significantly longer contact time than SP (GCT p =.002) in PEN but no significant differences of contact time were found in FINAL. It was also found that HH had significantly higher IMPs in both directions as compared to SP. For FINAL/PEN ratio, significant differences were also found in vRatio (p=.001) and hRatio (p=.047).

CONCLUSION: During deceleration phase of 180-degree COD, only PEN revealed significant differences of GRF parameters between the two techniques (3). When compared between the two techniques, HH provided greater GRFs, longer GCT and greater horizontal impulse which could be beneficial for athletes to be better prepared for the acceleration phase (4). However, future study is warrant for examining GRFs parameters between the two techniques during the acceleration phase.

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RELIABILITY OF JOINT ANGLE CALCULATION IN RUNNING MOVEMENTS USING AN INERTIAL MEASUREMENT UNIT

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INTRODUCTION: The purpose of this study was to clarify the standard error of measurement (SEM) and minimum detectable change (MDC) of joint angle data in running measured by the inertial measurement unit (IMU), as well as to provide information to help more accurately interpret subject differences and preintervention and postintervention comparisons in field assessments.

METHODS: The subjects were nine healthy males (28.0 ± 1.3 years old). To investigate the accuracy of joint angle data measurement in the right upper limb, pelvis, and right lower limb, myoMOTION (Noraxson) was applied to a total of 14 locations on the whole body, excluding the hands. During the calibration, the subjects were instructed to face forward and align both upper limbs with the trunk so that the joint angle reference points would not shift, and the feet were grounded parallel to the ground and the distance between the big toes was standardized at 10 cm. To assess the reliability of same-day measurement data, running measurements were taken twice daily on a treadmill (BIODEX, PRO WWT-600) at 10.0

km/h for 30 s. One running measurement was also taken on a different day to assess consistency of the data collected on different days. The acceleration data from the IMU in the foot were used to determine the right heel contact point, which is where the running cycle begins. The analysis included normalized joint angle data averaged over 10 running cycles from 10 s after the start of each running measurement. The SEM and MDC of each joint angle data were calculated using the following equations between measurements taken on the same day or different days: SEM = SDiff [standard deviation of difference in measurements] ÷ √2, MDC = SEM × 1.96 × √2. Further, to estimate the type of error affecting the calculated SEM and MDC, the Bland–Altman plot was used. This study was conducted with the approval of the Ethical Review Committee of Takasaki University of Health and Welfare.

RESULTS: The SEM and MDC between two measurements on the same day were 0.34–1.76 and 0.95–4.88 at all joints, respectively. For SEM and MDC between data measured on different days, all joints fell within the ranges 0.52–2.57 and 1.45–7.13. The SEM and MDC for ankle joint angle data were less accurate than those for other joint data. Further, fixed systematic error contamination was observed in the Bland–Altman plot for ankle dorsiflexion/plantar flexion angle data with a large measurement error.

CONCLUSION: It was found that for joint angles excluding the ankle joint angle data, changes of 1°–3° or more between measurements on the same day and 2°–5° or more between measurements on different days could be detected. Although the dispersion of ankle joint angle data is unknown, it is thought that the foot IMU sensor is susceptible to geomagnetism due to its proximity to the ground, which may result in errors in joint angles in a fixed direction.

EFFECTIVENESS OF THE CARBON FIBER PLATE TRAIL SHOES ON ENERGY COST AND LOWER LIMBS IMPACT DURING A SIMULATED TRAIL RUNNING SESSION

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INTRODUCTION: Besides the optimization of running performance by improvements of the cardiorespiratory capacity, the study of the repeated mechanical stress on the lower limb, at each step, during running in-field have reached great interest in sport sciences and in footwear development the last decades. Minimization of mechanical stress has been considered as major factor determining i) performance in trail running, ii) acute and chronic delayed neuromuscular alterations (e.g., fatigue and damage) and iii) trail-associated injuries.

This study aimed to investigate the effectiveness of an embedded decoupled carbon fiber plate (CFP) in a trail shoe associated to an increased rocker on running biomechanics (i.e., oxygen consumption and mechanical stress "impact" on the lower limbs) during a simulated 3 km-short distance trail running session in trained men and women in comparison to the trail market leader (without carbon fiber plate).

METHODS: Thirty-seven healthy well-trained trail runners' (age: 40 ± 8 years old; height: 170 ± 8 cm; body weight: 63 ± 10 kg) were involved in the present study. They were divided in two groups: MEN (n = 18) and WOMEN (n = 19). Two experimental sessions separated by at least 24 hours were made. During the first session, participants performed an incremental maximal aerobic speed test and a familiarization session with the trail course and pacing. Then, participants realized a 4 h session where they ran a 4 x 3 km trail lap divided as follows: 1 km at level, 1 km uphill and 1 km downhill at 60% of the speed at VO2max. During the field session, four shoes were compared (2 including a CFP) in a random order (3 km trail lap per shoe). Moreover, oxygen consumption, heart rate, rate of perceived exertion, running speed, spatio-temporal parameters of running and, tibial impact loading were analyzed.

RESULTS: The main results of this study showed that the running economy was significantly improved for both MEN and WOMEN when using CFP trail shoes (-3.1 ± 4.2 %) compared to the market leader at both level and uphill ($p<0.05$). Moreover, these differences were significantly higher in MEN (-3.6 ± 4.7 %) than WOMEN (-2.6 ± 3.7 %, $p<0.001$). Moreover, a reduced amplitude of the tibial vertical acceleration (-12.5 ± 18.5 %, $p<0.001$) was observed for CFP trail shoes compared to the market leader with lower values for MEN (-16.5 ± 23.0 %) than WOMEN (-9.0 ± 13.2 %) resulting in a reduced mechanical stress during running.

CONCLUSION: While, studies have suggested that the carbon fiber plate alone plays a limited role in the energy savings, the combination and interaction of the foam (cushioning), geometry (rocker), and plate plays a fundamental role in the attenuation of the impact transmitted from the ground to the lower limb reducing therefore the metabolic cost of running. It could be an interesting strategy to preserve muscle performance during trail running and to prevent lower limbs trail-associated injuries.

MUSCLE EMG ACTIVITY DISTRIBUTION BETWEEN THE HAMSTRING HEADS DURING HIGH-SPEED RUNNING IN HIGH ELITE ATHLETE WITH A HISTORY OF HAMSTRING STRAIN INJURY

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INTRODUCTION: Hamstring muscle strain injury (HSI) is the most prevalent injury in running-based elite level sports. After initial HSI, alterations in muscle activity may occur and influence the risk of reinjury. Bilateral differences in distribution of hamstring muscle activity dur-ing submaximal voluntary contraction have been observed in previously injured ath-letes

despite the completion of rehabilitation and the absence of symptoms (1,2). During sprint running, the alteration of muscle activity in previous HSI compared to the uninjured limb is unclear (3,4). This study aimed to compare the hamstring activity distribution between the two lower-limbs in a maximal sprint after a previous unilat-eral HSI.

METHODS: Ten elite athletes (age: 26.5±2.7years, height: 171.6±6.6cm, weight: 68.5±6.7kg) participating in Olympic, World and European events in athletics, rugby sevens and bobsleigh were included in this study. They reported unilateral HSI in average 3.3 ±1.6 years before testing. They performed two 40-m maximal sprints during which surface electromyographic electrodes (EMG) were used to estimate muscle activation of the biceps femoris long (BFlh) and short (BFsh) heads, the semitendinosus (ST) and the semimembranosus (SM). Sprint EMG was normalized to the EMG activity during MVIC. Mean EMG activity during the stance and swing phases were calculated for each muscle. The ratio of EMG activity between the hamstring muscles was calculated as the mean activity of the considered muscle divided by the sum of the activities of all muscle heads of the same limb. A linear mixed model by permutation was performed to compare the ratio of EMG activity between the uninjured (NI) and HSI limb.

RESULTS: No significant difference was observed between limbs for both the swing and stance phases for mean EMG activity and EMG activity ratio. The mean (±SD) EMG activity ratios during the swing phase for HSI side and NI side were 23.7±5.6% and 24.4±3.7% for BFlh, 28.0±6.9% and 27.6±7.2% for BFsh, 24.5±3.2% and 27.8±8.5% for SM, and 23.7±7.9% and 20.2±7.6% for ST, respectively. During the stance phase for HSI and NI side, ratios were 26.2±5.6% and 27.6±5.6% for BFlh, 29.7±7.5% and 29.5±10.6% for BFsh, 18.7±6.0% and 20.5±7.5% for SM, and 25.4±6.1% and 22.4±6.6% for ST, respectively.

CONCLUSION: The present study demonstrated that the mean and the distribution of EMG activity were not different during sprinting between injured and non-injured lower limbs. The tailored rehabilitation and training contents adopted by elite athletes may limit the alteration of muscle EMG activity. Further studies considering force-length and force-velocity properties, which influence muscle EMG activity in dynamic contractions, are required to strongly conclude on the muscle activity distribution within injured limb.

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RELATIONSHIP BETWEEN ATHLETIC PERFORMANCE AND VISCO-ELASTICITY OF THE PLANTAR FLEXOR MUSCLES REVEALED BY THE VIBRATION METHOD IN LONG-DISTANCE RUNNERS

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INTRODUCTION: During the contact phase of running, the visco-elastic properties of the muscle-tendon complex (MTC) play a crucial role in functional muscle-tendon interaction and the recycling of elastic energy (1). In human experiments using B mode ultrasound, long distance runners have lower tendon stiffness (2) and higher muscle stiffness (3) in the plantar flexor muscles, which are associated with faster 5000 m times. However, viscosity, which has been the focus of attention in running shoes development in recent years, and viscoelasticity due to the exertion of multi-step forces have not been measured. The purpose of this study was to measure these values using the vibration method and to examine the relationship between these values and athletic performance.

METHODS: Twenty male athletes in long-distance of track and field participated. Athletic performance was calculated by converting the best 5000m season record (15 minutes 16.35 ± 50.45 seconds) in 2020 and 2021 into the IAAF Score (768.30 ± 147.75). We used the vibration method similar to (4). This method involved hitting a weight placed on the knee with a hammer, vibrating the triceps surae muscle, and inducing a damped oscillation. By combining the equation of motion of the mass-spring model and the waveform of the force, we calculated the elastic coefficient of MTC, and the viscosity coefficient from the vibration frequency and the amplitude reduction. We estimated each coefficient by regression for every 100N up to 800N. Then, the elasticity of MTC was separated into muscle and tendon components, based on the assumption that they are arranged in series.

RESULTS: IAAF Score and the elastic coefficient of the muscle-tendon complex were significantly positively correlated under various force conditions (e.g. 800N: $r=0.72$, $p<0.01$). The coefficient of determination increased as the Achilles tendon tension rose (e.g. 100N: $r^2 = 0.22$, 800N: $r^2 = 0.52$). The separation of elasticity in muscle and tendon revealed a significant positive correlation ($r=0.47$, $p<0.05$) between IAAF Score and the muscle elastic coefficient, but not between IAAF Score and the tendon elastic modulus. IAAF Score and the viscosity coefficient were not significantly correlated.

CONCLUSION: IAAF Score and the elastic coefficient of both muscle-tendon complex and muscle were significantly positively correlated. Higher muscle-tendon elasticity allows more elastic energy to be stored with smaller displacements during the stretch shortening cycle motion that occurs during ground contact. High elasticity also shortens the ground contact time (5). These effects are thought to enable energy-efficient movements with less vertical movement of the center of gravity and increased pitch.

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Conventional Print Poster

CP-MH33 Disabilities II

EVENT-RELATED BRAIN POTENTIALS IN RESPONSE TO LOWER LIMB PROPRIOCEPTIVE STIMULI IN YOUNG ADULTS WITH A PROBABLE DEVELOPMENT COORDINATION DISORDER

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INTRODUCTION: Proprioceptive deficits have been shown to underly motor problems in individuals with a probable developmental coordination disorder (pDCD). Behavioral studies have employed response times of passive limb movement to evaluate proprioceptive function in individuals with pDCD. However, the motor impairments inherent to individuals with pDCD may interfere with the accuracy of proprioceptive outcome measures. To address this issue, this study aims to investigate neuropsychological and neurophysiological performances using event-related potentials (ERP) on proprioceptive-motor processing in young adults with pDCD.

METHODS: Twenty-four young adults were recruited in this study, including twelve young adults with pDCD (M ± SD: 20.5 ± 1.08) and 12 age- and sex-matched controls (M ± SD: 20.75 ± 1.05) determined by the Bruininks□Oseretsky Test of Motor Proficiency 2nd Edition (BOT-2). Participants placed their dominant foot on a passive ankle motion apparatus that plantarflexed the ankle under velocities of 22°/s for a total of 75 trials in each proprioceptive condition. With the vision occluded, participants had to press the trigger bottom held by the dominant hand when they sensed the passive motion of the ankle (voluntary response, VR), or purely receive the movement without voluntary response (non-voluntary response, NVR). Behavioral performances [i.e., mean movement detection time (MDT), the standard deviation of the movement detection time (SDMDT)] and ERP indices (i.e., N1, P3 amplitude, and latency) related to ankle kinesthetic stimuli were obtained to determine the proprioceptive-motor function.

RESULTS: The results showed that young adults with pDCD exhibited longer MDT ($p < .001$) and SDMDT ($p = .002$) when compared to their controls. Electrophysiological indices showed that young adults with pDCD exhibited smaller N1 ($p = 0.024$, partial$\eta 2 = 0.21$) and P3 amplitude ($p = 0.025$, partial$\eta 2 = 0.21$) during VR and NVR conditions. Notably, correlation analysis revealed a significant negative relationship between MDT and N1 ($r = - 0.64$, $p < .001$) and P3 amplitude ($r = - 0.63$, $p < .001$) in the VR condition in young adults with and without pDCD.

CONCLUSION: This study sheds light on the central brain mechanisms underlying proprioceptive-motor deficits in young adults with pDCD. The combined analysis of behavioral and ERP data suggests that longer MDT and larger SDMDT in young adults with pDCD are associated with weaker proprioceptive afferent inflow (decreased N1 amplitude) to the frontal and parietal cortices. Such degraded proprioceptive signals are followed by reduced P3 amplitude, suggesting that young adults with pDCD allocate fewer neural resources to modulate motor processes with regard to proprioceptive stimuli.

ASSOCIATION BETWEEN DIFFERENT DOMAINS OF LOWER LIMB PROPRIOCEPTION AND DYNAMIC BALANCE PERFORMANCE IN CHILDREN WITH A DEVELOPMENTAL COORDINATION DISORDER

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INTRODUCTION: Developmental coordination disorder is a condition marked by difficulties acquiring motor skills and performing coordinated movements. It has been shown that proprioception underlies motor abnormalities in children with DCD. However, it is still unclear how different domains of proprioception are affected and linked to motor dysfunctions in children with DCD. The purpose of this study was 1) to examine ankle proprioceptive function (i.e., ankle position sense and motion sense) in children with and without DCD, and 2) to investigate the relationship between different domains of ankle proprioception and dynamic balance performance in children with and without DCD.

METHODS: Forty children aged between 9-12 years, including 20 children with DCD and 20 age- and gender-matched typically developing children participated. Children in the DCD group had total motor scores below the 16th percentile assessed by Movement Assessment Battery second edition (MABC-2). Children underwent two proprioceptive tasks – a passive motion detection task and a position sense matching task. Mean and standard deviation of motion detection time (MDT and SDMDT) to passive ankle motion as well as position sense error (PE) and error variability (SDPE) were obtained to evaluate ankle motion and position sense performances. The dynamic balance performances were tested by Lower Quarter Y Balancing Test (YBT-LQ) and the component scores for the dominant and non-dominant foot were calculated.

RESULTS: In comparison to TD children, children with DCD showed significantly longer MDT ($p < .001$) and larger SDMDT ($p < .001$) when detecting the passive ankle motion. Furthermore, the PE and SDPE was significantly larger in the DCD group

than that of TD ($p < .001$). Correlation analysis revealed a significant negative relationship between MDT and YBT composite score in both dominant foot ($r = - 0.42$, $p < .01$) and non-dominant foot ($r = - 0.43$, $p < .01$) in children with and without DCD.

CONCLUSION: This study suggests that two submodalities of lower limb proprioception – motion sense and position sense – are both impaired in children with DCD. Poorer ankle motion sense sensitivity is correlated with poorer dynamic balance performance in children, which hints that decreased motion sense sensitivity might contribute to lower limb motor abnormalities in children with DCD.

CONTINUOUS RELATIVE PHASES OF WALKING WITH AN ADVANCED ARTICULATED PASSIVE ANKLE-FOOT PROSTHESIS TO PROMOTE PHYSICAL ACTIVITY

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INTRODUCTION: A new passive ankle-foot prosthesis was developed to improve the physical activity of people with unilateral transtibial amputations (TTA) and transfemoral amputations (TFA). The aim is to evaluate the walking patterns of the Talaris Demonstrator (TD) through continuous relative phases (CRPs).

METHODS: A total of 16 individuals aged 25 - 75 years were recruited for this explorative case-control study. Four TTA (one woman; mean ± SD age, 48.0 ± 15.9 yr; height, 176.0 ± 10.4 cm; weight, 85.8 ± 23.8 kg) and three TFA (one woman; mean ± SD age, 59.3 ± 2.5 yr; height, 177.3 ± 11.0 cm; weight, 95.0 ± 17.3 kg) individuals' current prosthesis were compared with the TD, and to nine able-bodied individuals (two women; mean ± SD age, 29.4 ± 5.7 yr; height, 183.2 ± 5.9 cm; weight, 82.3 ± 6.9 kg). Kinematics were captured during 6 minutes of treadmill walking in consecutive blocks of 2 minutes at slow, self-selected and fast speeds, and lower extremity CRPs were calculated. Gait cycles were defined based on the peak hip flexion angles. Statistical non-parametric mapping was applied, and statistical significance was set at 0.05.

RESULTS: The CRPs did not differ between the individuals' current prosthesis and the TD in people with TTA. Because of the limited sample size, no statistical tests could be conducted among individuals with a TFA. When comparing people with a TFA to able-bodied individuals, the CRP hip-knee was significantly larger in participants with a TFA at 0-5% ($p=0.009$) and 75-100% ($p=0.009$) of the gait cycle. In addition, results of the CRP knee-ankle in individuals with a TTA were smaller at 15-20% of the gait cycle during the fast ($p = 0.014$) and self-selected ($p = 0.014$) walking speeds compared to able-bodied individuals.

CONCLUSION: This study provides walking patterns in people with lower-limb amputation and reveals a possibly beneficial effect on physical activity improvement of the TD over the individuals' current prostheses. Our findings are consistent with prior studies using biomechanical kinematics in lower limb amputees. Further adequate sampled research is needed to investigate long-term adaptations in passive prostheses using CRPs.

THE REHABILITATION OF NEUROLOGICALLY IMPAIRED AND SPINAL CORD INJURED: EXOSKELETON (RISE) TRIAL

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INTRODUCTION: Neurological impairments (NI) of the central and peripheral nervous systems affect the brain, spinal cord, nerves, and muscles. The majority of individuals with NI rely on a wheelchair as their primary transportation, which may lead to a physically inactive lifestyle. Therefore, individuals with NI may be more susceptible to physical deconditioning and its comorbidities, therefore, appropriate rehabilitation techniques are paramount.

Powered exoskeletons have recently emerged as rehabilitation tools aiming to regenerate the physical capabilities of neurologically impaired individuals (Hong et al., 2013), however, research involving the devices remains limited. Existing research highlighted how powered exoskeletons can elevate cardiorespiratory and biomechanical response and can enable able-bodied participants to reach a moderate-intensity level of exercise (Duddy et al., 2022). Further research examining the effects of exoskeleton-based rehabilitation over time may be required to reach a more definitive conclusion. This trial aimed to investigate the effects of a 12-week exoskeleton-based physical activity (PA) and home-based strength training intervention on various physiological, biomechanical, emotional, quality-of-life (QoL), and mobility parameters.

METHODS: The impact of a 12-week exoskeleton rehabilitation program of neurologically impaired participants (N=6) was assessed using the six-minute walk test (6MWT), cardiorespiratory measurements using the Ganshorn PowerCube®, Shimmer 3 measurements of lower extremity movement, muscle activation and galvanic skin response, QoL and functional mobility. Participants received sufficient exoskeleton familiarisation upon recruitment.

RESULTS: Significant improvements in systolic blood pressure and gait performance ($P \leq 0.05$) were observed, while maintaining a similar cardiorespiratory stimulus. The 6MWT also significantly elevated all cardiorespiratory parameters, and gastrocnemius and rectus femoris electromyogram activity compared to the pre-walk standstill. Significant improvements in left knee acceleration from baseline to post-intervention, right hip acceleration from baseline to mid and post-intervention and left knee angular velocity from baseline to mid-intervention were also highlighted.

CONCLUSION: Participants improved gait function eliciting increased lower limb movement, muscle activity and PA levels.

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THE ACUTE EFFECT OF SELF-INDUCED UNCLASSIFIED THERAPEUTIC TREMORS ON CARDIAC AUTONOMIC RESPONSES AND INTERICTAL STATE ANXIETY SYMPTOMS IN INDIVIDUALS WITH EPILEPSY

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INTRODUCTION: Individuals with epilepsy (IwE) are diagnosed with comorbidities up to eight times more than the general population, of which anxiety disorders are one of the most frequently reported. Interictal anxiety is unique to IwE and includes anticipatory anxiety of epileptic seizures, seizure phobia, epileptic social phobia, and epileptic panic disorder, which leads to avoidance behaviour compromising quality of life. Further, health and wellness practitioners (HWP) are reported to feel inadequately resourced in treating anxiety in epilepsy. There is growing evidence that complementary and alternative medicine (CAM) may reduce anxiety in IwE by inducing parasympathetic activation, and thus increase heart rate variability (HRV) and reduce state anx

METHODS: A RedCap survey was distributed to HWP (n = 52; age: 41.15 ± 13.59 years) to gain insights into their perceptions of and attitudes towards CAM, in particular TRE®. The experimental study was a cross-over randomized study design in IwE (n = 11; age: 23.18 ± 2.36 years) with a confirmed diagnosis, but seizure free for at least three months. Descriptive information was collected pre-intervention. Cardiac autonomic responses ((HRV, heart rate (HR) and blood pressure (BP)) were measured at 5, 10 and 15 minutes pre- and post-intervention (i.e. TRE® session and control), via (H10, Polar Electro Oy®, Finland). Perceived interictal state anxiety symptoms were measured (STAI-S) pre-and post-intervention. The potential comfort of the TRE® session was also measured using a subjective VAS comfort rating scale.

RESULTS: Survey results reported that 94% of HWP believed CAM therapies to be useful in treating anxiety in IwE and the most preferred CAM therapies included Breathing Methods (96%), Physical Activity (90%) and Yoga (81%). Furthermore, 48% of HWPs were familiar with SUTT, 52% knew of TRE® and 17% were qualified, TRE® practitioners. The intervention's eleven participants presented with moderate perceived stress (16.55 ± 7.79 A.U) and anxiety (8.55 ± 4.50 A.U) levels as well as a moderate descriptive allostatic load index. State anxiety symptoms improved ($p = 0.04$) as well as comfort levels ($p = 0.04$) after a single TRE® session. No treatment effect was observed in the CAR between the control and treatment group thus, Systolic BP ($p = 0.60$); Diastolic BP ($p = 0.54$); HR ($p = 0.88$); nLF ($p = 0.41$); nHF ($p = 0.84$); nLF/nHF ($p = 0.80$); Mean R-R ($p = 0.96$); RMSSD ($p = 0.87$) and SDNN ($p = 0.68$).

CONCLUSION: Generally, HWPs agree that CAM therapies are effective in treating anxiety in IwE. Most are hesitant, however, to use TRE® as a treatment option, suggesting that additional substantiation is needed. In this intervention, a single TRE® session did not influence the CAR acutely, requiring longer-term investigation. Interictal state anxiety symptoms were significantly reduced, and comfort levels increased, without adverse events. Therefore, promoting TRE® as a possible immediate state anxiety intervention for individuals with controlled epilepsy.

TIME FOR CHANGE: TOWARDS AN ACTIVE LIFESTYLE FOR PEOPLE WITH INTELLECTUAL DISABILITIES

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INTRODUCTION: People with intellectual disabilities often have an inactive and sedentary lifestyle and low physical fitness levels, which puts them at an unnecessary risk for health problems. Even though the importance of an active lifestyle is well established and generally known, it remains difficult to improve the physical activity levels of people with intellectual disabilities and this group is not always prioritized and included in intervention and strategy development. We will present the socioeconomic value of sports and physical activity for people with intellectual disabilities and what the specific challenges are for this population to become sufficiently physically active.

METHODS: Based on literature and economic rapports, the socioeconomic value of sports and physical activity for people with intellectual disabilities has been assessed. The expenses for sports and physical activity in the Netherlands were compared to the monetary returns that adhering to the physical activity guidelines has by reducing the risk of negative outcomes in three domains: health, social aspects and employment. This socioeconomic value was compared to that previously found in the general population (1). Previous studies and sessions with both clients and stakeholders identified challenges for being sufficiently physically active for this population.

RESULTS: The socioeconomic value of sports and physical activity for adults with intellectual disabilities between 25-54 years was estimated at €50-90.000 compared to €35-75.000 for this age group in the general population, and at €20-40.000 for adults with intellectual disabilities aged 55 years and older compared to €12.5-25.000 for this age group in the general population. Challenges for people with intellectual disabilities to be sufficiently active were identified at the indi-

vidual (e.g. cognitive and physical capabilities, co-existing health conditions), interpersonal (e.g. lack of social support, lack of knowledge of caregivers, time constraints) and environmental level (e.g. limited opportunities, lack of financial and logistic support, lack of clear policy guidelines).

CONCLUSION: The relatively high socioeconomic value of sports and physical activity for adults with intellectual disabilities compared to the general population shows that it is time to prioritize investing in supporting this population towards an active lifestyle. This will result in high societal and health benefits. To take into account the challenges that are experienced by people with intellectual disabilities and stakeholders, it is important to take a socioecological approach and apply interventions and strategies at individual, interpersonal and environmental level.

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DETERMINATION OF SECOND LACTATE THRESHOLD USING NEAR-INFRARED SPECTROSCOPY IN AN INDIVIDUAL WITH SPINAL CORD INJURY: A CASE STUDY

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INTRODUCTION: Sports scientists and trainers are constantly studying new methods to determine thresholds in a non-invasive way in field situations. Near-infrared spectroscopy (NIRS) is a non-invasive and portable technology which provides information about muscle oxygen saturation (SmO2)[1]. Despite different mathematical methods were developed to determine systemic thresholds using lactate and gas exchange data, there is a lack of research about the best mathematical method to determine muscle oxygen threshold [2] in individuals with spinal cord injury. This case study aimed to explore the determination of muscle oxygen threshold in comparison with the second lactate threshold (LT2) in an individual with spinal cord injury.

METHODS: A highly trained male with complete spinal cord injury (age: 47 years; weekly training: 12h; level of injury: L1) visited the laboratory one time and completed an incremental test (start with 30W and increasing steps of 15W every three minutes) on an arm crank ergometer. SmO2 was measured continuously in the biceps and triceps brachialis (Moxy, Minneapolis, USA). Lactate samples were collected at rest and after each interval (Lactate Plus, Waltham, USA). LT2 and its associated SmO2 threshold (MOT) were calculated using the "lactater" package in RStudio. The methods that could not be applied to SmO2 data were discarded. Variation (Δ) of each variable was calculated as the difference between LT2 and MOT.

RESULTS: Similar values of power output were obtained between LT2 and MOT in biceps in five mathematical models (Dmax 80W vs 81W, ΔDmax = -1W; Log-Exp-ModDmax 92W vs. 93W, ΔLog-Exp-ModDmax = -1W; LTP2 90W vs. 91W, ΔLTP2 = -1W; Log-Poly-ModDmax 89W vs. 86W, ΔLog-Poly-ModDmax = 3W and ExpDmax 85W vs. 89W, ΔExpDmax = -4W). However, ModMax presented higher power output at the LT2 than MOT (92W vs 81W, ΔModDmax = 11W).

Similar results of power output were obtained between LT2 and MOT in triceps in three mathematical models (LTP2 90W vs. 91W, ΔLTP2 = -1W; ExpDmax 85W vs. 83W, ΔExpDmax = 2W and ModDmax 92W vs 97W, ΔModDmax = -5W). The remaining methods presented differences beyond 10W (Log-Exp-ModDmax 92W vs. 104W, ΔLog-Exp-ModDmax = -12W; Log-Poly-ModDmax 89W vs. 105W, ΔLog-Poly-ModDmax = -16W and Dmax 80W vs 97W, ΔDmax = -17W).

CONCLUSION: The lower differences obtained between a systemic variable, like the lactate, and local variables, such as SmO2, in biceps and tripes brachialis, suggest that LTP2 and ExpDmax may be the best mathematical models to determine thresholds in arm-crank exercise in individuals with spinal cord injury. However further research is necessary to affirm these mathematical models.

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EFFECT OF AN EXERCISE PROGRAM ON CARDIOVASCULAR VARIABLES IN PEOPLE WITH MODERATE TO HIGH CARDIOVASCULAR RISK

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INTRODUCTION: A higher cardiorespiratory fitness is associated with a protective effect on overall mortality and the benefit on the attenuation of cardiovascular, hematologic, immunologic, and nervous system risk factors, being physical exercise known as non-pharmacological intervention for people with moderate to high cardiovascular risk (m-h CVR) (1). This pilot study aims to determine how physical exercise impacts cardiopulmonary variables in people with CVR.

METHODS: Sixteen m-h CVR patients, divided in exercise (N=8) and control group (N=8) volunteered to participate in a twelve-week exercise pilot study. Exercise program consisted in forty-five to sixty minutes sessions, twice a week for twelve weeks, and sessions were divided into aerobic and resistance training. Subjects performed two visits to the labora-

tory to scope cardiopulmonary exercise performance and limitations, and to establish first ventilatory threshold (LV1) to prescribe exercise intensity for the intervention, from an incremental Bruce protocol exercise stress test. In both visits, the cardiorespiratory variables of interest were the maximal oxygen consumption (V ̇O2max) and heart rate (HRmáx) and the oxygen consumption (V ̇O2LV1) and heart rate (HRLV1) at the first ventilatory threshold. The magnitude of between-subjects effects was assessed with a Mann–Whitney test. Significance level was set at p≤.05.

RESULTS: After exercise program the intervention group had a higher V ̇O2max (V ̇O2máxcontrol: 1.91±4.60 L.min-1; V ̇O2máxintervention: 2.07±3.85 L.min-1; p=0,046), a higher HRmáx (HRmáxcontrol: 140,3±12.8 bpm; HRmáxintervention: 150.8±25.7 bpm; p=0,046) and a higher V ̇O2LV1 (V ̇O2LV1control: 1.25±1.43 L.min-1; V ̇O2LV1intervention: 1.54±3.23 L.min-1; p=0,046), but no statistical differences in the HRLV1 (HRLV1control: 108.00±22.0 bpm; HRLV1intervention: 114.0±23.0 bpm; p=0,293).

CONCLUSION: The practice of physical exercise promotes improvement in the cardiorespiratory functional capacity in individuals with CVR, being important that this population benefits from public policies that improve their levels of physical activity.

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EFFECTIVENESS OF TELEREHABILITATION VERSUS FACE-TO-FACE REHABILITATION IN SUBJECTS TREATED WITH SHOULDER ARTHROSCOPY: A SYSTEMATIC REVIEW AND META-ANALYSIS

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INTRODUCTION: Shoulder arthroscopy has become the primary treatment modality for many shoulder disorders due to the unique advantages [1]. And rehabilitation after surgery is crucial. Compared with traditional in-person rehabilitation, telerehabilitation has advantages in the accessibility and convenience of access to physical therapy [2]. Previous study has shown the effectiveness of telerehabilitation in many musculoskeletal pain conditions [3]. Thus, telerehabilitation may have similar effects on shoulder function and patient-reported outcomes as traditional rehabilitation in subjects treated with shoulder arthroscopy. To confirm the hypothesis, we conducted this systematic review and meta-analysis.

METHODS: Six databases consisting of PubMed, Web of Science, CNKI, Cochrane Library, PEDro, and Embase before January 2023 were searched. Independent reviewers selected randomized controlled trials that compared the effects of telerehabilitation with face-to-face treatments in individuals with shoulder arthroscopy. Patient-reported outcomes (PROs), range of motion (ROM), motor function, and adverse events were reported. Effect size of PROs and motor function was synthesized using the standardized mean difference (SMD) with a 95% confidence interval (CI). Effect size of ROM was synthesized using the weight mean difference (WMD) with a 95% CI.

RESULTS: A total of 58 data points (covering 2611 individuals) from 7 studies were included in this meta-analysis. Our results showed that the difference between the effect of telerehabilitation and face-to-face rehabilitation on ROM (abduction: WMD = -2.02, 95% CI = -7.85 to 3.81, p = 0.50, I2 = 54%; flexion: WMD = 1.02, 95% CI = -1.11 to 3.15, p = 0.35, I2 = 22%; external rotation: WMD = -1.19, 95% CI = -4.16 to 1.77, p = 0.43, I2 = 0%) was not significant. Additionally, the difference between the effect of telerehabilitation and face-to-face rehabilitation on patient-reported outcomes (SMD = -0.12; 95% CI = -0.30 to 0.06; p = 0.020; I2 = 66%) and motor function (SMD = -0.19; 95% CI = -0.57 to 0.19; p = 0.34; I2 = 0%) was also not significant.

CONCLUSION: Both forms of rehabilitation have similar effects on improving patient-reported outcomes, ROM, motor function. Hence, telerehabilitation appears to be another option for patients after shoulder arthroscopy.

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Conventional Print Poster

CP-AP28 Female athletes

EFFECTS OF MENSTRUAL CYCLE ON CHEMOSENSITIVITY AND PREDICTION OF ACUTE MOUNTAIN SICKNESS

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INTRODUCTION: The prevalence of acute mountain sickness (AMS) is estimated at 25-30% at an altitude of 3500 m and can cause serious discomfort (e.g., headache, gastrointestinal symptoms, fatigue, or dizziness). The severity of AMS is assessed by the Lake Louise Score. Several chemosensitivity tests (e.g., the hypoxic ventilatory response; HVR), including the pure nitrogen breathing test (N2T) (1) have been proposed to predict AMS. HVR is the ratio between the increase in minute ventilation (VE) and the decrease in pulse saturation (SpO2) during hypoxic exposure.

Moreover, sexual hormones such as Progesterone (P4) and Estradiol (E2) have a stimulatory effect on VE and HVR (2) and fluctuate over the menstrual cycle.

The aim of this study was to investigate chemosensitivity changes across the menstrual cycle which may alter the effectiveness of N2T to predict AMS.

METHODS: Thirteen eumenorrheic women (age= 31.7±7.8 yr) performed N2T, blood sampling, and a cycling exercise (5-min rest followed by 5-min cycling at 1.5 W/kg) in hypoxia (FiO2= 0.14) at three different phases of their menstrual cycle: early (Fol1) and late (Fol2) follicular, luteal (Lut3). They were then exposed to one night in hypobaric hypoxia (3375 m) with AMS assessment.

RESULTS: P4 and E2 fluctuated across the cycle (P4: 0.8±2.1, 1.0±1.8, 12.8±8.3 ng/ml; E2: 5.8±2.1, 44.0±81.0, 23.9±27.0 pg/ml for Fol1, Fol2 and Lut3, respectively), while HVR (0.34±0.12, 0.45±0.20, and 0.34±0.12 L.min-1.%-1) and VE (9.9±1.2, 9.6±1.6, and 10.1±1.6 L.min-1) did not differ between the three phases. SpO2 during exercise in hypoxia was higher (P= 0.04) at Fol2 (84.6±4.4%) compared to Fol1 (81.0± 3.7%) but not Lut3 (82.1± 4.0%).

After 6h at altitude, 31% of the participants developed AMS but no difference in HVR was noted between the subjects prone to AMS (AMS+) and others (AMS-). Interestingly, AMS+ had a lower SpO2 both at rest (87.5±2.6 vs 90.9±2.0%, P= 0.023) and exercise (78.5±3.0 vs 84.2±3.7%, P= 0.019) in hypoxia at Fol1, and a larger normoxia-to-hypoxia SpO2 decrease at rest (-6.2±2.7 vs -5.0±2.2%, P= 0.044) at Fol2.

CONCLUSION: Contradictory to previous studies (2,3) that reported an increased HVR during the luteal phase, we did not observe any differences between the menstrual cycle phases on HVR. AMS+ participants did not have a decreased HVR but showed larger hypoxia-induced desaturation during the follicular phase suggesting that AMS prediction is likely more effective during this phase.

Acknowledgment: Foundation SpArk for funding this study.

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COMPARATIVE BIOMECHANICAL ANALYSIS BETWEEN PROFESSIONAL FEMALE SOCCER PLAYERS

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INTRODUCTION: A biomechanical and epidemiological study by Hewett et al. (2005) showed that knee abduction moments and angles were significant predictors of future ACL injury risk and an increase valgus and valgus moments at the knee joint during the impact phase of jumping and landing tasks are key predictors of increased ACL injury potential in women (1). There is some controversy regarding whether jumps are a reliable test to measure these variables, thus, Krosshaug et al. (2016) established that vertical drop jump tests cannot predict anterior cruciate ligament injuries in elite handball and soccer players. The aim of this study is to evaluate the kinetic and kinematic variables of the knee during drop jumps in relation to the risk of injury, specifically the biomechanical variables related to the knee risk factors such as valgus, knee and ankle flexion and moment of force in the sagittal and frontal plane in the first landing after a deep drop jump in comparison between football players surgical operated and football players no operated.

METHODS: : Longitudinal descriptive observational study. Population: 11 female soccer players from the squad of a team belonging to the Feminine League (Spanish First Division of Womens Soccer) suffered an ACL and were compared to 11 female soccer players from a team belonging to the Feminine League (Spanish First Division of Womens Soccer) not operated. Methods: The evaluations of the jumps were performed using Go5D technology, reflective markers, BTS SMART DX cameras, dynamometric force platforms and a 30 cm box. Drop Jump starts with the participant climbing on a 30 cm box

and arms at the waist, then she will step forward one foot and land on both feet on the force platform. Then a monopodal deep jump test was performed and the athletes were asked to land on one foot only and jump as high as possible.

RESULTS: The results after the statistical analysis for each of the players in the jumping tests reveal the presence of significant differences between the injured and non-injured group in the monopodal jump with the dominant leg in the variables of ankle angle, knee flexion angle, knee valgus and ground reaction force. It was found that in the monopodal jump with the non-dominant leg there were statistically significant differences in knee valgus and GRF

CONCLUSION: The result follows the same line of studies that looked for the same differences previously where increased knee valgus and decreased ankle flexion turn out to be risk factors for ACL rupture, so that preventive work should consider these two variables to reduce the risk of injury. Although the present study agrees with the findings of other studies, it is necessary to measure the different variables to obtain greater reliability in the results, the type of longitudinal study limits the values obtained as the indicator of the limitations in only one moment in time, which makes it impossible to detect the adaptive changes that the players will present over time, therefore a prospective study would be necessary to follow up the players in their process of recovery, rehabilitation and return to play after undergoing ACL surgery.

DECISION MAKING INFLUENCES MOVEMENT VARIABILITY AND PERFORMANCE OF ELITE FEMALE FOOTBALL PLAYERS IN A BALL RESISTANCE TASK

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INTRODUCTION: Nowadays, constraints are included in resistance training in order to develop strength within the context of sport and to maximise its effectiveness [1]. Considering that perceptual-cognitive abilities play a fundamental role in sport as they are directly related to individual and team success [2], decision making could be introduced in resistance training as a constraint to promote the development of the athletes abilities in a holistic way. Therefore, the aim of this study was to investigate the effects of the attacker and defender decision making on movement variability and performance during an elastic resisted forward-backward movement with ball in elite female football players.

METHODS: Twenty-three elite female football players (22.65 ± 5.16 years, 167.00 ± 6.37 cm, 59.75 ± 14.08 kg) performed the resistance task with ball as attackers and defenders without (NDM) and with decision making (DM). The movement variability was analysed by calculating the sample entropy of the acceleration, recorded at the lower back with an accelerometer. The accuracy of attacker's passes was measured as an indicator of task performance using a scoring scale.

RESULTS: The movement variability was higher in DM compared with NDM only in the defender. Furthermore, the attacker had a higher movement variability in both NDM and DM compared to defender. The attacker's passing accuracy was lower in DM than in NDM.

CONCLUSION: These findings suggest that adding a decision making to a football specific resistance task increased the defenders movement variability and compromised the attackers passing accuracy. Therefore, it is a useful strategy to reduce the control and movement regularity of the player who plays the role of defender and to increase the technical difficulty for the attacking role, which can favour the adaptive process of the players.

DOES MUSCLE STIFFNESS MEASURED WITH SHEAR WAVE ELASTOGRAPHY VARY ACROSS THE MENSTRUAL CYCLE?

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INTRODUCTION: Shear wave elastography (SWE) is a novel non-invasive imaging technique to evaluate muscle stiffness and elasticity. It provides a quantitative measurement of tissue stiffness by determining shear wave velocity displayed as a color-coded map. Research investigating skeletal muscle stiffness across the menstrual cycle is sparse, although it can be assumed that hormonal fluctuations may affect the elasticity of the muscle tissue.

METHODS: Muscle stiffness of m. rectus femoris was investigated and displayed as shear wave velocity (Vs) in the early follicular phase, at ovulation, and in the mid-luteal phase in six regularly menstruating women not taking oral contraceptives (age 24.8 ± 3.0 yrs; body mass 59.7 ± 5.8 kg; height 1.68 ± 0.04 m; cycle length 28.2 ± 1.2 d; BMI 21.1 ± 1.3). The onset of menses determined the early follicular phase, while a rise of luteinizing hormone in urine detected ovulation. The mid-luteal phase was set 7 to 10 days after ovulation. The stiffness of the m. rectus femoris was evaluated in a relaxed and contracted state, in which participants were verbally requested to contract the muscle to the maximum. Furthermore, the absolute stiffness between resting and contracted conditions was expressed as stiffness increase rate [(Vscontracted – Vsresting)/Vsresting].

RESULTS: SWE revealed a clinical-meaningful difference in shear wave velocity in the contracted state, which narrowly missed significance ($F(2,8) = 4.32$, $p = .053$, $\eta^2_{sub(p)} = 0.52$), with the highest values obtained at ovulation (3.55 ± 1.04 m/s) compared to the early follicular phase (2,60 ± 0.89 m/s) and the mid-luteal phase (3.04 ± 0.55). No significant differences were found in the relaxed state ($F(2,10) = 0.750$, $p = .50$, $\eta^2_{sub(p)} = .13$) or in the stiffness increase rate ($F(2,8) = 3.36$, $p = .09$, $\eta^2_{sub(p)} = .46$) between menstrual cycle phases.

CONCLUSION: Although the results missed significance due to the small sample size, the observed high effect size indicates a strong relationship between the menstrual cycle phases and stiffness. It may be suspected that fluctuating estrogen concentrations can affect skeletal muscle metabolism and, consequently, influence the quantity and quality of cross-bridges, displayed as altered muscle stiffness. However, future research should control the intensity of muscle contraction

evaluated during SWE. Furthermore, cycle phases and hormone concentrations need to be controlled according to the recommended methodology for cycle monitoring to elucidate if there are correlations between hormone concentrations and stiffness. In addition, future studies need to clarify whether the results gain significance with a larger sample size.

UNDERSTANDING EXPERIENCE, KNOWLEDGE AND PERCEIVED CHALLENGES RELATED TO BRA FIT FOR SPORTS PARTICIPATION: A SCOPING REVIEW

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INTRODUCTION: The breasts are reported as the fourth largest barrier to participation in physical activity (PA).

METHODS: This scoping review provides a comprehensive understanding of experiences, knowledge and challenges relating to bra fit and sports participation. The search strategy was adopted by the Preferred Reporting Items for Scoping Reviews (PRISMA-ScR) guidelines and multiple databases were searched. All research was in English and within the last 20 years. Exclusion criteria excluded reviews, male participants and the inability to locate or access full-text articles. The JBI critical appraisal tool assessed methodological quality.

RESULTS: Twenty-three studies were included. Key themes from the studies are breast motion during PA, sports bra design, perceived barriers to participation in PA and education/knowledge of breast support and bra fit. Increasing breast support reduces breast movement during PA yet breast motion and bra fit are still the most common breast concerns for females. This is likely influenced by poor breast knowledge, leading to poor breast support choices.

CONCLUSION: Future research should explore to what extent breast motion, knowledge and bra fit influences sport participation, and this research should include a more diverse range of adult ages, cup sizes, ethnicities and PA levels to provide a wider understanding.

PREVALENCE OF PROHIBITED SUBSTANCE USE AND METHODS BY FEMALE ATHLETES: EVIDENCE OF GENDER-RELATED DIFFERENCES

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INTRODUCTION: To achieve optimal sports performances, women and men may show specific doping practices because of the physiological and psychological gender differences, but there are few data on this topic.

METHODS: Here, we report the apparent use of prohibited substances and methods by female athletes based on analyses of the doping tests collected by the French Anti-Doping Agency from 2013 to 2019. We compared the frequency of use and the ergogenic and side effects to those of their male counterparts.

RESULTS: The results revealed lower use of prohibited substances in female vs. male athletes, with significantly fewer anabolic agents, hormone and metabolic modulators, and cannabinoids. Gender specificity in utilization of substance classes was also shown.

CONCLUSION: Relatively lower use of hormone modulators and cannabinoids and higher use of beta-2 agonists, diuretics and glucocorticoids were found in the woman cohort compared with men cohort, combined with the different choice of substances, possibly because of the altered ergogenic and/or side effects. However, no impact due to gender regarding the sports disciplines was observed, with both women and men showing similar use of anabolic agents, mainly in the anaerobic sports, and EPO and corticoids, mainly in endurance or mixed sports.

Conventional Print Poster

CP-BM10 Muscle and tendon function I

ARCH-SPRING OR WINDLASS MECHANISM? THE STIFFNESS OF SPRINTERS' AND SWIMMERS' FEET: A PILOT STUDY

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INTRODUCTION: The human foot is thought to function like a flexible spring (Ker 1987) or a stiff lever (Hicks 1954). In both mechanisms, the stiffness of the plantar aponeurosis (PA) plays a central role in the deformation of the longitudinal arch (LA) under loading. If the PA is sufficiently stiff, metatarsophalangeal joint (MPJ) dorsiflexion should be closely coupled to LA deformation. We assume that, due to their daily impact load, sprinters have stiffer LA than swimmers. Therefore, more force might be needed for MPJ dorsiflexion, which should lead to greater deformation of the LA of sprinters compared to swimmers.

METHODS: Force-deformation of the MPJ during passive dorsiflexion was determined with a custom-built device in five male competitive sprinters (100 m PB 11.57 ± 0.46 s, training/week 10.8 ± 1.1 hrs) and eight male competitive swimmers (50 m freestyle PB 24.8 ± 1.18 s, training/week 12.5 ± 3.3 hrs). Deformation of the LA (change in navicular angle) was recorded with a motion analysis system (Vicon, Oxford). For statistics a Mann-Whitney-U-Test (SPSS Statistics 23, IBM) with a level of significance $\alpha < 0.05$ was used.

RESULTS: Forces for MPJ dorsiflexion were sig. ($p < 0.05$) higher in sprinters than in swimmers throughout the whole range of motion. At 40° MPJ dorsiflexion, the stiffness was 1.6 times higher in sprinters ($p < 0.05$). Energy absorption and return were 1.7 times elevated in sprinters compared to swimmers. Energy loss for the sprinters' feet was 28% and for the swimmers' feet 35%. The deformation of the LA increased by about 5° with increasing MPJ dorsiflexion, but showed no sig. differences ($p > 0.05$) between groups.

CONCLUSION: Our results showed that the forces for MPJ dorsiflexion noticeably deformed the LA (Carlson et al. 2000). The relationship between MPJ angle and LA deformation aligned well with the windlass mechanism and was observed for both groups. The higher force requirement to induce a similar LA deformation in sprinters might be explained by the difference in tissue material properties between the groups (Arampatzis et al. 2007). It is possible that the stiffer LA of the sprinters was a result of the higher impact load per training week. Their stiffer tissue was able to absorb and return more energy with a smaller hysteresis. Sprinters might benefit from their stiff arch-spanning structures that inhibit LA deformation and allow an efficient force transfer rapidly to the ground during running. As a stiff foot is a requirement for efficient ground contact, specific long-term training interventions may be developed and monitored using this device. Further, the interaction with muscular factors (strength and activation) may be included in the scope of study.

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AN INITIAL EXPLORATION OF MUSCLE-TENDON UNIT PROPERTIES IN HIGHLY TRAINED FEMALE NETBALLERS AND RUNNERS

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INTRODUCTION: Muscle-tendon interaction during movement can be categorised into energy conservation or power amplification/attenuation strategies (1), and the mechanical and morphological properties of male athletes' tendons adapt to these loading demands (2). Although previous research observed no differences in tendon properties between female endurance runners and inactive controls (3, 4), little is known about these properties in females undergoing habitual power amplification-type loading, such as that experienced by team sport athletes. Therefore, this study investigated Achilles' tendon (AT) properties in trained female endurance runners and netballers.

METHODS: An observational investigation of 7 national level female netballers (16.2 ± 4.5 years netball training experience) and 7 female runners (8.3 ± 2.9 years training) was conducted. AT thickness was assessed at rest using B-mode ultrasound. The AT moment arm was calculated using the tendon excursion method. Participants performed graded isometric ankle plantar flexion contractions on a Cybex dynamometer until a voluntary maximum was reached, whilst dynamic ultrasound recorded displacement of the gastrocnemius medialis myotendinous junction. From each contraction plantar flexion moment, AT force, elongation, and strain were calculated. AT stiffness was defined as the slope of the AT force-elongation relationship (from 20-100% of maximum force). Mean differences (MD) with 95% confidence intervals (CI), Student's t-tests, and Hedge's g effect sizes (ES) were used to assess differences in AT properties between groups.

RESULTS: Netballers displayed a significantly greater maximal plantar flexion moment (MD 58.1 N.m-1, CI 35.5-80.7 N.m-1, ES 2.81, $p<0.001$), AT force (MD 822.4 N, CI 294.4-1350.5 N, ES 1.70, $p=0.008$), AT elongation (MD 5.70 mm, CI 0.40-11.07 mm, ES 1.17, $p=0.044$), and AT thickness (MD 0.69 mm, CI 0.08-1.30 mm, ES 1.24, $p=0.031$). No significant differences were found in maximal strain, stiffness, length, or moment arm.

CONCLUSION: The greater AT thickness of the netball group suggests that the power amplification-type loading demands inherent to netball training (i.e., jumping, landing) have a hypertrophic effect on the tendon. Additionally, the greater maximal plantar flexion moment, and hence AT force experienced by the netballers may also contribute to this hypertrophic stimulus. This adaptation may be protective in nature, as increased thickness (and presumably cross-sectional area) would reduce peak operating stress and enhance the safety factor of the tendon. Despite differences in AT thickness, no differences in strain or stiffness were found, corroborating earlier findings of uncoupled mechanical and morphological properties (2). These results provide evidence that the AT can adapt to high intensity loading in females.

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ALTERED MUSCLE AND TENDON FUNCTION OF THE MEDIAL AND LATERAL GASTROCNEMII IN INDIVIDUALS WITH ACHILLES TENDINOPATHY DURING WALKING

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INTRODUCTION: Achilles tendinopathy is a challenging-to-treat condition, which is common in runners (up to 52% prevalence) (1). Recent studies suggest that this condition is associated with altered neural function of the lateral gastrocnemius (LG) in submaximal isometric contractions (2). Whether this translates into suboptimal muscle-tendon interaction (i.e. decoupling) in functional tasks, such as walking, is unknown. Therefore, this study aimed to examine muscle-tendon interactions in the LG and medial gastrocnemius (MG) in walking in tendinopathy patients, as compared to healthy runners.

METHODS: In this ongoing study, four individuals with mid-portion Achilles tendinopathy and five healthy runners participated so far. They walked at self-selected speed on a treadmill while ultrasound images visualizing the muscle-tendon junctions of the MG and LG were recorded at 100 Hz after 6-min walking. 3-D motion analysis was used to estimate joint angles and in combination with the ultrasound data the length changes of the MG and LG tendons. Muscle-tendon junction displacement was tracked from the ultrasound images during the whole stride cycle to differentiate between muscle and tendon function for each of the MG and LG.

RESULTS: Maximal muscle-tendon junction displacement in healthy runners was 0.36±0.11 cm (ranged from 0.21 to 0.49) in MG, and 0.45±0.05 cm (ranged from 0.37 to 0.52) in LG. Individuals with tendinopathy showed larger displacement in both muscles, which was 0.41±0.04 cm (ranged from 0.37 to 0.45) in MG, and 0.59±0.19 cm (ranged from 0.46 to 0.87) in LG.

CONCLUSION: Although Achilles tendon function has mostly been examined through MG behaviour solely, muscle-tendon decoupling seems to be specific to each of the MG and LG. This was observed both in healthy runners and tendinopathy patients. In this study, displacements of MG and LG muscle-tendon junctions differed but the interpretation of the findings depends on joint kinematics which are yet to be analysed. Additionally, the difference between the two groups was more pronounced in LG than in MG. Further examining the mechanical behaviour of these muscles will help to further understand the sources and/or consequences of Achilles tendinopathy.

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THREE-DIMENSIONAL DEVELOPMENTAL ASPECTS OF THE PECTORALIS MAJOR AND DELTOID MUSCLES IN SHOT PUTTERS.

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INTRODUCTION: In shot put, the mechanical output of the shoulder muscles is important. Among the shoulder muscles, the pectoralis major (PM) and deltoid (DELT) muscles are primarily responsible for horizontal shoulder adduction and anterior elevation of the upper extremity (1). Although the PM and DELT are not multifidus muscles, they are composed of multiple portion, each responsible for a specific action. Because of the multiple portion responsible for different actions, inhomogeneous development may occur in shot putters. However, to our knowledge, no study has investigated the size distribution of the PM and DELT in shot putters. We compared the intramuscular size distributions of PM and DELT in shot putters and controls. We hypothesized that PM and DELT are inhomogeneously developed in different portion.

METHODS: Transverse water-weighted magnetic resonance imaging (MRI) scans of the upper extremities (2 mm Interval) and trunk (5 mm Interval) were obtained from 11 male shot putters and 14 height-matched untrained males. Cross-sectional area (CSA), PM and DELT volumes of each slice were measured based on manual segmentation of the MRI. Welchs t-test was used for comparisons between groups. Welchs t-test was used for comparisons between groups. Cohens d was used for effect size for each t-test. CSA region curves were normalized to 101 data points (100% superoinferior muscle length). One-dimensional statistical parametric mapping (SPM1d) was used to test for significant differences between groups for CSA in continuous muscle regions.

RESULTS: The volumes of PM and DELT were significantly greater in shot putters than in controls ($p < 0.01$), with a larger effect size for PM ($d = 2.52$) than for DELT ($d = 1.42$). SPM1d showed significant differences at 0-88% for PM and 25-80% for DELT, with the peak t-values at 69% for PM and at 50% for DELT.

CONCLUSION: These results suggest that the PM and DELT develop differently and that some regions are more likely to develop with training than others. The mid-lower regions of the PM that showed specific development in this study are primarily responsible for horizontal shoulder adduction based on muscle structure, suggesting that development of this region may lead to improved shot-putting motion. The DELT is mainly developed in the middle part, suggesting that the muscle belly is homogeneously developed with respect to the vertical direction.In shot putters, the PM developed inhomogeneously, mainly in the middle and lower part of the muscle, whereas the DELT developed uniformly. These results suggest that PM and DELT develop in a site-specific manner due to their athletic characteristics.

RELATIONSHIP BETWEEN THE SHEAR MODULUS OF THE QUADRICEPS AND GASTROCNEMIUS MUSCLES AND THE HEIGHT OF THE DROP JUMP IN BASKETBALL ATHLETES

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INTRODUCTION: Basketball is a complex contact sport that involves multiple jumps, acceleration, deceleration and changes of movement direction. The mechanical properties of the musculotendinous tissue may be important for understanding the prevalent injuries and athletes performance. Elastography is a technique for assessing, in vivo, the shear modulus which is proportional to tissue stiffness, estimated from the propagation velocity of shear waves generated by high-intensity ultrasonic pulses focused at different tissue depths (1). Using another technique, Ando et al. (2) observed a relation between the stiffness of the medial gastrocnemius muscle and the Drop Jump height of non-athlete individuals, after a training period. There seem to be no studies describing this relationship in basketball athletes. This study aimed to correlate the shear modulus (μ) of the medial and lateral gastrocnemius, vastus medialis and the distal site of the vastus lateralis muscles with the height obtained in the Drop Jump jump test.

METHODS: Twelve male, competitive basketball players, for more than 5 years, in the sub20 category (18±0.92 years; 86.5±17.17 kg, 193±7 cm) with no history of lower limb injuries in the last 6 months, were submitted to the jump test protocol Drop Jump (DJ) (Ethic committee 5.776.787). Three trial of DJ tests were filmed and analyzed offline in the Kinovea® application. Three elastographic images of the vastus medialis (VM), vastus lateralis (VL), medial gastrocnemius (MG) and lateral gastrocnemius (LG) muscles of the non-dominant lower limb were acquired at rest, by an experienced examiner (Aixplorer® v.11 Supersonic Image, Aix-en-Provence, France, linear 40 mm, 10-2 MHz). The averages of the three jumps and three images for each muscle were considered for analysis.

RESULTS: The average height of the Drop Jump test was 41.23 ± 4.55 cm. The mean μ of the VL and VM muscles were 4,23 ± 1,32 kPa and 4.25 ± 0.58 kPa, respectively. The mean μ of the LG and MG muscles were 5.39 ± 1.26 kPa and 4.65 ± 1.06 kPa, respectively. Pearsons correlation showed a significant relationship between the DJ height and the μ of the VL (r= 0.64; p= 0.02) and the LG (r=0.75; p=0.004).

CONCLUSION: Our results with this group, very well trained for jumping, suggest that the muscle components with longer fibers showed a better adaptation to the jump demands. As specialized for contraction velocity (3), these muscles are heavily tensioned during jumps. The analysis of the shear modulus of these muscle groups can be an important factor for monitoring basketball players jump performance.

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EXAMINATION OF THE ACTION OF THE ILIOCAPSULARIS – FOCUSING ON CHANGES IN SHEAR ELASTIC MODULUS DUE TO MUSCLE ELONGATION–

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INTRODUCTION: The iliocapsularis muscle (IC) attaches to the anterior capsule of the hip joint. IC is assumed to stabilize the hip joint by tensioning the capsule through its muscle tension[1]. While the aforementioned anatomical characteristics have been revealed[1, 2], it is not clear how the IC works on the hip joint, and its actions have not yet been elucidated. Therefore, this study aimed to reveal the action of the IC using ultrasound shear wave elastography (SWE). The higher shear elastic modulus (G) means more muscle elongation, and the muscle is more elongated when the joint angle changes in the direction opposite to the moment arm. Given these, this study estimated the IC action, which is the direction of the IC's moment arm by studying the moment arm of the muscle from the increase in G during the passive stretching.

METHODS: The study included 15 healthy young females (age 22.5±1.3 years). G of the right IC was measured using SWE at the inferomedial aspect of the anterior inferior iliac spine. The following seven positions were used: rest (hip flexion 0°, abduction 0°, external rotation 0°), hip flexion 15°, hip extension 15°, hip abduction 15°, hip adduction 15°, hip external rotation 15°, hip internal rotation 15°. The subjects were instructed to relax completely, and their pelvis was fully fixed with a belt. G was measured three times for each position, and the average value was used for analysis. The Wilcoxon signed-rank test with Holm correction was used to compare the G between the rest and each position, as well as the G between hip flexion 15°–extension 15°, hip abduction 15° –adduction 15°, and hip external 15° –internal rotation 15°. The statistical significance level was set at 5%.

RESULTS: The interclass correlation (1,3) is above 0.91 for all positions, indicating high reproducibility of the measurement. The average G (unit: kPa) of each position is as follows; rest : 12.6, hip flexion 15°: 7.7, hip extension 15°: 19.6, hip abduction 15°: 10.9, hip adduction 15°: 10.2, hip external rotation 15°: 15.9, hip internal rotation 15°: 10.7. The G of the IC was significantly lower at hip flexion 15° compared to the rest ($p = 0.008$) and significantly higher at hip extension 15° ($p = 0.026$). Furthermore, the G was significantly higher at hip extension 15° compared to hip flexion 15° ($p = 0.006$). Although not significant, there was a trend toward higher G at external rotation 15° compared to internal rotation 15° ($p = 0.088$).

CONCLUSION: The results of this study show that the IC is significantly elongated in hip extension, which means the IC has a significant action of hip flexion. However, no clear trends were observed for the action of abduction or adduction and external or internal rotation of the hip joint.

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FINITE ELEMENT ANALYSIS TO PREDICT THE EFFECTS OF ACHILLES TENDON GEOMETRY ON RUPTURE OR TENDINOPATHY

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INTRODUCTION: The Achilles tendon (AT) is the largest and plays an important role in the human body's movement. AT is involved in human body movement such as walking, running, or sports activity and is exposed to high loads frequently and continuously. In elite runners, the cumulative incidence during their lifetime of AT rupture and tendinopathy is reported to be 5% and 52%, respectively (1). A previous study on AT rupture has reported that it takes 13.1 weeks to return to full sports activity (2). Achilles tendinopathy can also cause a prolonged absence from sports participation (3). Thus, it is important to identify risk factors for AT rupture and tendinopathy and to prevent them. This study aimed to investigate the effects of the AT geometry on a local strain that would relate to its rupture and tendinopathy using the finite element (FE) method.

METHODS: We calculated the following eight parameters from the 18 three-dimensional AT models obtained in our previous study (4): the thickness and width of the most distal site; the thickness and width of the minimum cross-sectional area (mCSA); the thickness and width of the most proximal site; and the length and position of the mCSA. We developed a standard three-dimensional AT model that has the aforementioned eight parameters. Furthermore, we developed the model by changing the parameter values every 1 standard deviation (SD) in the range of −2SD to +2SD. To simulate the loading applied to the AT during jumping, the models were only allowed to displace in the long axis direction, and a 4000 N (approximation of peak AT force during hopping: 3786 N, (5)) lengthening force was applied to the proximal surface. The distal surface was fully fixed. V-Biomech was used for FE analysis (6), and the maximum principal strain (MPS) was calculated. The mean and SD of MPS for 96% of the range except for the top and bottom 2% of the length of the model were determined every 3%. The highest mean MPS value in each model was used for analysis.

RESULTS: The MPS value was 0.071 (SD: 0.016) in the standard model at the 86–89% site (0% is the most distal, and 100% is the most proximal site of the AT). The highest MPS value was observed in the distal thickness −2SD model, and the 2–5% site had a 27.1% higher value than the standard model. The mCSA width −2SD model had the second-highest MPS value, and the 89–92% site had an 18.4% higher value than the standard model.

CONCLUSION: Our result suggests that ATs with a thin distal site and narrow mCSA have a higher risk of rupture or tendinopathy. Also, our results suggest that the location with the highest risk of rupture or tendinopathy may be different depending on the AT geometry.

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MEASUREMENT OF MUSCLE-TENDON LENGTH USING 3D ULTRASOUND: VALIDATION OF OPENSIM MODEL AND DEVELOPMENT OF PERSONALIZED MODELS

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LABORATOIRE MOTRICITÉ, INTERACTION, PERFORMANCE

INTRODUCTION: Measuring the muscle-tendon unit (MTU) length is important to better understand their functional role. Models were developed to assess MTU length using joint angles and anthropometric data's (1). More sophisticated approaches, like OpenSim, involve the scaling of a generic skeleton using coordinates of body markers obtained using a 3D motion capture system (2). However, the validity of these approaches has not been demonstrated. This study aimed to investigate the validity of OpenSim for the measurements of MTU length of lower limb muscles in several postures using 3D freehand Ultrasound and to explore the development of 3D ultrasound personalized models.

METHODS: Fourteen participants performed 3D ultrasound scans for 6 biarticular MTU: Semimembranosus (SM), Semitendinosus (ST), Biceps femoris (BF), Rectus femoris (RF), Gastrocnemius medialis (GM) and lateralis (GL) in 5 postures per muscle. From these scans, MTU insertions and paths were used to calculate the MTU length (3D US). During the postures, motion capture acquisitions were also performed in order to scale a generic musculoskeletal model using OpenSim. MTU length was computed in OpenSim using 3 different models: OS: i.e. the generic scaled model, OS+INSER: OS with custom-

ized 3D US MTU insertions, OS+INSER+PATH: OS with customized 3D US MTU insertions and path obtained from one posture.

RESULTS: Linear mixed effect models showed the significant ($p<0.001$) differences in MTU length between OS model and 3D US for RF, GM, and GL (in average -10.9%, -7.4%, -6.3% respectively). Non-significant effects were reported for hamstrings, notably for ST (-1.5%, $p=0.71$) and BF (-1.9%, $p=0.54$), while the SM just crosses the alpha level (-3.4%, $p=0.049$). The OS+INSER model reduced the magnitude of bias by an average of 4% for RF, GM, GL but the difference was still significant ($p\leq0.001$). OS+INSER+PATH model showed the smallest biases in length measurements making them negligible and non-significant for all MTU (i.e. ≤ 2.2%; $p>0.05$).

CONCLUSION: The present study developed a 3D US pipeline to validate models developed to estimate MTU length. In our group of participants, the effect of personalization seems less important for hamstrings compared to RF, GM, and GL. A method is also proposed to personalize models using one 3D US scan. This could be valuable for musculoskeletal modeling and particularly for population that probably have specific MTU geometry (e.g., elite athletes, obese patients, patients with tendon transfer of bone deformations…).

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REGIONAL DIFFERENCE IN MUSCLE ELONGATION TO COMPRESSION DURING STRETCHING.

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INTRODUCTION: Manual compression of a muscle is often performed during stretching (Ylinen, 2008). However, no studies have investigated whether manual compression during stretching could elongate the muscle more than only stretching does. Additionally, the effects of compressed tissue (muscle or tendon) and intra-muscle difference (proximal and distal) on muscle elongation are unclear. This study aimed to investigate ⅰ) the change in the muscle shear modulus when compression of either the muscle or tendon was added to stretching, and ⅱ) the influence of the measurement point on the muscle shear modulus using shear wave elastography.

METHODS: Twenty healthy adults participated in this study. Two conditions, namely stretching with ⅰ) muscle belly compression and ⅱ) Achilles tendon compression, were performed for the gastrocnemius in random order. The shear modulus of the medial gastrocnemius muscle was measured during stretching and stretching with compressions. The measurement points were a point just proximal to the compression point for muscle belly compression (PROXIMAL) and a point distal to it (DISTAL). The shear moduli during stretching with compressions were compared with those during only stretching in each measurement point using a paired t-test.

RESULTS: For muscle belly compression, the shear modulus in stretching with compression was significantly higher than that in only stretching at PROXIMAL ($p < .01$), but significantly lower at DISTAL ($p = .01$). For Achilles tendon compression, there was no significant difference in the shear modulus between only stretching and stretching with compression for PROXIMAL and DISTAL ($p = .12, .92$).

CONCLUSION: As a result of stretching with muscle belly compression, the muscle was elongated more at PROXIMAL when compared with that during only stretching, whereas it was slackened at DISTAL. In gastrocnemius muscle that is pennate muscles, compression force from the body surface can be decomposed into a component perpendicular to the fiber which can elongate the muscle, and a component parallel to the fiber which can shorten the muscle. The former could be generated proximally to the compression point, while the latter in distally. On the other hand, stretching with tendon compression did not affect muscle elongation. Because the Achilles tendon is stiffer than the muscle (Zhou et al., 2019), when compression is applied to a muscle and tendon with the same pressure, the muscle could be compressed but the tendon could not. Therefore, in this study, the muscle was not elongated by the tendon compression because the applied pressure might not be sufficient.

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CHARACTERISTICS OF MUSCLE STIFFNESS DURING ISOMETRIC CONTRACTION AND RELAXATION BY SHEAR WAVE ELASTOGRAPHY

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INTRODUCTION: Well-coordinated control of both muscle contraction and relaxation are essential for various movements. Muscle conditions such as stiffness or contractile state during present force exertion may influence the subsequent force control. A previous study has characterized the stiffness of hamstring muscles during muscle contraction using ultrasound-based shear wave elastography (1). In the small muscle groups under small contraction levels, the relationship

between shear elastic modulus and torque have been determined by performing ramp contraction (up-going/down-going). However, the difference in the characteristics of muscle stiffness between muscle contraction and relaxation remain unclear. The aim of the study was to investigate the characteristics of muscle stiffness during isometric contraction and relaxation by shear wave elastography (SWE) and electromyography (EMG).

METHODS: Seventeen participants performed the force control tasks between 0-60% of maximal voluntary contraction (MVC) with isometric knee extension. They were asked to increase their force 10s each from 0% to 60% MVC in the contraction task and decrease from 60% to 0% MVC in relaxation task, with visual feedback. While conducting tasks, the produced force (torque), SWE (VL; vastus lateralis muscle), and EMG (RF; rectus femoris muscle, VM; vastus medialis muscle), were recorded. Then, SM (shear modulus) from SWE, and iEMG (integrated EMG) from EMG were analyzed. These variables were analyzed by two-way ANOVA with repeated measures using within-subjects of the task direction (contraction and relaxation) and the force level (0 to 60%MVC).

RESULTS: Force at each level was accurately performed in both task directions. iEMG of RF increased in proportion to the force levels in the contraction task, but began to decrease after 40%MVC in the relaxation task. As for between the task directions, 60%MVC was greater in the contraction task, but 10-40%MVC was greater in the relaxation task. Interestingly, the SM showed peak values at 30%MVC in both directions. At 20% and 30% MVC of the force levels, the SM was significantly greater in the relaxation task than in the contraction task ($p < 0.05$).

CONCLUSION: The SM during relaxation was greater than that during contraction in adjustment for the same force level. Similarly, EMG had greater activity while relaxing muscles compared with contracting muscles. Our results show the difficulty of performance due to muscle relaxation in relation to SWE and EMG.

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CP-AP13 Interventions

IMPLEMENTATION OF TAILORED ERGONOMICS TRAINING FOR THE IMPROVEMENT OF NURSES MOVEMENT BEHAVIOR DURING THE REPOSITIONING OF RESIDENTS

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INTRODUCTION: Everyday nursing care for the elderly is characterized, in particular by physical strain. Heavy physical work, frequent upper body bending and twisting during care activities, and repositioning residents in awkward body postures under time pressure can lead to musculoskeletal complaints such as back pain in nurses. Therefore, health promotion to reduce physical strain is of particular relevance (Kurowski et al., 2019). The present study investigates the effects of tailored ergonomics training (BASE program; Wollesen et al., 2016) on ergonomic movement behavior and trunk forward lean during the repositioning of residents.

METHODS: The randomized controlled trial was conducted in two nursing homes and included n= 15 in the intervention and n= 20 nurses in the control group. Trunk forward lean during repositioning was recorded using the validated Xsens MVN 2018, while a movement observation sheet recorded movement behavior. The analysis included ANOVA and statistical parametric mapping to assess time changes and differences between groups (SPSS 27, Matlab).

RESULTS: The analysis showed significant differences between the intervention and control group in foot position during turning ($F(1,33)= 5.912$, $p= 0.021$) and setting the person down ($F(1,33)= 5.617$, $p= 0.024$) in the repositioning process. However, there were no differences in trunk forward lean during repositioning between groups over time.

CONCLUSION: Tailored ergonomics training improved intervention group nurses' movement behavior. Nurses demonstrated a better standing position during repositioning, which is particularly relevant when dealing with heavy residents. In future research approaches, ergonomics training should be supplemented by further strategies for transferring the learned movement principles into everyday nursing care.

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EFFECTS OF RESISTANCE EXERCISE WITH WEARING A KF94 MASK ON PERFORMANCE, VASCULAR, AND CARDIORESPIRATORY RESPONSES

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INTRODUCTION: Wearing a face mask in public spaces including fitness training centers is recommended to reduce airborne transmission of the COVID-19 virus. Although physiological responses to wearing a mask during aerobic exercise have been reported, the effects of wearing a mask during resistance exercise on vascular and cardiorespiratory respons-

es remain largely unknown. This study aimed to investigate the effects of wearing a KF94 mask during resistance exercise on performance, vascular, and cardiorespiratory responses.

METHODS: Eighteen healthy and active young men voluntarily participated in this randomized crossover trial. All participants performed moderate resistance exercise (1RM 60%) sessions in two different conditions (without and with a wearing KF94 mask). Exercise volume (sets x repetitions x load [kg]), rating of perceived exertion (RPE), heart rate (HR), and respiratory parameters (minute ventilation [VE], oxygen consumption [VO2], carbon dioxide production [VCO2], and respiratory quotient [RQ]) were measured during exercise. In addition, lactate and arterial stiffness (augmentation index [AIx], carotid to femoral pulse wave velocity [cfPWV], and brachial to ankle PWV [baPWV]) were measured at pre-exercise and post-exercise.

RESULTS: VE, VO2, VCO2, and exercise volume were significantly lower in the KF94 mask condition than in the no mask condition during resistance exercise ($P < 0.001$, $P = 0.002$, $P < 0.001$, and $P < 0.001$, respectively). However, RPE was higher in the KF94 mask condition than in the no mask condition ($P = 0.001$). HR and RQ did not show significant differences between the conditions ($P = 0.843$ and $P = 0.486$, respectively). There was a significant time by group interaction for AIx, AIx75@, and cfPWV ($P < 0.001$, $P = 0.011$, and $P = 0.032$, respectively). Changes in AIx, AIx75@, and cfPWV after resistance exercise were significantly higher in the mask condition than in the no mask condition ($P = 0.001$, $P = 0.005$, and $P = 0.003$, respectively). However, there was no significant time by group interaction for baPWV and lactate ($P = 0.155$ and $P = 0.253$, respectively).

CONCLUSION: Our findings show that wearing a KF94 mask reduced exercise performance and increased RPE during resistance exercise. Furthermore, in the condition of wearing a face mask, respiratory volume decreased during exercise, whereas arterial stiffness increased after exercise. Therefore, people with respiratory or cardiovascular diseases need to be careful and consider wearing a face mask during resistance exercise.

EFFECTS OF REPEATED CRYOSTIMULATION EXPOSURES ON SLEEP AND WELLNESS IN HEALTHY SUBJECTS.

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INTRODUCTION: The importance of sleep for both mental and physical health has widely been demonstrated. Health-related sleep characteristics involve appropriate schedules, sufficient duration, and especially a good sleep quality. However, all these key factors for a restorative sleep are insufficiently complied. Even in a healthy young population with no severe sleep disorders, bad sleep quality is commonly observed and may affect mood, anxiety, and psychological well-being.

New strategies are therefore required to optimize sleep quality. In this context, whole-body cryostimulation (WBC) appears to be an interesting option, known to lead to numerous beneficial effects particularly on wellness feelings, through the activation of analgesic processes and autonomous nervous system. Acute cryostimulation sessions have already been investigated but the effects of repeated WBC exposure on healthy subjects, independently of training have not been assessed yet. The aim of this study was to evaluate the effects of daily WBC sessions during 5 consecutive days on wellness and sleep parameters in healthy young men and women.

METHODS: Twenty healthy subjects (9 females; 11 males) aged 23.1 ± 2.6 years old participated in this randomized protocol, with 5 consecutive days with or without WBC exposure. Sleep was analyzed over the 5 nights in each condition (CONT / CRYO). Skin temperatures were measured before and after each WBC session. Sleep quality and quantity were assessed via actimetry, cerebral activity and questionnary. Nocturnal heart rate variability (HRV) was also recorded and questionaries were given to assess wellness and mood.

RESULTS: Skin temperatures dropped after WBC exposure for all participants but with a greater amplitude in females. The inter-sex difference was significative and associated with body composition, as females exhibited higher body fat % compared to males. Repeated WBC exposures during 5 consecutive days had a beneficial impact on mood and anxiety. It also improved subjective sleep quality, especially in females. Repeated WBC modulated sleep architecture, increasing slow wave sleep duration during the nights, without impacting other sleep parameters, nor nocturnal HRV.

CONCLUSION: Repeated WBC in an effective strategy to improve slow wave sleep duration of healthy young subject. The reported psychological improvements may benefit women more than men.

EFFECT OF CO2 AND H2 GAS MIXTURE IN COLD-WATER IMMERSION ON THE SCAVENGING ACTIVITY OF REACTIVE OXYGEN SPECIES AND THE WINGATE PERFORMANCE IN HIGH-INTENSITY EXERCISE.

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INTRODUCTION: Cold water immersion (CWI) is commonly used by athletes as a post-training recovery technique. Our previous study showed that CWI with CO2 (C-CWI) could be an effective method to increase skin and muscle blood flow, decrease sublingual temperature (Tsub) and maintain aerobic work efficiency. Besides, high-intensity exercise in athletes results in the production of excess reactive oxygen species (ROS), thus athletes should maintain greater ROS scavenging activity in the body. We hypothesised that adding H2 to C-CWI could accelerate the removal of ROS after high-intensity exercise.

METHODS: Twenty trained male athletes (age 20.6±1.2 years) of a university athletic association team were randomised into four groups: control, CWI, C-CWI and CO2/H2 gas mixture CWI (CH-CWI). In the three CWI groups, all subjects were immersed in one of the three baths at 20 °C for 20 min immediately after the first high-intensity Wingate anaerobic test (WAnT). After the recovery intervention, the subjects performed the second WAnT. Tsub, blood lactate concentration ([La]b) and ROS (OH• and O2•–) were measured four times at basal rest (BL), end of first WAnT, recovery intervention and end of second WAnT. The ROS scavenging activities were evaluated by the electron spin resonance (ESR) spintrapping method. The mean power output of WAnT was also measured at first and second bout following each recovery intervention.

RESULTS: The Tsub values were significantly increased in CON after the recovery intervention compared to the first WAnT ($p<0.05$). The rate of Tsub increase in CH-CWI tended to be less than in the other three groups. [La]b disappearance was significantly accelerated in CH-CWI comparing the first WAnT and recovery interventions ($p<0.05$). At the second WAnT of the CWI and C-CWI, the OH• scavenging activity converted by using the GSH concentration tended to increase compared to the BL, otherwise it tended to decerase in control and CWI interventions. Similar trend in the O2•- scavenging activity converted using the superoxide dismutase concentration was found from BL to the second WAnT. A significant correlation between the rate of increase in mean power of WAnT and the rate of increase in the OH• scavenging activity in CH-CWI was revealed ($n=5$, $r = 0.89$, $p < 0.05$).

CONCLUSION: CH-CWI has the effetcitive of suppressing the increase in body temperature after high-intensity exercise and reducing blood lactate accumulation. CH-CWI may increase OH· and O2•- scavenging activity, and athletes having greater OH· scavenging activity may be able to generate higher mean power in high-intensity anaerobic exercise.

THE ORDER OF CONCURRENT EXERCISE AFFECTS THE DEGREE OF EXERCISE-INDUCED ACUTE COGNITIVE IMPROVEMENT

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INTRODUCTION: Concurrent training, a combination of endurance exercise and resistance exercise in succession, simultaneously improve muscular strength and cardiovascular function (1), but exercise effects (e.g., muscle hypertrophy) are modified by the exercise order (i.e., aerobic exercise before or after resistance exercise) (2). In addition, aerobic exercise followed by resistance exercise (A-R) induces a large increase in the proliferator-activated receptor-γ coactivator-1α (PGC-1α) which regulates mitochondrial biogenesis than aerobic exercise alone (3). Concurrent training also improves cognitive function, and the degree of improvement is greater than aerobic training alone (4). However, it has not been clarified whether the order of concurrent exercise modifies exercise-induced improvement in acute cognitive function. Given the possibility that muscle PGC-1α is associated with acute neurotrophin increase (5), we hypothesized that the order of exercises in concurrent exercise modifies the degree of acute cognitive improvement. To test our hypothesis, we aimed to examine cognitive function after concurrent exercise with resistance exercise followed by aerobic exercise (R-A) and with A-R.

METHODS: Twelve healthy males (aged 21 ± 2 yrs; peak oxygen uptake [VO2 peak] = 47 ± 4 ml/kg/min; 1 repetition maximum [RM] = 120 ± 22 kg) performed trial for R-A and the trial for A-R in a within-subjects crossover posttest comparison design. Both trials consisted of a 20-min cycling exercise (60% VO2 peak; 148 ± 20 W) (6) and knee extension exercise of 6 sets of 10 repetitions (80% 1RM; 93 ± 16 kg) (7), which were separated by a 25-min rest interval. The reaction time and the response accuracy of color-word Stroop task as cognitive test was recorded 30-min after second exercise. The higher-order cognitive function (i.e., executive function [EF]) was estimated using the interference score calculated from reaction time. A paired t-test and the Wilcoxon signed-rank test were used to compare the response accuracy and EF at 30-min after second exercise between R-A and A-R trial.

RESULTS: There was no significant difference in response accuracy between both trials (R-A 91 ± 12 vs. A-R 91 ± 21 %, $P = 0.93$). EF (i.e., reaction time-based interference score) was better in the A-R trial than in the R-A trial (R-A 12.6 ± 6.0 vs. A-R 8.0 ± 5.1 %, $P = 0.02$).

CONCLUSION: This result shows that the degree of acute concurrent exercise-induced improvement in EF with A-R was better than with R-A. Because acute exercise-induced cognitive improvement may predict the long-term effects, habitual concurrent exercise with A-R may effectively improve EF and should be verified in the future.

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COMBINING PASSIVE ISOKINETIC EXERCISE AND ELECTROMYOSTIMULATION EFFORTLESSLY IMPROVES MUSCLE STRENGTH

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INTRODUCTION: Regular exercise is considerably difficult for those who are in inadequate environments for voluntary exercise or who are not good at exercise. The combination of isokinetic, passive, and easy exercise with electromyostimulation (EMS) may be an effective exercise that 1) does not require effort or voluntary strength, 2) is not difficult, 3) has a low risk of injury, and 4) can be performed while doing other things. We hypothesized that a completely passive isokinetic cycle (PIC) exercise combined with EMS improves muscle strength without any effort, make daily activities less strenuous, and increase the likelihood of inducing vigorous voluntary movement.

METHODS: Participants were 19 sedentary female university students and were divided into 2 groups. The EMS anterior group comprised 9 participants who performed the PIC exercise while EMS was applied to the anterior thigh muscles. The EMS whole group comprised 10 participants who performed the PIC exercise while EMS was applied to the whole thigh muscles. Both groups performed the PIC exercise without EMS 3 times a week for 3 weeks (week 1-3) followed by a 1-week break and then performed the PIC exercise with EMS 3 times a week for 3 weeks (week 4-6). They fully relaxed their muscles while pedaling at 40 rpm for 10 min. An exponential waveform of EMS (frequency: 20 Hz, pulse width: 260 μs) was superimposed on each target muscle of both legs. The intensity was set at 100% of the baseline value (approx. 2.5 mA) in week 4, 110% in week 5, and 120% in week 6. The effects of training were evaluated by measuring the 30 second chair stand test (CS-30), maximum isometric knee extension (MIKE) and flexion (MIKF) torque, muscle soreness, and kinesthesia in daily life before the start of week 1, and 3 days after the end of week 3 and week 6. None of the participants found the PIC exercise with EMS difficult or hard.

RESULTS: The PIC exercise without EMS in weeks 1 - 3 did not increase the CS-30 scores and decreased the MIKE and MIKF torque in both groups. None of the participants reported muscle soreness and changes in their kinesthesia in daily life after week 3. The PIC exercise with EMS in weeks 5 - 7 significantly increased the CS-30 scores, MIKE and MIKF torque in both groups. The MIKF torque was more significantly altered in the EMS anterior group. Most of the participants in both groups reported that they felt more comfortable with daily exercise after week 6. Muscle soreness was significantly greater in the EMS anterior group than in the EMS whole group after training, but it was not severe.

CONCLUSION: The results suggest that superimposing EMS on the thigh muscles during the PIC exercise improves leg muscle strength easily and effortlessly, leading the participants to a kinesthesia that makes moving feel lighter. In particular, the EMS superimposition on the whole thigh muscles may be able to produce training effects similar to those of the anterior thigh muscles with less muscle soreness.

ECCENTRIC CYCLING EXERCISE TRAINING ENHANCES AEROBIC/MUSCULAR FITNESS AND BIOENERGETIC EFFICIENCY OF T LYMPHOCYTES IN SEDENTARY MALES

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INTRODUCTION: Eccentric cycling exercise (ECE) features lower metabolic demand and higher improvement of muscle strength compared to traditional concentric cycling exercise (CCE). Mitochondria can regulate energy metabolism and adaptive immune quality in T lymphocytes. However, the effects of ECE on mitochondrial functions in T-lymphocytes have not yet been established. The study was to investigate the effects of ECE and CCE regimens on adaptive immune functions and mitochondrial bioenergetics of T lymphocytes in sedentary males.

METHODS: Eighteen healthy sedentary males were randomized and divided into ECE (n=9) and CCE (n=9) groups. These subjects progressively performed CCE or ECE from 60% to 80% maximal workload on a bicycle ergometer for 40 min/day, 5 days/week for 6 weeks. A graded exercise testing and an isokinetic strength test were conducted to evaluate cardiopulmonary fitness and muscle strength, respectively. Phenotypes and mitochondrial respiratory capacity in T lymphocyte were analyzed using flow cytometry and high-resolution respirometer, respectively. All statistical analyses were performed using two-way repeated measures ANOVA with Bonferroni post-hoc test.

RESULTS: After training for 6 weeks, there were significant increases in the VO2 values at anaerobic threshold (20.0 ± 1.6 vs. 25.6 ± 1.3 ml/min/kg, $p<0.001$) and maximal performance (31.8 ± 1.4 vs. 37.0 ± 1.6 ml/min/kg, $p<0.001$) in the CCE, compared to those in the ECE. Moreover, the ECE, rather than the CCE, regimen significantly improved maximal voluntary contraction in knee flexion (162.2 ± 7.4 vs. 184.3 ± 7.0 N-M, $p=0.021$) and extension (96.9 ± 5.4 vs. 111.9 ± 5.8 N-M, $p=0.010$). The ECE increased the percentage of effector memory T cell (CD45RO+62L-) in blood than the CCE (27.2 ± 1.8 vs. 40.5 ± 3.1 %, $p<0.05$). Additionally, the ECE produced a higher mitochondrial reserve respiration of intact T lymphocyte than the CCE (16.5 ± 1.8 vs. 24.1 ± 2.4 pmol/s/106 cells, $p=0.029$).

CONCLUSION: The ECE regimen effectively enhances aerobic/muscular fitness and simultaneously mobilizes more effector memory subsets into peripheral blood and improves mitochondrial reserve respiration in blood T lymphocyte. This study provides a suitable training strategy for improving either aerobic/muscular fitness or bioenergetic efficiency in T lymphocytes.

EXERKINES RESPONSE TO A SINGLE BOUT OF EXERCISE ACCORDING TO INTENSITY IN YOUNG MEN

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INTRODUCTION: Exerkines are exercise-induced bioactive hormones that contribute to beneficial effects on cardiometabolic homeostasis and neurological health. Exercise intensity is a potentially important regulator of various exerkines secretion, but the optimal exercise intensity (moderate vs. high intensity, and submaximal continuous vs. supramaximal interval) that increases and sustains exerkines levels in humans have not yet been fully elucidated. Therefore, this study aimed to examine the levels of circulating exerkines according to the intensity of exercise using a cycle.

METHODS: Ten healthy and active young men (24.3 ± 0.5 years old) voluntarily participated in this study. All participants performed 4 different experimental sessions at 1 week intervals, and the order of exercise sessions was randomly determined using a counterbalanced Latin square design. The experimental sessions consisted of the following 4 parts: 1) a control session (CTRL; no exercise); 2) moderate-intensity continuous exercise (MICE, 55% of heart rate reserve [HRR]); 3) vigorous-intensity continuous exercise (VICE, 85% HRR); and 4) high-intensity interval exercise (HIIE, four 30 s bouts of "all-out" cycling efforts [Wingate test] interspersed with 4 min recovery). Whole blood samples were collected intravenously at 4 different time points (pre-exercise, immediately post-exercise, 30 min post-exercise, and 90 min post-exercise). Serum concentrations of FGF-21, FSTL-1, BDNF, and cathepsin B were measured using ELISA kits.

RESULTS: Serum FGF-21 concentration was significantly higher in the HIIE group than in the MICE group immediately post-exercise ($P = 0.0306$). In addition, the serum FGF-21 concentration was significantly higher in the VICE and HIIE groups than in the CTRL group at 30 min post-exercise ($P = 0.0177$ and $P = 0.0369$, respectively). Serum FSTL-1 concentration was significantly higher in the HIIE group than in the CTRL and MICE group immediately post-exercise ($P = 0.0086$ and $P = 0.0157$, respectively). Serum BDNF and cathepsin B concentrations were significantly higher in the HIIE group than in the MICE group immediately post-exercise ($P = 0.0174$ and $P = 0.0385$, respectively). Furthermore, serum cathepsin B concentration was significantly higher in the VICE group than in the MICE group immediately post-exercise ($P = 0.0432$).

CONCLUSION: This study showed that acute HIIE effectively increased serum FGF-21 and FSTL-1 compared to CTRL and MICE. Furthermore, BDNF and cathepsin B secretion responses were more effective in the HIIE than in the MICE group immediately post-exercise. Therefore, the secretion of exerkines, including FGF-21, FSTL-1, BDNF, and cathepsin B may be exercise intensity-dependent.

EFFECTS OF CAFFEINE SUPPLEMENTATION AND ZUMBA TRAINING ON FUNCTIONAL PERFORMANCES IN MIDDLE-AGED WOMEN

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INTRODUCTION: As a consequence of aging and menopause, functional issues and disability are burdens for middle-aged women. Importantly. Zumba, as one of the most successful and popular dance-fitness programs especially for women, was proved to enhance functional capacity (i.e. cardiorespiratory fitness, walking speed, body composition, muscle strength and endurance, and dynamic balance) in women with or without clinical conditions (Arol, 2020; Barene et al., 2016; Donath et al., 2014; Kolayiş & Arol, 2020; Oktay, 2018). Despite all these Zumba training benefits, no data about Zumba effect on functional performance in middle-aged women was available. Additionally, caffeine is widely recommended as a useful strategy to enhance performance during daily living tasks in older adults (Cherniack, 2012). Combining physical activity and nutritional supplementation (as caffeine) has been proven to have additional effects on muscle mass and function as well as health-related quality of life (Rondanelli et al., 2016). While these beneficial effects of Zumba have been evidenced in different populations, to the best of our knowledge, there is still a paucity of data on this training modality in middle-aged women. This study aimed to explore the effect of daily caffeine supplementation (100mg/day) combined with a Zumba training program for 12-week on functional performances in middle-aged women.

METHODS: Seventy-nine healthy middle-aged women, aged between 50 to 60 years, were randomized into a caffeine-Zumba group (CZG), a Zumba group (ZG) and a control group (CG). Functional performances were assessed in two test sessions, before and after the intervention period, using 10m Walk test for walking speed, Timed Up and Go test for functional mobility, Functional Reach test for dynamic balance and 30-Second Chair Stand test for lower body strength.

RESULTS: Both Zumba and caffeine-Zumba training programs showed a significant functional performances improvement (mobility (CZG: $p<.0001$; ZG: $p<.05$); gait speed (CZG: $p<.0001$; ZG: .005); lower body strength (CZG: $p<.0001$; ZG: $p<.0001$) and dynamic balance (CZG: $p<.0001$; ZG: $p<.005$) with large effect size. However, CZG showed significantly ($p<.05$) better functional performances scores in terms of mobility, gait speed and lower body strength except for dynamic balance.

CONCLUSION: Supplementing caffeine (100mg/day) to a Zumba training program was effective in boosting Zumba benefits on functional performances in terms of mobility, gait speed and lower body strength in middle-aged women. Clinicians may, therefore, consider such a combination while designing intervention strategies for middle-aged women to improve their functional performances during performing daily physical activities, and therefore to achieve healthy aging.

EXERCISE-INDUCED MUSCLE DAMAGE AND RECOVERY IN YOUTHS; A META-ANALYTICAL COMPARISON

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INTRODUCTION: Exercise-induced muscle damage (EIMD) is a by-product of high volume, eccentrically biased or unaccustomed exercise. An understanding of how the peak magnitude of EIMD in youths compares to adults could help practitioners when scheduling high volume and eccentric exercise in youths. The aim of this meta-analysis was to provide a comparison of peak changes in indirect markers of EIMD in youth versus adults.

METHODS: Three data sources (Google Scholar, PubMed and Sport Discus) were searched from July 2022. Studies were eligible for inclusion if they 1) provided a youth versus adult comparison, 2) provided muscle strength, soreness or creatine kinase (CK) markers beyond ≥ 24 hours, 3) did not provide a recovery treatment or included a treatment free control group, 4) was performed in humans. An inverse-variance random-effects model for meta-analyses was employed because it allocates proportionate weight to comparisons based on the size of their individual standard errors whilst accounting for heterogeneity across studies. Effect sizes (ES) were represented by the standardised mean difference and presented alongside 95% confidence intervals.

RESULTS: Fourteen comparisons from 12 individual studies were included in the analysis; nine included a marker of muscle function, 11 included a marker of muscle soreness and nine measured CK. The main effects for strength (ES= 2.01, 95% CI range = 1.08 to 2.95, Z= 4.20, P <0.001), muscle soreness (ES = -1.52, 95% CI range = -2.15 to -0.90, Z= -4.76, P <0.001) and CK were (ES = -1.98, 95% CI range = -2.93 to -1.04, Z= -4.13, P <0.001) indicated greater peak changes in adults than youths.

CONCLUSION: The magnitude of EIMD as determined by changes in muscle strength, muscle soreness and CK is substantially less in youths compared to their adult counterparts. These findings provide insight and encouragement to practitioners who may be concerned about the potential impact of EIMD on youth athletes specifically.

Conventional Print Poster

CP-AP14 Endurance Training

CHANGES IN CARDIORESPIRATORY FITNESS FOLLOWING EXERCISE TRAINING PRESCRIBED RELATIVE TO PHYSIOLOGICAL THRESHOLDS AND TO TRADITIONAL INTENSITY ANCHORS: A META-ANALYSIS OF INDIVIDUAL PARTICIPANT DATA

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INTRODUCTION: Exercise intensity is commonly prescribed relative to traditional (TRAD) intensity anchors such as maximum oxygen uptake (VO2max). Such approaches, however, elicit marked variation in exercise tolerance and physiological responses among individuals. This may explain a portion of the response variability observed in VO2max following training. Prescribing exercise intensity relative to physiological thresholds (THR) is shown to better normalise exercise intensity, creating a more homogenous exercise stimulus. Prescribing exercise intensity instead to physiological thresholds may thus elicit more homogenous changes in VO2max following a period of training.

METHODS: Electronic databases were searched for original articles using a predefined search strategy. Authors of studies meeting the inclusion criteria (N=206) were invited to share individual participant data (IPD). Data was received for 38 studies resulting in IPD for n=1422 participants. The dataset was divided into: controlled studies (N = 4), which contained volume-matched exercise groups (THR: n=46; TRAD: n=44) as well as non-exercise control groups (CON; n=49); and non-controlled studies (N=38), where data from any single THR and TRAD exercise group was included. A Bayesian approach with multi-level distributional models was used to separately analyse relative VO2max change scores from the two datasets where we: a) compared the difference in mean change scores between THR and TRAD exercise groups (plus CON group in the 2-ARM analyses), b) compared the proportion of individuals expected to increase CRF beyond a minimum clinically important difference (MCID: 3.5 ml/kg/min) following THR and TRAD (plus CON group in the 2-ARM analyses), c) tested the hypothesis that VO2max response variability is lower in THR compared to TRAD, and d) explored whether there was any evidence of inter-individual differences in trainability. Inferences were made using Bayes factors (BF).

RESULTS: In the controlled studies mean change scores were greater in THR compared to TRAD (4.1 vs 1.8 ml/kg/min, BF:>100). Individuals were 48% more likely to experience an increase in CRF > MCID in THR compared to TRAD. There was no difference in the standard deviation of change scores between THR and TRAD (1.5 vs 1.7 ml/kg/min, BF: 0.55), but greater variation in THR and TRAD combined compared to CON (1.9 vs 1.3 ml/kg/min, BF: 12.4). Similar results were obtained in the non-controlled studies with greater mean changes in THR compared to TRAD (4.6 vs 3.4 ml/kg/min, BF: 63.3) but no difference in standard deviation (2.9 vs 3.2 ml/kg/min, BF: 0.41).

CONCLUSION: Prescribing exercise intensity using THR approaches elicited superior mean changes in VO2max and increased the likelihood of experiencing increases in CRF exceeding the MCID compared to when TRAD approaches were used. There was no difference in variation between THR and TRAD exercise training, however, there was evidence of trainability whereby variation in THR and TRAD exceeded that of controls.

CHANGES IN THE MAXIMAL RATE OF HEART RATE INCREASE IN RESPONSE TO OVERLOAD TRAINING ARE LINEARLY RELATED TO SUBSEQUENT CHANGES IN EXERCISE PERFORMANCE

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INTRODUCTION: The maximal rate of heart rate increase (rHRI) during the transition from rest to light exercise has shown to be linearly related to exercise performance across different training phases. As a result, it has been proposed that rHRI could be used to guide training, but for this to be the case changes in rHRI during training would need to be related to subsequent adaptations in exercise performance.

METHODS: Five-minute cycling time trial performance (5CTT) and rHRI were assessed in 112 male cyclists after six days of light-training (LT), 13 days of heavy-training (HT) and a 13-day recovery taper (T).

RESULTS: rHRI was linearly related to 5CTT within-individuals across LT, HT and T (B = 0.02, 95% CI 0.004 to 0.04, p=0.02). Percent change in rHRI from LT to HT (overload period) was linearly related to subsequent percent change in 5CTT performance by the end of T (B= 0.037, 95% CI 0.002 to 0.072, p=0.04). In 13 non-functionally overreached (NFOR) participants rHRI decreased from LT to HT compared with those who were functionally overreached (FOR) (NFOR = -3.96 ± 35.95%; FOR = 18.17 ± 32.59% p=0.04). A 9.2% reduction in rHRI was associated with an increased risk of NFOR (OR 1.02; 1.0009 – 1.05, p=0.04).

CONCLUSION: A faster rHRI after overload training was related to improvements in performance following a period of recovery and adaptation, while reductions in rHRI were associated with less improvement or an increased risk of NFOR. rHRI could be used to guide training to optimise performance.

THE RELATIONSHIP BETWEEN RUNNING ECONOMY AND RUNNING PERFORMANCE AND STRIDE PARAMETERS

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INTRODUCTION: Training aimed at enhancing running economy (RE) has been conducted in the field to improve running performance. Stride parameters such as stride frequency (SF) and stride length (SL) are components of RE. Recently, SL and SF have been assessed noninvasively and simply using wearable devices. If RE and running performance are related to stride parameter constants, they can be measured on a regular and continuous basis. This study aimed to determine the relationship between stride parameters, RE, and running performance at various velocities.

METHODS: This study was conducted with 36 runners, recording the results of the incremental running test and those of the JAAF-approved 5000 m race. Experiments were conducted during the summers of 2021 and 2022. For the 5000 m race, the highest record within two weeks before and after the incremental running test was used as the seasonal best time (SB). Nine runners were able to track all data for both years. The incremental test was divided into two parts with a five-minute rest: the first test consisted of three minutes of running divided by a two-minute rest, with each stage increasing by 1.2 km/h until the blood lactate concentration (bLa) exceeded four mmol. The first test was set to the personal best running pace of 10000 m in the fifth stage. The participants ran in five to six stages. The second test contained no rest period and was performed at an acceleration of 0.6 km/h per minute from the velocity at which bLa was observed to be four mmol. SF was measured using a stride sensor attached to a shoe strap. SL was calculated by dividing the treadmill velocity by the SF. The relative stride length was calculated by dividing the stride length by the height (SL/H). The velocity at which all the subjects ran with a bLa of less than four mmol was 16.8 km/h. A 16.8 km/h stride parameter and RE were used in the analysis.

RESULTS: SF, SL, and SL/H were correlated with RE and SB ($r = 0.40$, $r = -0.43$, and $r = -0.41$, $p < 0.05$, respectively). No changes in stride parameters could be identified in runners that could be tracked. No significant differences from the previous year were identified in RE and SB in the nine trackable runners. No significant relationship was identified between changes in SF and SL, and changes in RE and SB.

CONCLUSION: This result is contrary to that of Ruiter et al. (2014), who reported that a higher SF utilizes more elastic energy. Traditionally, runners do not wear high-cushion carbon fiber plate (CFP) shoes. Highly cushioned CFP shoes have been reported to improve RE while extending the SL (Hoogkamer et al., 2017). The runners in the present study wore high-cushion CFP shoes, and the relationship between SF, SL, and RE may differ from previous studies. In conclusion, athletes with a larger SL/H have superior RE, which may lead to higher performance in 5000 m running.

INFLUENCE OF STRIKE PATTERN ON RUNNING ECONOMY IN RUNNERS OF DIFFERENT ABILITIES

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INTRODUCTION: Running economy (RE) is influenced by multiple factors, such as running biomechanics. Several studies had evidenced the beneficial effect of running biomechanics on RE. The results have shown benefits on low vertical oscillation, minus 3% self-selected step length, barefoot or lightweight shoes. Currently, there is still some controversy about the influence of strike pattern on RE. Therefore, the aim of this study was to analyse the influence of strike pattern and spatiotemporal variables on RE in two group of runners (trained and recreational runners).

METHODS: A total sample of 27 runners, divided into 2 groups based on performance levels (14 trained and 13 recreational runners) were individually evaluated in a single visit. Two consecutive 3-minute intervals were performed at different submaximal speeds depending on their performance level (13 and 17 km·h-1 for trained group; 9 and 13 km·h-1 for recreational group). Energy cost (EC) and oxygen consumption (VO2), as well as spatiotemporal variables (contact time, flight time, step length, step frequency, vertical oscillation) and strike pattern (fore-foot strike, mid-foot strike, heel strike) were measured using the Stryd® Power Meter device and Runmatic® mobile application. To prevent the influence of shoe characteristics on strike pattern, all runners used the same shoe model during the test.

RESULTS: As the most relevant result, no significant differences were found in RE according to the type of runner's strike pattern between the two performance groups. At the common speed in both groups (13 km·h-1), trained runners had lower RE than recreational runners (p=0.003); however, no significant differences were observed between strike patterns (p=0.577). Trained runners that used a forefoot pattern presented lower RE than trained runners using a rearfoot pattern (p=0.003). The RE assessed as VO2 showed no significant differences depending on the performance group, strike pattern, or the interaction performance * strike pattern.

CONCLUSION: It seems that strike pattern has lower influence on RE. Therefore, we would not recommend a specific strike pattern for RE improvement. In that case, coaches should not attempt to improve performance by modifying the spontaneous strike pattern of endurance runners. Despite not having found significant differences in RE, the strike pattern remains a fundamental component for measuring running performance maybe with a clinical or injury prevent purposes.

Based on these findings, trained runners seem more economical than recreational runners, with no clear influence of the strike pattern to explain these differences.

THE ACUTE EFFECT OF HIGH-INTENSITY TRACK RUNNING ON NON-LINEAR ANALYSIS OF HEART RATE VARIABILITY

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INTRODUCTION: Recently, a non-linear index of heart rate variability (HRV) - detrended fluctuation analysis alpha 1 (DFAa1) - has been investigated as a metric to delineate exercise intensity domains and to quantify physiological disturbances following prolonged exercise. For example, DFAa1 values of 0.75 and 0.5 coincided with the first and second ventilatory thresholds during incremental exercise, respectively [1], and an attenuation of DFAa1 was observed following completion of an ultramarathon [2]. It remains unknown whether DFAa1 responds similarly to short-duration, high-intensity exercise. The purpose of this investigation was to evaluate DFAa1 measures during severe intensity running and to determine the subsequent effect of intense exercise on DFAa1 measures during moderate intensity outdoor running.

METHODS: During three separate visits to a 400m outdoor athletic track, 10 trained runners (mean[SD]; 7M, 3F; 29[7] years; 59.0[4.2] ml/kg/min) performed maximal running time trials (TT) at distances between 1200-4400m. Prior to (PRE) and 5-min following (POST) each TT, runners performed 800m of track running at a running speed of 2.36 m/s. During all running trials, heartbeat RR-interval (RR) data were recorded (H10, Polar Electro Oy, Kempele, Finland). After preprocessing, DFAa1 values were calculated every 10 seconds throughout each trial using 2-min RR data series, using a window width of 4 >= n >= 16. The average calculated DFAa1 during each trial was used for analysis. A one-way repeated measures ANOVA was used to examine differences in DFAa1 measures across the three TT intensities. A two-way repeated measures ANOVA (time x intensity) was used to examine differences in DFAa1 measures between PRE and POST and across intensities.

RESULTS: Average running speeds during the 1200m, 2400m, 3600-4400m TTs were 4.8[0.4] m/s, 4.3[0.4] m/s, and 4.2[0.4] m/s, respectively. Average DFAa1 measures during the 1200m (0.56 [0.15]), 2400m (0.54 [0.13]) and 3600-4400m (0.54 [0.15]) TTs were not significantly different (p=0.528; n=9). No significant time x intensity interaction effect (p=0.084) or main effect of intensity (p=0.305) for DFAa1 measures was detected. However, a main effect of time for DFAa1 was detected, indicating that POST DFAa1 (0.69 [0.20]) measures were significantly lower than PRE DFAa1 (1.12 [0.22]) measures (p=0.001; n=10) at the same intensity.

CONCLUSION: Average DFAa1 measure during all three TTs were greater than 0.5, suggesting that DFAa1 measures below 0.5 - as previously suggested [1] - may not appropriately delineate the severe exercise intensity domain during high intensity running. However, an attenuation in DFAa1 measures following high intensity running suggests a disturbance in autonomic control of HRV that may indicate physiological perturbation induced by intense running exercise.

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DECREMENTAL EXERCISE PROTOCOL AS A TRAINING STIMULUS: MORE OR LESS EFFICIENT THAN TRADITIONAL HIGH-INTENSITY INTERVAL TRAINING?

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INTRODUCTION: A high-intensity interval sessions based on decremental exercise loads (DEC) has been shown to elicit higher levels of physiological perturbation in trained cyclists compared to a traditional, even-paced session (TRA). This

study tested whether a training period including either DEC or TRA would lead to differences in performance increments during a 40-km time-trial (TT40) in well-trained cyclists.

METHODS: On separate visits, twenty cyclists performed an incremental test to determine peak power output (PPO), the lactate threshold (determined using Dmax), maximal cardiac output (using thoracic bioimpedance) and maximal oxygen uptake (VO2max), plus a TT40 on an ergometer, which was preceded by a standardized warm-up used to determine gross efficiency. All testing was repeated to account for any familiarization effects (Baseline). Both groups performed 4-weeks of supervised high-intensity training in the laboratory (3 x per week). The sessions consisted of 4 x 4 min intervals at 80% of PPO with 3 min of active recovery in between. Power output was held constant for every bout within TRA (N = 10, 3 female) whereas power started 40 W higher and finished 40 W lower than average within each bout of DEC (N= 10, 2 female). Training loads during the 4-week period were adjusted based on physiological and perceptual responses during the preceding session and the warm-up of the day, which was kept constant throughout the training period. At least 48 h after the last training session, participants returned to the laboratory for post training assessments (POST). All comparisons were performed using 2-way ANOVA (factors time and group) with significance set at $P < 0.05$.

RESULTS: There was no difference in time spent above 90% heart rate max per supervised session between the groups (12.1 ± 3.9 vs. 11.3 ± 2.7 min for DEC and TRA respectively, P = 0.603). TT40 performance significantly improved from PRE to POST training (factor time, $P < 0.001$), with a 1.3% reduction in time in DEC (64.63 ± 4.75 vs. 63.79 ± 4.80 min) and a 2.9% in TRA (66.12 ± 5.36 vs. 64.17 ± 5.54 min). This difference was not significant between the groups (group * time interaction P = 0.122). PPO (factor time P= <0.001) as well as power at the lactate threshold (factor time P = 0.002) increased from PRE to POST training, again without differences between the two groups. Neither VO2max, peak cardiac output nor gross efficiency showed significant differences following the training program.

CONCLUSION: Both DEC and TRA interventions were effective in enhancing TT40 performance. Performance improvements seemed related to the ability to sustain a higher percentage of maximal VO2max during the time-trials, as seen from the higher power at the lactate threshold, rather gains in efficiency or aerobic capacity. Contrary to our hypothesis, high-intensity interval training based on decremental loads did not lead to further gains in performance compared to a traditional, even-paced approach.

RESTRICTED NASAL-ONLY BREATHING STIMULATES VENTILATORY EFFICIENCY DURING LOW INTENSITY TRAINING BUT DOES NOT AVOID TRAINING INTENSITY FLUCTUATION

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INTRODUCTION: Low-intensity endurance training is frequently performed at gradually higher training intensities than intended, resulting in a shift towards threshold training. By restricting oral breathing and only allowing for nasal breathing this shift might be reduced and ventilatory efficiency may be trained.

METHODS: N = 19 physically healthy adults (3 females, age: 26.5 ± 5.1 years; height: 1.77 ± 0.08 m; body mass: 77.3 ± 11.4 kg; VO2peak: 53.4 ± 6.6 ml·kg−1·min−1) performed two 60 min sessions of self-paced low-intensity cycling with breathing restriction (nasal-only breathing; induced by a strip of tape applied over the mouth) and without restrictions (oro-nasal breathing) in a randomized order. During these sessions, heart rate, respiratory gas exchange data and power output data were recorded continuously. Furthermore, capillary blood lactate was obtained every ten minutes (T10-T60).

RESULTS: No significant condition x time-effects were found for power ($F(1.5, 22.7) = 1.42$, $p[GG] = 0.26$, $\eta p2 = 0.09$) and cadence ($F(3.0, 44.7) = 2.27$, $p[GG] = 0.09$, $\eta p2 = 0.13$). For blood lactate concentrations, a significant and large condition x time-interaction effect was found ($F(3.2, 57.1) = 3.61$, $p[GG] = 0.02$, $\eta p2 = 0.17$) with lower values during the nasal-only compared to the oro-nasal breathing condition towards the end of the session (T50: 1.21 ± 0.52 vs. 1.48 ± 0.59 mmol·l-1, $p = 0.01$, SMD = 0.49 & T60: 1.21 ± 0.47 vs. 1.45 ± 0.52 mmol·l-1, $p = 0.02$, SMD = 0.48). VO2 showed significant and large main effects for both time ($F(1.7, 31.1) = 5.73$, $p[GG] = 0.01$, $\eta p2 = 0.24$) and condition ($F(1, 18) = 5.49$, $p = 0.03$, $\eta p2 = 0.23$), indicating higher values for the oro-nasal training session. In terms of gross efficiency, simple main effect analysis for time revealed large effect sizes ($F(1.9, 29.2) = 37.9$, $p < 0.001$, $\eta p2 = 0.72$). Although main effect analysis for condition did not show statistical significance ($F(1.0, 15.0) = 3.7$, $p = 0.075$, $\eta p2 = 0.20$), pairwise comparison between time points indicated small to moderate effects with higher values for the nasal-only condition ($0.24 \leq SMD \leq 0.31$). Nevertheless, heart rate based calculations of the time in training zones did not reveal significant effects (Zone 1: ($F(1, 18) = 0.03$, $p = 0.85$, $\eta p2 = 0.00$); Zone 2: ($F(1, 18) = 0.14$, $p = 0.71$, $\eta p2 = 0.01$); Zone 3: ($F(1, 18) = 0.19$, $p = 0.67$, $\eta p2 = 0.01$).

CONCLUSION: Although nasal-only breathing seems to stimulate ventilatory efficiency, it does not prevent participants from performing low-intensity training at higher intensities than intended. Longitudinal studies are warranted to evaluate longitudinal responses of changes in breathing patterns.

EFFECT OF HYPOBARIC "LIVE HIGH – TRAIN LOW" TRAINING ON BLOOD PARAMETERS IN ELITE TRACK CYCLISTS.

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INTRODUCTION: By combining hematological adaptations to chronic hypoxia benefits, while avoiding the hypoxia-induced reduction of maximal training intensity, "Live High – Train Low" (LHTL) has popularly grown to be a common hypoxic training practice in elite endurance sport disciplines [1]. However, despite arguably being the "gold standard" of altitude training for sea-level competition, its validity and effect, particularly within elite athletes with a high natural hemo-

globin mass (Hb(mass)), remain debated [2]. Hence, the purpose of this case-study was to evaluate the effect of LHTL on blood parameters in elite track cyclists.

METHODS: Four Swiss male national team track cyclists (age: 24.9 ± 2.1 years; relative VO2max: 73.3 ± 3.8 ml/kg/min; relative Hb(mass): 14.7 ± 1.0 g/kg) underwent a typical 23-day hypobaric LHTL altitude training intervention, residing in hypobaric hypoxia (2309 m) and training between 440 m and 1850 m. Hematological parameters were assessed with duplicate measures before (PRE) and after (POST) the intervention with a modified version of the carbon monoxide rebreathing technique [3]. Blood oxygen saturation (SpO2), body weight, subjective sleep quality, and subjective training quality were recorded daily. Training, as well as nutrition and hydration were individualized, adapted and optimized according to these parameters. Athletes' ferritin levels were assessed two weeks pre-altitude, and were thenceforth supplemented with 138 mg elemental iron three times/week until the end of the intervention.

RESULTS: From PRE to POST, the total Hb(mass) increased by 8%, from 1097 ± 111 g to 1185 ± 143 g ($p = 0.01$). Similarly, the red blood cell volume increased by 6% from 3294 ± 295 ml to 3518 ± 397 ml ($p < 0.05$). Pre-altitude ferritin levels were 82.0 ± 9.1 µg/L. Mean SpO2 the first four and last four days were 93.6 ± 0.9% and 95.05 ± 1.29% ($p > 0.05$), respectively. The body weight remained stable from PRE to POST (74.5 ± 3.5 kg vs 73.9 ± 4.6 kg, $p > 0.05$).

CONCLUSION: A 23-day LHTL sojourn at 2309 m induced large improvements in hematological values in elite endurance athletes, despite already high natural Hb(mass) values. This underlines the importance of both individualizing all possible parameters as well as maximizing the altitude dosage (high altitude and sufficient time spent at altitude) in order to trigger erythropoietic adaptations.

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AMATEUR FEMALE ATHLETES PERFORM THE RUNNING SPLIT OF A TRIATHLON RACE AT A HIGHER RELATIVE INTENSITY THAN THE MALE ATHLETES: A CROSS-SECTIONAL STUDY

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INTRODUCTION: In spite of the increase in female interest on endurance sports, such as triathlon [1], the majority of studies on this subject are restricted to male athletes [2]. Therefore, the aim of the study was to evaluate the differences between male and female triathletes considering the physiological variables that are commonly used predictors of endurance performance, such as: the ventilatory threshold (VT), respiratory compensation point (RCP), and the percentage of the maximal aerobic speed (MAS) that they can maintain in a triathlon race.

METHODS: Forty-one triathletes (22 men and 19 women) that had at least three years of experience in the triathlon practice and raced the same Olympic triathlon underwent a cardiorespiratory incremental maximal test using a treadmill (Inbrasport, ATL, Porto Alegre, Brazil). The VO2, VCO2, O2 end-tidal pressure (PET O2), CO2 end-tidal pressure (PET CO2) and minute ventilation (VE) were measured to assess their VT, RPC, and MAS, and compare them to the race speed.

RESULTS: The absolute (4.00±0.52 vs. 2.89±0.40 L/min, $p < 0.001$) and relative to body mass maximal oxygen uptake (VO2 max) (54.0±5.1 vs. 49.8±7.7 ml/kg/min, $p < 0.001$) and MAS (17±2 vs. 15±2 km/h, $p=0.001$) were significantly higher in male than in female athletes. Conversely, there were no sex differences according to the percentage of VO2 max reached at VT (74.4±4.9 vs. 76.1±5.4%, $p = 0.298$) and RCP (89.9±3.6 vs. 90.6±4.0%, $p = 0.560$). However, the speeds at VT (11.8±1.1 vs 10.7±1.5 km/h, $p = 0.021$) and RCP (14.3±1.2 vs 12.8±1.6 km/h, $p = 0.001$) were higher in male athletes. Also, the mean speed during the race also did not differ between men and women (12.1±1.7 km/h and 11.7±1.8 km/h, $p=0.506$, respectively). Finally, men performed the running split at a lower percentage of speed at RCP than women (84.0±8.7 vs. 91.2±7.0%, respectively, $p = 0.005$).

CONCLUSION: Despite showing no differences according to the VT and RCP in the percentage of VO2 max values, male and female athletes accomplished the running split in an Olympic triathlon distance at distinct relative intensities, as female athletes run at a higher relative intensity (a higher RCP percentage). These finding can be useful for coaches and athletes to design the strategy for a triathlon race that may be different for each sex.

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100 000 STEPS DAILY FOR MORE THAN A YEAR: MORPHOLOGICAL AND FUNCTIONAL (DIS)ADAPTATIONS OVER AN EXTREME ULTRARUNNING CHALLENGE

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INTRODUCTION: While sport enthusiasts such as ultra-endurance athletes strive for very high daily exercise energy expenditures, the side-effects of excessive training volume may eventually abolish the benefits e.g. by precluding the continuation of regular physical activity. The aim of the study was to follow the morpho-functional (dis)adaptations of a male runner in response to an extreme ultrarunning challenge.

METHODS: A highly experienced male ultra-distance runner (49 yrs) undertook a challenge of running around the globe (>30 000 km) and covering the longest ever distance on foot during a year. The challenge was preceded by regular running (~120 km/wk) and resistance training (up to 10 h/wk). Due to travelling restrictions, it was mainly performed in Lithuania (mostly on flat asphalt roads, temperatures ranging from –25 to +33 °C). Distances were recorded using a GPS watch and data were transferred on Strava. Various morphological and functional parameters were measured before, during and after the race.

RESULTS: Daily distances ranged from ~80 km during first weeks, to ~60 km in the middle, and to ~70 km towards the end of the challenge, totaling 30303 km in 444 days. During the first 12 months, the subject ran ~25 000 km. Body mass was reduced by 7 % (4 kg) within the first month and remained stable afterwards. % body fat estimated from skinfold thickness dropped from 13.5 % to 10 % at the end of the challenge. Compared to baseline, plasma creatine kinase activity (CK) soared to ~15-fold during the first few weeks and remained elevated by ~4-fold afterwards. Other blood markers (except ferritin) remained largely unchanged. Baseline ultrasound (US) examination revealed multiple but mostly mild lesions in the knees and ankles of both legs. Most of them remained morphologically stable, but some, especially those in the left leg, exacerbated in the middle and/or by the end of the challenge. After ~14 000 km (i.e., ~200 days), pain appeared in the lower left leg and a tibial stress fracture was confirmed by US and MRI. Although the subject maintained a roughly similar training load (i.e., distance and speed), the pain gradually decreased and no lesions were visible at the post-race examination. Post-race US-measured m. quadriceps thickness was reduced by 12 % in the left and by 6 % in the right leg, with ~20 % decrease in voluntary and electrically stimulated knee extension torques of both legs, and vertical jumping ability and muscle power were severely compromised. No changes in either absolute cardiac size and function (US, MRI) or size of the parenchymal organs (except for a slight liver enlargement at the end of the run) have been observed.

CONCLUSION: This case study proved that highly increased energy turnover with ~9 hours of daily running is feasible for periods extending beyond a year. Even though some lesions in the legs seem inevitable with such large daily running distances, these do not preclude the continuation of the activity in an athlete with high intrinsic motivation.

Conventional Print Poster

CP-BM11 Neuromuscular Physiology I

NEURAL ADJUSTMENTS DURING REPEATED BRAKING AND THROTTLE ACTIONS ON A MOTORCYCLE SETUP

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INTRODUCTION: Previous work indicates a progressive increase in muscle activity, as assessed by surface electromyography (EMG), during submaximal intermittent fatiguing protocols (IFP) (1, 2). However, the recording of surface EMG alone does not permit to assess the potential neural (spinal vs. supraspinal) mechanisms that limit the endurance time (TLim). In that context, the recording of both the Hoffmann (H) reflex and the maximal M-wave (Mmax) can provide relevant information on neural changes at spinal level during the time course of a fatiguing contraction (3, 4). Furthermore, as the neural adjustments observed during a fatiguing contraction are specific to the details of the task performed (5), it is necessary to assess the fatigue-related mechanisms as much as possible during ecological protocols. This study aimed to assess the acute neural adjustments during an IFP designed to replicate the fundamental actions and ergonomics encountered when riding a motorcycle.

METHODS: Twenty height participants repeated a sequence of six submaximal brakes-pulling (0.6 duty cycle) and two gas throttle actions, interspaced by one 3-s maximal brake-pulling (MVC), until failure. During the submaximal brakes-pulling actions performed at 30% of MVC, force fluctuations (FF), EMG root mean square (RMS30), and elicited Mmax and H reflex responses were measured in the flexor digitorum superficialis (FDS).

RESULTS: At the end of the IFP (1975 ± 813-s), the MVC force and the associated RMS (RMSMVC) of the FDS decreased ($P<0.001$) by 46% and 26%, respectively. During the IFP, the FF and RMS increased gradually (106% and 61% respectively) with respect to the pre-fatigue state ($P<0.029$ for both parameters). The Hmax amplitude increased by 49 % ($P<0.039$) without significant change of the Mmax first phase amplitude ($P>0.524$). Noteworthy, the relative increase in H-reflex amplitude (Hmax/Mmax) was positively correlated with changes in RMS values during the IFP ($r=0.68$; $P<0.001$).

CONCLUSION: The results suggest that an IFP mimicking brakes-pulling and gas throttle actions observed during race motorcycling induces a gradual decrease in MVC force production capacity and its associated RMS/MVC, possibly due to a derecruitment process (6). The increment of the Hmax/Mmax ratio suggests that the spinal reflex pathway and the motoneurone excitability were not a limiting factor of TLim. The fact that the FDS muscle activity (RMS30) reached at TLim was only 55% of the prefatigued MVC activity, in absence of noticeable peripheral propagation failure (Mmax), support the hypothesis of a fatigue- induced deficit in supraspinal activation.

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DOES EXTRA FORCE OCCUR DURING WIDE-PULSE, HIGH-FREQUENCY NEUROMUSCULAR STIMULATION ON WRIST FLEXORS COMPARED WITH CONVENTIONAL STIMULATION ?

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INTRODUCTION: In contrast to conventional (CONV) neuromuscular electrical stimulation (NMES), the wide-pulse, high-frequency (WPHF) NMES can generate a progressive increase in force when delivered at a low and constant stimulation intensity (1,2,3). This phenomenon called "extra force" (EF) has been mainly attributed to the recruitment of sensory axons in addition to the direct recruitment of motor axons (4). To this day, EF development has been mainly studied in lower limb muscles (1,2), while only one study conducted in patients with neurological impairments investigated EF in upper limb (5). Here, we aim to compare forces evoked by CONV and WPHF NMES of the flexor carpi radialis muscle (FCR).

METHODS: In this experiment, fourteen healthy participants (age: 28 ± 6 years) took part in one session consisting of two NMES protocols targeting the FCR: WPHF (100 Hz, 1ms) and CONV (20 Hz, 0.05 ms). Two electrodes were placed over the FCR belly. For each protocol, contractions were evoked at a stimulation intensity eliciting an initial force corresponding to 5%, 10% and 20% of maximal palmar flexion during 10 s. For each contraction, real force-time integral (i.e. FTI resulting from the NMES, FTIr) and theoretical FTI (i.e. calculated by multiplying FTIr measured during the first second of NMES by the duration of the evoked contraction, FTIth) were measured. A FTIr/FTIth > 1 indicated EF development (4).

RESULTS: The results revealed a condition (P = 0.006) and intensity (P = 0.001) effect on EF (WPHF, 5%: 0.87, 10%: 0.95, 20%: 1.00; CONV, 5%: 1.07, 10%: 1.1, 20%: 1.11). EF was significantly higher during CONV than WPHF, and EF was significantly lower during 5% compared to 10% and 20%.

CONCLUSION: These results showed that EF only occurred during CONV. In contrast, the FTIr/FTIth < 1 observed during WPHF suggests a progressive decrease in force in response to WPHF. In the same way, a decrease in force has already been reported during submaximal electromyostimulation at high frequency stimulation (6). Therefore, in contrast to what has been observed in lower limb, this absence of EF during WPHF suggests that muscle stimulation of FCR induced a reduction in the recruitment of motor units due to 1) fatigue of the activated motor units and/or 2) changes in axonal excitability threshold.

CORTICOSPINAL EXCITABILITY OF THE TRICEPS BRACHII FOLLOWING HIGH-VELOCITY CONCENTRIC CONTRACTIONS: EXTENDING OUR UNDERSTANDING OF PERFORMANCE FATIGABILITY

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INTRODUCTION: Muscle fatigue is often induced and characterized by isometric contractions, with reductions in maximal torque accompanied by alterations in cortical and motoneuronal excitability. Despite the task-dependent nature of fatigue, little is known regarding fatigue-related alterations in excitability at the cortical and motoneuronal levels as a result of repetitive, dynamic contractions. The purpose of this study was to explore the fatigue-related effects of high-velocity elbow extensions on cortical and motoneuronal excitability of the triceps brachii.

METHODS: Although data collection is ongoing, to date, five healthy participants (age:31+/-7 years; height:168.8+/-12.2cm; mass:67.2+/-8.5kg) performed a fatiguing task that included 2 sets of 60 isotonic-like elbow extensions against a resistance set to 30% of maximal voluntary isometric contraction (MVC) torque. Performance fatigability was characterized via a reduction in peak power during the dynamic task, as well as a change in MVC torque with voluntary activation (VA) from baseline to 30s following task termination. Neural excitability was assessed before and immediately following task termination via triceps brachii surface electromyography (EMG). Motor evoked potentials (MEPs) from transcranial magnetic stimulation, cervicomedullary motor evoked potentials (CMEPs) from transmastoid electrical stimulation, and maximal compound muscle action potentials (Mmax) from brachial plexus electrical stimulation were recorded during brief (~5s) isometric contractions at the level of integrated EMG produced at 15% of baseline MVC torque. At baseline, both MEP and

CMEP were elicited at ~20% Mmax peak-to-peak amplitude. To isolate changes in motoneuronal and cortical excitability, the CMEP and MEP were normalized to Mmax and CMEP absolute area, respectively.

RESULTS: Although VA (93.9+/-7.2% at baseline) was not reduced by the fatiguing protocol following task termination (p=0.96), MVC torque decreased by 29.0+/-13.6% (p<0.01) and peak power was reduced by 70.2+/-14.9% (p<0.01). Compared to baseline (amplitude: Mmax=18.2+/-3.9mV; CMEP=26.4+/-10.2%Mmax; MEP=19.1+/-6.1%CMEP), there were no detectable differences after task termination for Mmax (108.2+/-16.1%Change; p=0.19), CMEP (51.7+/-78.2%Change; p=0.10), and MEP (166.1+/-124.4%Change; p=0.34) areas.

CONCLUSION: Despite large fatigue-related decrements in elbow extension peak power, isometric strength was only reduced moderately, which was likely owing to factors predominantly within the muscle as VA remained high following task termination. Although the post-fatigue normalized CMEP and MEP values were 51% and 166% of their baseline values, respectively, these did not represent statistically significant changes, presumably owing to the small sample size collected to date. Thus, further, ongoing investigation is required to adequately assess the possibility of fatigue-related alterations in triceps brachii cortical and motoneuronal excitability following fast, dynamic elbow extensions.

COMPARISON OF SIMULATED AND ACTUAL TRAIL RUNNING RACES ON NEUROMUSCULAR FUNCTION IN TRAIL RUNNERS

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INTRODUCTION: The effects of trail running on neuromuscular function and muscle fatigue are not fully understood primarily because the evaluation of such function in trail runners is challenging in field settings. The present study aimed to compare the impact of simulated and field trail running races on neuromuscular function in 26 trail runners (13 females and 42 ± 6 years) with an average of 4.1 ± 1.5 years of trail-running experience. The participants had a maximal oxygen consumption (VO2max) of 42.7 ± 8.1 ml/kg/min measured on a treadmill and knee extension/flexion torque of 144 ± 41/62 ±21 Nm measured on a Biodex machine.

METHODS: A simulated trail running test was conducted in a laboratory, consisting of 30 minutes of uphill running at 75% of heart rate reserve (HRR) and 30 minutes of downhill running at 40% HRR on a treadmill. Transcutaneous electrical stimulation was applied to the femoral nerve before and after the running. The short distance trail running test was run on mountain single tracks with technical rocky sections and a total distance of 18 km with a positive elevation of 1,080 m (located in Khao Chalak, Chon Buri in Thailand).

RESULTS: The results showed that after the treadmill running test, quadriceps maximal voluntary contraction (MVC) and rectus femoris M-wave decreased significantly (p<0.05), indicating total and peripheral fatigue. However, no significant changes were observed in central fatigue as assessed by maximal voluntary activation. After the short distance trail running test, the average time was 279 ± 45 minutes, and counter movement jump (CMJ) decreased significantly (p<0.05). The decreases in MVC observed in the laboratory were associated with the corresponding reductions in CMJ (r = 0.428, p = 0.029) obtained in the field setting, VO2max (r = 0.548, p = 0.004), and knee flexion torque (r = 0.534, p = 0.005).

CONCLUSION: In conclusion, the simulated trail running test produced total and peripheral fatigue but not central fatigue in trail runners. Additionally, maximal voluntary contraction measured after the simulated trail running was significantly associated with counter movement jump obtained after the actual trail running race. This is a first step in creating a useful experimental tool for simulating short trail running and investigating neuromuscular fatigue in this population.

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POST-ACTIVATION POTENTIATION AND POTENTIATED MOTOR UNIT FIRING PATTERNS IN THE VASTUS LATERALIS AMONG BOYS AND MEN

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INTRODUCTION: Post-activation potentiation (PAP) describes the enhancement of twitch torque following a conditioning contraction in skeletal muscle. In adults, PAP is greater in muscles with a higher percentage of type-II fibres1 and PAP-related augmented contractility is accompanied by a decrease in motor unit (MU) firing rates (MUFRs)2. Children may have lower PAP due to lower type-II muscle fibre composition3 and lower activation of their higher-threshold (type-II) MUs compared to adults4. The purpose of this study was to examine PAP and MU firing patterns of the potentiated knee extensors in boys and men.

METHODS: Twenty-three boys (10.5±1.3 years) and 20 men (23.1±3.3 years) completed familiarization and experimental sessions. Maximal isometric evoked-twitch torque (Digitimer stimulator model DS7AH) and MU firing patterns during

submaximal contractions (20% and 70%MVC) were recorded before and after a conditioning contraction (5s MVC). PAP was calculated as the percent-increase in evoked-twitch torque after the conditioning contraction. MU firing patterns were extracted from the vastus lateralis using Trigno Galileo surface electrodes (Delsys Inc) and decomposition algorithms (NeuroMap, Delsys Inc). MU action potential amplitudes (MUAPamp) and MUFRs were calculated for each MU found during the submaximal torque traces. For each participant and trial, exponential MUFR vs. MUAPamp relationships were calculated. The y-intercepts and rates of decay for these relationships were extracted to estimate changes in firing rates with potentiation. Age-related differences in PAP data were analyzed using independent t-tests and MU data were analyzed using 2-way mixed-model ANOVAs.

RESULTS: PAP was higher in men (98.3±37.1%) than in boys (68.8±18.3%) (p=0.002). There was a significant decrease in the rate of decay of the MUFR vs. MUAPamp relationships in both the 20%MVC (p=0.009) and 70%MVC (p=0.001) contractions in the potentiated relative to the unpotentiated state, reflecting a decrease in MUFRs with increasing MUAPamp following potentiation. This decrease was greater among boys during 70%MVC contractions (p=0.017).

CONCLUSION: It is concluded that despite greater PAP in men, similar or even smaller MUAPamp-dependent reductions in MU firing rates occur during low and high-intensity contractions, respectively, in men compared with boys. These differences may be related to children's lower fatiguability5 and potentially lower functional type-II muscle fibre pool4.

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SOLEUS RESPONSES TO TRANSCUTANEOUS SPINAL CORD STIMULATION SHOW SIMILAR CHANGES THAN H-REFLEX IN RESPONSE TO TENDON VIBRATION

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INTRODUCTION: Recording of the H-reflex through percutaneous electrical stimulation is widely considered the go to method for investigating changes in spinal loop excitability following an intervention (Zehr 2002). Yet, it remains difficult to evoke H-reflexes in a large variety of muscles and it is further limited by the very localized effect, necessitating several setups to investigate more than one muscle within the same experiment. Recently, the use of transcutaneous spinal cord stimulation (TSCS), a method in which one stimulates the lumbar part of the spinal cord to elicit muscle responses throughout the lower limbs, has been proposed as a viable alternative to prevent these limitations (Saito, Masugi et al. 2019). Although H-reflex and TSCS responses are thought to involve the same neural pathways, it remains to be verified if those two responses behave the same in response to a given intervention. In this study, we therefore aimed at comparing the effect of Achilles tendon vibration on soleus TSCS and H-reflex responses. It was hypothesized that the two modes of spinal cord excitability investigation would be similarly sensitive to the vibration-induced depression.

METHODS: Fifteen healthy participants enrolled in this study. Participants were tested at baseline (PRE), during Achilles tendon vibration (VIB) and after 20 min of vibration (POST). Right Soleus EMG responses to tibial nerve stimulation (H-reflex) and TSCS were recorded at each timepoint, their size being matched at PRE and expressed as a percentage of maximal M-wave. Care was taken that effective stimulation intensity was comparable across timepoints.

RESULTS: Both H-reflex and TSCS responses decreased in VIB (pooled mean decrease: -73%) and POST (pooled mean decrease: -32%) when compared to PRE-values ($p < 0.05$ both). Vibration-induced changes in responses amplitude correlated well throughout the study ($p < 0.05$, coefficient of correlation = 0.65)).

CONCLUSION: TSCS can detect similar changes to those detected by percutaneous electrical stimulation in the soleus muscle of healthy young people, suggesting that the two stimulation modalities share the same neural pathways.

EFFECTS OF TIME-OF-DAY ON MOTOR UNIT FIRING AND MUSCLE CONTRACTILE PROPERTIES IN HUMAN

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INTRODUCTION: Many physiological responses, i.e., hormones secretion or body temperature, have a diurnal rhythm. Diurnal differences of exercise performance such as muscle strength were also well known. Muscle strength are determined by two main factors; the central nervous system and peripheral muscle components. Since both factors can be influenced by various physiological processes, it is necessary to evaluate the time differences of them separately. The knowledges of time-of-day differences would be effective to establish training strategies and to provide higher performance based on diurnal rhythms in neural and muscular components. This study aimed to demonstrate the time-of-day differences of neural excitability and muscle contractile properties in human.

METHODS: Ten healthy young men participated in the present study (age: 22.6±5.1years). At 10:00 (morning), 13:30 (noon), 17:00 (evening), and 20:30 (night), the knee extensor maximal isometric voluntary contraction (MVC) torque and high-

density surface electromyography (HDsEMG) of vastus lateralis, electrically evoked twitch torque, and skin and core (intra-aural) temperature were measured. HDsEMG was recorded during isometric ramp-up contraction to 50**%**MVC. Individual motor unit was detected and tracked among four different times, and firing rate (FR) at 35-45%MVC (median) and recruitment thresholds (RT) were calculated.

RESULTS: Ninety-one motor units were detected and tracked among four different times, totally. There were no significant differences in the maximal strength, RT, or body temperatures among the times. FR significantly changed among the times ($p<0.001$), and those at evening and night was significantly higher than those at morning and noon. Twitch torque significantly changed among the times ($p=0.036$), and those at noon, evening and night were significantly higher than that at the morning.

CONCLUSION: Since we found the time differences in FR and twitch torque, there are a diurnal rhythm in neural excitability and muscle contractile properties. The higher FR at evening and night may be explained by diurnal variations in excitability of the spinal cord and cerebral motor cortex, as well as in the secretion of melatonin and other substances . Whereas, the time differences in twitch torque may be influenced by diurnal variations in core temperature, muscle viscoelasticity, and calcium ion concentrations in sarcoplasmic reticulum . Diurnal rhythms in neural excitability and muscle contractile properties were not consistent, suggesting that different mechanisms may be contribute to each factor. According to these findings, we may be able to establish diurnal rhythm-based training or peaking/tapering strategies. In conclusion, the motor unit FR increased at the evening and night, and the evoked muscle strength by electrical stimulation increased in the noon, evening, and night, allowing us to observe the effect of time-of-day in neuromuscular function.

STIMULATION FREQUENCY: SHOULD WE GO BEYOND WHAT'S NATURAL?

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INTRODUCTION: Despite the understanding that stimulation frequency influences the contractile responses of skeletal muscle, including fatigability, no study to date has assessed force loss across stimulation protocols when all parameters apart from frequency are identical. To limit discomfort, it is common practice for electrical stimulation (ES) frequencies to be two- or three-fold higher than the natural motor unit discharge rates (MUDRs) expected for a given level of force. However, there is evidence that force loss is exacerbated by high- compared to low-frequency ES, which means that unnaturally high frequencies may be ill-suited for protocols that involve repeated or prolonged muscle stimulation (e.g., fatigue, rehabilitation, and training-based studies). The aim of the current study was to compare quadriceps force loss with intermittent ES at frequencies of 10, 15, and 30Hz, which represent the mean MUDR at 25% maximal voluntary contraction (MVC) force (10Hz) and two higher frequencies that have been used in previous studies to evoke this level of force. We hypothesized that the magnitude of force loss will increase with stimulation frequency.

METHODS: Eight healthy, young adults (29±3yr, 173±13cm, 74±14kg; 3 females) completed three sessions of ES separated by at least 48h. To begin, participants performed brief MVCs with the interpolated twitch technique to assess voluntary activation (VA). The ES current was set to evoke a contraction of 25% MVC force, with single trains having 7, 10, and 19 pulses train for 10, 15, and 30Hz, respectively. The intermittent fatigue protocol was 3-min in duration, consisting of 144 contractions, with each contraction separated by 1.25s (0.6s stimulation and 0.65s rest). After the final train, recovery of evoked force was tracked over a 5-min period.

RESULTS: Baseline MVC force (54.9±19.3kg) and VA (95.9±1.9%) were not different across sessions ($p\geq0.231$). At the end of the 3-min protocol, force loss was greater for 30Hz (53.6±4.3%) than 15Hz (40.7±7.3%) or 10Hz (23.3±9.5%), and greater for 15 than 10Hz. After 5min of recovery, peak evoked force returned to baseline for 10Hz, but not 15 or 30Hz (96.6± 9.9, 82.2±9.7 and 75.2±7.8% baseline, respectively).

CONCLUSION: As hypothesized, force loss was exacerbated by increases in ES frequency. Indeed, even with a seemingly modest increase in frequency (10 vs. 15Hz), force loss was nearly doubled. Furthermore, evoked force generation remained impaired for at least 5min following the protocols involving ES frequencies higher than the mean MUDR at 25% MVC force (i.e., 15 and 30Hz). The exacerbated force loss at higher frequencies of stimulation likely reflects greater metabolic cost and myofibril impairment associated with additional E-C coupling cycles.

ECCENTRIC CYCLING AT DIFFERENT PEDALLING CADENCES LEADS TO SIMILAR NEUROMUSCULAR ALTERATIONS BUT DISTINCT PERCEIVED RESPONSES

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INTRODUCTION: While the effects of locomotor submaximal eccentric exercise performed on cycle ergometers have been explored since the 50s, characteristics still need to be fully considered. Current equipment allows specific parameters to be modulated, such as power output, mode (isoload or isotonic), or pedalling cadence. The effect of the latter on the neuromuscular alterations remains unknown. A previous study found a greater loss of strength after pedalling at 35 compared to 5 rpm during 5 min. However, as exercises were maximal, power output at the lower pedalling cadence was five times lower than at the higher one. Since the rehabilitation program chose submaximal intensities, longer exercises and higher pedalling cadences, the present study aimed to compare the effects of pedalling cadence of 30 and 60 rpm during 30 min eccentric cycling.

METHODS: Twenty-two participants completed three sessions three weeks apart: 1) a determination of maximal concentric aerobic power and a familiarisation of eccentric exercise cycling and neuromuscular function assessment; 2) and 3) eccentric cycling exercise consisting of 30 min at 60% MAP, at 30 or 60 rpm. Perceived effort (PE) was rated by the participants every 2 minutes. In addition, the knee extensors maximal voluntary contraction (MVC) torque, the torque evoked by double stimulations at 100 Hz and 10 Hz (Dt100; Dt10), and the voluntary activation level (VAL) were evaluated before and after each exercise.

RESULTS: PE was greater and increased more during cycling at 30 rpm than at 60 rpm ($P < 0.01$). MVC and evoked torques decrease (all $P < 0.05$) in both conditions without cadence effect. VAL did not change ($P > 0.082$) for any cadence. Dt10/Dt100 ratio declined ($P < 0.001$) in both conditions without cadence effect.

CONCLUSION: As it was previously found that cycling at 30 rpm caused greater perceived effort compared to cycling at 60 rpm (1), it also appears that 30 rpm led to greater perceived fatigability. However, MVC torque decreased similarly after pedalling at both cadences. The loss of voluntary torque was mainly caused by peripheral alteration, as evidenced by reduced evoked torque, while VAL remained constant. Moreover, we found a decrease in Dt10/Dt100 ratio usually associated with a failure in excitation-contraction coupling due to a reduction in Ca2+ release (2). Therefore, even if performance fatigability was similar in both conditions, as perception of effort could limit peoples engagement in regular physical activity, a rehabilitation program should be proposed at 60 rpm.

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SEX-DIFFERENCES IN PERFORMANCE-RELATED VARIABLES DURING A MAXIMAL INTERMITTENT SQUAT TEST PERFORMED ON A FLYWHEEL DEVICE

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INTRODUCTION: Flywheel devices (FW) have gained relevance due to their benefits compared to traditional training (1), not only in domains as sports performance and injury rehabilitation, but also in clinical settings. Furthermore, this type of training can elicit larger levels of force and muscle activity in the eccentric phase compared to the concentric phase (2). Despite the increasing number of studies focused on women population in recent years (3), research oriented on sex-differences while using FW maximal testing protocols is still limited. This study aimed to investigate the sex-differences in performance-related variables measured throughout a maximal intermittent squat flywheel protocol (FWsq).

METHODS: Eighteen active young adults (11 women and 7 males) performed a maximal intermittent FWsq consisting of 10 sets of 10 repetitions with three minutes of recovery between sets. Three additional repetitions were performed at the beginning of each set to accelerate the disc and develop maximal momentum. The 10 effective repetitions of each set were averaged. Representative mean power (MP) and work (W) per set were obtained by averaging the values corresponding to the eccentric and concentric phases separately from the 10 repetitions. Both variables were also normalized to body mass (MPBm and WBm). A three-way ANOVA of repeated measures (factors: contraction phase, sets and sex) was used to study the time-course of change of the MP and W, and potential interactions among the two groups. Statistical level of significance was set at $p<0.05$.

RESULTS: In both sexes MP and MPBm decreased significantly throughout the 10 sets ($P=0.005$) and in the two phases ($P=0.018$; $P=0.016$). Significant sets by sex interactions were found in MP ($P=0.021$). W and WBm diminished significantly across the sets ($P=0.001$), with different patterns of fatigue between sexes, confirmed by a significant set by sex interaction ($P=0.005$) and set x phase x sex interaction ($P=0.016$; $P=0.042$).

CONCLUSION: It appears that changes in MPBm along the maximal intermittent FWsq do not differ between men and women. However, larger decrement in MP, W and WBm were observed in men than in women. These data suggest that, among other variables such as strength or speed, MP, W and WBm should be considered when using such devices to compare motor performance between men and women.

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CP-BM12 Sports Biomechanics I

KINEMATICAL DIFFERENTS BETWEEN HEALTHY AND SHOULDER-INJURED SOFTBALL PLAYERS

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INTRODUCTION: Softball is a sport that is growing in popularity. Injuries related to throw movement are increasing in softball players. The shoulder and elbow constitute the main sites of injuries in professional softball players. To design and prescribe a sport-specific strength and conditioning program targeted at reducing the risk of injury, boosting performance, and improving health and lifespan, it is essential to comprehend softball task mechanics. The aim of the study was to assess the kinematic differences in the upper limb and trunk between healthy and shoulder-injured softball field players.

METHODS: A cohort of 11 first-division softball players (mean age 25.9±8.1) were enrolled in the study. Among the participants, 5 experienced a shoulder injury with consequent surgery while 6 did not report previous shoulder injuries. The shoulder-injured and the healthy groups have been practicing softball for 15.8±7.5 and 18.8±9.3 years, respectively. After a proper warm-up for throwing, the players were asked to perform 3 trials. The players were assessed while performing a typical field motor task, from the moment when they pick up a ball on the ground to the complete throw. For the analysis, the motor task was divided into 2 phases: Pickup, which starts from ball grabbing to throw position; Pass, from hand far in the back to the complete throw. Wearable inertial sensors (Xsens MTw Awinda) were used to collect kinematical data on the shoulder, elbow, and trunk. The kinematical parameters analyzed were peaks joint angle and range of motion (ROM). The data extraction and analysis were made in Matlab. The unpaired T-test was used for comparing the difference between the groups and $p<0.05$ was considered statistically significant.

RESULTS: In the Pickup phase, the shoulder showed a higher internal-/external rotation ROM in healthy players than in injured ones ($p<0.001$). The same results were observed for the elbow flex-/extension ROM ($p<0.01$). Healthy players showed a higher peak of trunk flexion than the injured ones ($p<0.01$). Concerning the Pass phase, the ROM of shoulder internal/external rotation and flex-/extension of healthy players was wider than the injured ones ($p<0.001$). Healthy players showed a higher elbow flexion ($p=0.01$).

CONCLUSION: The shoulder-injured players showed less ROM than healthy ones during the assessed motor task. Kinematics differences were found in the shoulder, elbow, and trunk. Despite being all returned to play at the pre-injury level, the injured players could voluntarily or unconsciously perform the motor task in a more conservative way than the healthy players. The kinematical analysis through wearable sensors could be used to assess compensatory movements in softball and inform the return-to-sport process after shoulder injuries.

AN EMPIRICAL STUDY OF HOW TASK CONSTRAINTS CAN INFLUENCE THE INTERPRETATION OF FUNCTION

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INTRODUCTION: In darts or ball throwing, the release positions and velocities of the darts or ball (release parameters) may be systematically related [1,2]. The systematic relationship between release parameters reduces the variability of the ball or darts arrival position. However, it should be noted that such a systematic relationship between release parameters does not always increase the success rate of the motor tasks (e.g., hitting rate to the target during the darts or ball throwing). Without recognizing this point, we might incorrectly conclude that the systematic relationship always has the function of increasing the success rate of motor tasks. Here our study will experimentally illustrate that the systematic relationship between release parameters may not increase the hitting rate to the target during ball throwing. Given the results of this experiment, our study attempts to discuss the proper interpretation of function.

METHODS: Twelve right-handed college baseball players participated in the study. Each participant threw 30 baseballs at two different-sized targets (small and large targets) aiming at a target 10 m away from the participants, for a total of 60 balls. Furthermore, the participants threw alternately with an overhand and a sidearm throwing. Therefore, the participants threw 15 balls with overhead throwing and 15 balls with sidearm throwing to a large target out of the 30 balls and did the same to a small target. We identified the systematic relationship between release parameters to reduce the variability of the ball arrival position and to increase the hitting rate to the target by using the method of the previous study [3].

RESULTS: The height of the release position and vertical release velocity were systematically related to reducing the variability of the ball arrival position in the small target. In other words, these release parameters had the function of reducing the variability of the ball arrival position. Furthermore, these release parameters also had the function of increasing the hitting rate. For the large target, the height of the release position and vertical release velocity parameters had the function of reducing the variability of the ball arrival position. However, these release parameters did not have the function of increasing the hitting rate to the target. These findings showed that the function of the parameters may be altered depending on the target size, or task constraints in abstract terms.

CONCLUSION: Our study concluded that the proper interpretation of the function requires the consideration of the task constraints.

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THE INFLUENCE OF THE FORCE-VELOCITY MECHANICAL PROPERTIES OF UPPER LIMB ON THROWING PERFORMANCE IN YOUNG EXPERIENCED HANDBALL PLAYERS

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INTRODUCTION: Overarm throwing is considered one of the most critical actions in handball sports related to the gain of competition, which requires the players to throw as fast and accurately as possible to score a goal. It is well known that the overarm throw is a typical ballistics movement that requires the athlete to accelerate a given ball as much as possible to reach the highest throwing velocity in the shortest amount of time (1). Although previous studies have proposed fundamental methods for quantifying upper-limb explosive capacity, such as the ballistics bench press, the Force-Velocity (F-V) mechanical properties obtained during the ballistics bench press have not explored its association with the throwing performance. Thus, the present study aimed to investigate the F-V mechanical properties obtained during the ballistics bench press with a different type of throwing performance in handball players

METHODS: Twenty-seven French national second-division male handball players (age: 20.0 ± 3.2 years, height: 180.5 ± 6.3 cm, weight: 73.9 ± 7.9 kg) volunteered for the investigation. Force-Velocity (F-V) mechanical parameters (i.e., theoretical maximal force [F0], velocity [V0], power [Pmax]) of the upper limb were obtained during the single-arm ballistics bench-press for the dominant arm according to the validated method (2). The throwing performance was assessed by the maximal standing and 3-step running throwing velocity using a Stalker ® ATS II radar gun.

RESULTS: The simple linear correlation analysis found that the V0 was significantly correlated with standing throwing velocity ($r2 = 0.51$, $f2 = 1.04$, $p < 0.001$) and 3-step running throwing velocity ($r2 = 0.46$, $f2 = 0.85$, $p < 0.001$). Additionally, a significant correlation was found between the 3-step running throwing velocity and the Pmax ($r2 = 0.18$, $f2 = 0.22$). In contrast, no significant correlation was found between other mechanical properties and throwing performance.

CONCLUSION: The main results of the present study showed the importance of the upper limb F-V profile assessment in predicting throwing performance, especially the V0. In short, the handball players revealed higher V0 during the ballistics bench press, which could also perform the faster-throwing performance. This finding demonstrated that the mechanical parameters obtained from the ballistics bench press should be used to evaluate the upper-limb explosive capacity and allow the coach to design the particular training session to improve the explosive capacity of the upper limb to enhance the throwing performance.

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AN ANALYSIS OF KINEMATIC DIFFERENCE BETWEEN SUCCESSFUL HURDLE STEP AND BAULK IN 3M SPRINGBOARD DIVING

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INTRODUCTION: In springboard diving, which is one of the diving competitions, a certain approach called hurdle step must be performed. Although the baulk in which the stop of jumping due to incorrect performance of hurdle step by divers happens often, a clear kinematic difference between successful hurdle step performance and baulk has not yet been identified. The purpose of this study was, therefore, to identify the difference between successful hurdle step performance and baulk.

METHODS: Ten finalists for the 3m springboard at the National Sports Festival (age: 23.4±3.4 yrs.; weight: 64.9 ±5.6 kg; height: 170.1±5.8 cm; Career: 10.6±2.4 yrs) participated in this study. The motions to be analyzed were limited to those with a difficulty level of 3.0 or higher, and baulks motions were compared with hurdle step motions performed in trials with a skill score of 7.5 or higher. The hurdle step motions were recorded using six video cameras (sampling rate: 60Hz). To set the spatial coordinates, DLT camera calibration was performed around the springboard. 14 body joint points were digitized using the Kwon 3D XP (Visol, Korea) program. In this study 4 events were set for analysis (E1: hurdle step contact, E2: maximum springboard depression, E3: hurdle step take off, E4: highest jump point). A paired t-test was conducted to compare the kinematic differences between two groups and the statistical significance level was set at $\alpha=.05$.

RESULTS: The results showed that the difference in CoM velocity between two groups was statistically significant at E3: the backward velocity in the baulk (-0.01 ± 0.07 m/s) was faster compared to that in the successful hurdle step (0.12 ± 0.04 m/s). They also showed that the difference in the take off angle between two groups was statistically significant at E3: the take off angle in the baulk (-7.74±1.44°) was bigger compared to that in the successful hurdle step (-6.55±1.55°), showing the non-perpendicular jump angles.

CONCLUSION: Since the huddle jump performed immediately after the hurdle step is a forward jump, it is estimated that the take off angle greatly deviating from the perpendicular and the backward movement of the CoM have a negative effect on the successful performance of the technique. Therefore, the divers that recognized the backward movement of the CoM during the hurdle step are likely to commit baulk without connecting hurdle step to jump in the hurdle step.

KINEMATIC PROPERTIES OF JUDO ATHLETES WHEN PERFORMING THE THROWING TECHNIQUE UCHIMATA.

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INTRODUCTION: Severe neck injury of attacker in judo (tori) often occurs in the situation where tori tries to throw the opponent (uke), caused by direct hitting of the head against mat (tatami) resulting in hyperflexion of the cervical vertebrae, especially in uchimata. However, there is no sophisticated instruction method to teach uchimata based on the detailed kinematical analysis. In addition, most previous studies exhibiting the kinematical feature of uchimata have focused on the movement of tori when the opponent makes no resistance. Thus, the purpose of the present preliminary study was to compare the kinematic features of tori under two conditions where uke intends to resist being thrown or not.

METHODS: Two female judo athletes（subject A and B）whose specialties are uchimata participated in the All Japan University Tournament were recruited as tori (left kumite). They conducted two different practices: yakusoku rensyu (uke is thrown by tori with no resistance) and jiyu rensyu (uke resists being thrown by tori, like a real match). In each judo practice, we collected 3D coordinate values of toris body analysis points from the captured video using FrameDias-6 for one trial to throw. The analysis interval was set from the time when tori took off her left foot to take the first step, until ukes back touched tatami after thrown by uchimata. The three phases of toris movement were categorized as follows: "kuzushi" until toris left foot touches the tatami, "tsukuri" until toris right foot touches the tatami, "kake" until ukes back hits against tatami. Forward trunk inclination angle in the sagittal plane was measured by connecting a perpendicular line from the superior tip of the greater trochanter to the tatami and a line from the superior tip of the greater trochanter to the top of the head. The angle formed by lines connecting the top of the humerus head, the epicondyle of the humerus and the scaphoid was defined as the elbow joint angle.

RESULTS: In both subject A and B, maximal forward trunk inclination angles were observed in kake phase regardless of whether uke resist to being thrown. In subject A, values of the forward trunk inclination angle were obviously greater with resistance (average±SD, 110.7±7.2 deg; maximum, 119.1 deg) than without resistance (average±SD, 78.1±22.0 deg; maximum, 110.2 deg). Additionally, subject B also showed a greater angle with resistance (average±SD, 131.3±12.7 deg; maximum, 148.6 deg) than without resistance (average±SD, 96.6±21.0 deg; maximum, 120.9 deg).

CONCLUSION: From these preliminary results observed in two judo experts, the forward trunk inclination angle of tori is apparently large when uke resists being thrown and the maximal angle might be derived in kake phase. In other words, if uke resists being thrown by uchimata, the possibility that tori falls into tatami from the top of the head causing to overflex the cervical spine increases as previous studies have expected.

FIXING THE FIRST BOUNCE IN TABLE TENNIS SERVE

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INTRODUCTION: In table tennis, the serve length can be usually distinguished by its first bounce point. That is, a short serve first bounces close to the net, whereas a deep serve first bounces close to the endline. Recently, top players seem to reduce such differences by fixing the first bounce of serves. However, the current understanding is limited. Moreover, whether rotation of the serve has an impact on this strategy (fixing the first bounce) remained unknown. Therefore, the aim of this study was to investigate the bounce location of short and deep serves with different rotation types, with and without using this strategy.

METHODS: We recruited 2 male national representatives as participants. They were asked to perform short and deep serves, with 2 types of rotation (no rotation and backspin), with and without fixing the first bounce, each with 20 serves. The bounce location of each serve was recorded with a videocamera from the bird's eye view, and then input to Kinovea for tracking the bounce location in x-axis of the table. Two sets of three-way (2 ways of serve x 2 serve lengths x 2 serve rotations) repeated measures ANOVAs were performed to examine the serves of the two participants under different manipulated conditions separately. The significance level was set at alpha =.05.

RESULTS: For both players, there were significant serve length x strategy interaction effects [$F(1, 19) = 431.466$, $p < .001$; $F(1, 19) = 1.155$, $p = .296$, for player #1 and player #2, respectively]. These results revealed that both players could successfully fix or differentiate the first bounce locations between short and deep serves when they were asked. Moreover, there were significant three-way interaction effects [$F(1, 19) = 5.911$, $p = .025$; $F(1, 19) = 6.041$, $p = .024$, for player #1 and player #2, respectively]. Post hoc comparisons indicated that for player #1 when serving short in standard way, the first bounce location of serves without rotation was closer to the table compared to serves with backspin. On the contrary, when serving short by fixing the first bounce, the first bounce location of serves without rotation was closer to the net compared to serves with backspin. For player #2, the differences were found when serving short by fixing the first bounce. That is, the first bounce location of serves without rotation was closer to the table compared to serves with backspin.

CONCLUSION: Our results revealed that top players successfully fix the first bounce of serves between short and deep serves, and this might be difficult for the opponent players to anticipate their serve length by observing the first bounce.

The serve rotation seemed to have an impact on the first bounce location, but the differences between different rotation types were within 5 cm. Whether they are empirically important needs future study to further investigate.

Conventional Print Poster

CP-AP15 Individual Sports

EARLY DEVELOPMENT IN YOUTH SWIMMING? A CATEGORISATION OF MATURITY STATUS AND RELATIVE AGE EFFECTS

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INTRODUCTION: In talent identification, recent investigations provide data contributing to research on the relative age effects (RAE) and its relation to biological maturity (Deprez et al., 2013; Müller et al., 2016). These studies have shown no significant differences in maturity-related characteristics (i.e., age of peak height velocity; APHV) between the four age quartiles (Q), regardless of gender. Therefore, relatively younger swimmers may be able to counteract their relative age disadvantage if they have the same biological maturity status as their somewhat older counterparts. Thus, an in-depth analysis was conducted to categorise the swimmers into early, normative, and late-developed athletes. Whether the sample tends to include early developers because the parameter APHV cannot provide insight into the biological maturity categorisation remains to be elucidated.

METHODS: 650 German state-level swimmers (age 11.00 ± 1.27 years; female n=377, APHV: 11.56 ± 0.46; male n=273, APHV: 13.31 ± 0.61) were categorised into three groups of biological maturity (late, normative vs early) based on APHV's mean (M) ± standard deviation (SD), regarding gender (normative: APHV = M ± SD; early: APHV < M – SD; late: APHV > M + SD). To analyse the difference between the expected standard normal distribution and the observed relative frequency distribution [%] of early, normative, and late-developed athletes for the male and female sample, Chi-square tests were computed ($p<.05$).

RESULTS: Female athletes were normative developers if they had an APHV between 11.10 and 12.02 years (male: APHV = 12.70-13.92), early developers if their APHV was less than 11.10 years (male: APHV < 12.70), and late developers with an APHV higher than 12.02 years (male: APHV > 13.92). Most athletes (70.31%) were normative developers, 14.92% were early developers, and 14.77% were late developers. The percentage distributions of the developmental categorisation did not differ significantly from the expected standard normal distribution in both gender (male: $p = .753$, female: $p = .193$).

CONCLUSION: The findings indicate that the sample of German youth swimmers only includes a small proportion of early developers on average. At the same time, there are conspicuously few late developers born in Q4. Therefore, it can be assumed that relatively younger swimmers can counteract their disadvantage only with an early or normative biological maturity status, which significantly impacts swimmers talent identification and development.

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PHASE ANGLE IS A PREDICTOR OF PERFORMANCE IN SWIMMING

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INTRODUCTION: Preparation for major competitions in swimming involve monitorization of physical and physiological measures along the season, where overload periods are followed by a reduction of training load, or taper. Taper is designed to obtain peak performance in the main competitions. It is associated with increased muscular strength, power, fiber size, and glycogen storage, affecting intracellular water volume, and body composition.

Bioelectrical impedance analysis (BIA) is a non-invasive, cheap and practical field measurement that allows for evaluation of body composition and phase angle (PhA). PhA has been suggested as an indicator of nutritional status, cellular integrity, and muscle quality and as a predictor of the competitive level/sports performance of athletes. It is obtained through the raw data (resistance (R) and reactance (Xc)) representing cellular health, as R arises from water intra and extracellular compartment, while Xc appears from cell membranes lipidic structures.

Our two-aim study intended, to verify if PhA is a predictor of performance, more specifically of 100m swim time simulation, along a 3-month training macrocycle; and to attest the existence of correlations between PhA and body composition, strength, and performance variables, in young swimmers.

METHODS: 20 youth age group swimmers (11 females, 9 males; 13-15 yrs.) were evaluated in 4 moments (M) of a winter macrocycle: M1, 3rd wk of the season; M2, 8th wk, after a period of elevated volume and high aerobic capacity loads; M3, 13th wk after a progressive decrease of volume and increase of aerobic power and anaerobic loads; and M4, 14th wk, after the 1st wk of taper. Athletes were assessed for phase angle (PhA), whole-body composition [fat free mass (FFM, kg), fat mass (FM, kg)] and water compartments [(total body water (TBW, kg), extracellular (ECW, kg) and intracellular water

(ICW, kg)] using bioelectrical impedance raw data or BIA-based equations for athletes, previously developed from our group. Regarding performance athletes were evaluated for forearm maximal isometric strength using a portable dynamometer and performed an all-out 4x25m front crawl on a 30s cycle. Time at each 25m (T25, s) was recorded and 100m total time was calculated [T100 (s)].

RESULTS: A positive correlation of PhA with FFM, TBW, ECW, ICW, and handgrip was observed. Also, a negative correlation with FM and T100, average T25 and minimum T25 was found. PhA itself explained T100 between 26.8% (in M3) and 49.4% (M4).

CONCLUSION: Our results show that phase angle, being an indicator of cellular integrity and muscle quality, is a good predictor of performance (T100) in short distance races and is representative of the peaking throughout a macrocycle culminating with the swimmers' personal best performance. Also, should be acknowledged that swimmers with more FFM and less FM have better performance and higher PhA.

THE RELATIONSHIP BETWEEN LOAD-VELOCITY PROFILES AND SPATIOTEMPORAL PARAMETERS IN ELITE 100 M AND 200 M FREESTYLE SWIMMERS

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INTRODUCTION: Power, strength and speed assessment is of great interest when monitoring swimming performance (1). In this perspective, semi-tethered swimming tests are commonly used to evaluate dynamic parameters based on load-velocity (L-V) profiles in conditions consistent with free swimming (2). Maximal predicted velocity (V0) and maximal predicted load (L0) assessed by a L-V profiling, has been reported respectively as strongly and moderately correlated with the mean velocity in the 50 m butterfly (3) as well as the 50 m freestyle (4). Nevertheless, it is unclear if L-V profiling is associated with performance in other distances. Therefore, the aim of this study was to test the correlation between load-velocity profiling and performance parameters in the 100 m and 200 m freestyle events.

METHODS: Seven male elite swimmers (100 m freestyle best time: 51.17 ± 1.04 s; 770 ± 49 FINA points) completed a freestyle load-velocity profiling using a resisted sprint protocol. Swimmers were asked to swim four all-out distances (25, 25, 20 and 15 m) against increasing loads (0.1, 2.0, 4.0 and 6.0 kg respectively). Average swimming speed was obtained from three cycles on the middle of the sprint (4). V0, L0 and the slope of L-V linear regression were computed from the testing session. Swimmers competed the 200 m & 100 m freestyle events in a 50 m pool within 3-4 days after the tests, at an international competition. Video analysis of both races were performed to compute average values of speed (Vmean), stroke length (SL) and stroke rate (SR). The normality of all variables was verified using a Shapiro-Wilk test and Pearson correlations were computed between race performance parameters and L-V results (α=5%).

RESULTS: Main results show that, on the 100 m, SR and V0 as well as SL and L0 have a low negative correlation (r= -0.13 and r= -0.46 respectively). On the other hand, on the 200m, SR and V0 as well as SL and L0 show large positive correlations (r= 0.69 and r= 0.53 respectively). Slope has also a large correlation with Vmean on the 100 m (r=0.59) but a trivial correlation with Vmean on the 200 m (r= 0.09). Other results indicate a nearly perfect correlation of SR in the 100m with L0 (r= 0.91) and Slope (r= 0.91).

CONCLUSION: It appears that the correlations between L-V profiling and performance parameters differ depending on the race distance, each one involving specific physiological and biomechanical constraints. Indeed, this conclusion could be related to active drag as the correlation between the slope of the L-V regression, which is described as an indicator of drag (5), and the average speed over 100 m is strong whereas negligible with the average speed over 200 m.

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VALIDATING LABORATORY-BASED EXERCISE TESTING FOR SPORT-SPECIFIC PERFORMANCE IN RECREATIONAL SCUBA-DIVING

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INTRODUCTION: Improvement of physical fitness increases safety for all underwater activities with higher reserves during unexpected and rescue scenarios (Bosco et al., 2014). Many diving-related accidents are caused by poor physical conditioning (Lynch & Bove, 2009). However, medical examinations mandatory in SCUBA diving include only laboratory-based bicycle exercise, neglecting sport-specific factors and physiological adaptations to water immersion (Astrand, 1984). Thus, the transfer to underwater performance is critically mitigated. Although in-water testing should be preferred (Steinberg et al., 2011), we hypothesized incremental bicycle exercise in the supine position to mimic submersion-induced blood-shift and closely match the physiological reactions of underwater exercise testing with SCUBA (Toska & Eriksen, 1994).

METHODS: 15 experienced SCUBA-divers (age: 28 ± 6.4) conducted incremental exercise-testing on two separate days: In the laboratory, exercise was conducted on a bicycle ergometer in the supine position, starting at 50W and increasing intensity by 25W every 3 minutes until exhaustion. Underwater, incremental fin-swimming exercise testing was conducted

(fin-swimming with SCUBA, 4m water depth), starting with 0.4m/s, velocity increased by 0.1m/s every 3 minutes. Measurements were performed continuously (heartrate (HR), minute ventilation (VE)) and following every exercise step (blood lactate concentration (lac), rate of perceived exertion (RPE)). Values of HR, VE, RPE, and lac were investigated with Wilcoxon pairwise comparisons for rest, max, and recovery values (1, 3, and 5 minutes after stop of exercise for lac; HR until 5 minutes after stop of exercise). Statistical significance was set to 0.05.

RESULTS: For maximum values, significant differences were observed for VE max ($p < 0.001$; effect size $r = 0.85$), RPE max ($p < 0.001$; $r = 0.91$), and lac ($p = 0.006$; $r = 0.7$). No significant differences were found for HR max ($p = 0.121$).

CONCLUSION: Findings show persisting differences between underwater exercise and lab exercise, even in the supine position. However, because HR does not differ significantly, it can be assumed that participants were equally stressed in both conditions. Data might enable an improved transfer from lab to underwater. Still, sport-specific factors like water immersion and movement technique have to be considered and further investigation on underwater performance assessment is required.

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THE PERFORMANCE EFFECT OF AGE ON IRONMAN HAWAII MALE AND FEMALE AMATEUR TRIATHLETES

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INTRODUCTION: The effect of age in endurance athletic performance is already well stablished. However, it is not known whether the effect of aging is similar in both sexes. Therefore, the aim of the present study was to examine the performance effect of age on Ironman Hawaii male and female amateur triathletes from 2003 to 2019.

METHODS: 30,354 amateur triathletes were selected using the OBSTRI website. For further analysis, a "TOP 5" division filter was applied, which resulted in a total of 1,851athletes being included in this study. Moreover, Kruskal-Wallis non-parametric test with independent variables and pairwise comparison was used to analyze the impact of age group and overall time. Differences found were investigated with the Posthoc Bonferroni test. The level of significance was set at 0.05. SPSS version 26.0 (SPSS, Inc., Chicago, IL, USA) was used for all statistical analyses.

RESULTS: Female age group 18-24 years seemed to present higher overall race times than in 25-29 age group as for their male counterparts. There were no significant performance differences ($p>0.05$) between age groups 25-29 and 40-44 years for both sexes. Moreover, in agreement with the pattern observed in male age groups, the female age groups between 25-29 years and 40-44 years showed a plateau in performance. In addition, female triathletes had this plateau broken at the same age as males, in the age group 45-49 years. As the athletes started to get older, a significant difference ($p>0,001$) in performance started to appear when compared to the previous decade (e.g., 45-49 vs. 35-39, 50-54 vs. 40-44, 55-59 vs. 45-49 and continued until 70-74 years).

CONCLUSION: The main finding of the present study was that the aging effect on performance is similar in male and female athletes. The best overall race times were found between the age groups 25-29 and 40-44 for both sexes. The expected performance decline because of aging was observed after 45 years for both sexes. The predicted starting age of the decline in performance was correct. The investigation showed that the youngest age group (18-24 years) presented a significant performance improvement when it got older. This reinforces the notion that experience gain and physical training are significant contributors to the final performance.

When comparing the decades of life for both male and female groups, the differences start to appear significantly, suggesting that race times gradually get slower with the advanced age. These findings align with the expected physiological and functional capacity of aged participants and the peak performance in endurance sports of older athletes for both sexes.

IMAGERY AND PERFORMANCE DURING JUMPS IN WOMEN'S ARTISTIC GYMNASTICS: PRELIMINARY FINDINGS

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INTRODUCTION: In artistic gymnastics, the athlete's performance depends not only on motor abilities and technical skills but also on psychological abilities [1]. In general, motor and visual imagery is widely accepted as a strategy to enhance performance, also in gymnastics [3]. Based on the effects of two different visual perspectives (i.e., external-visual, internal-visual) and kinesthetic imagery, the aim was to investigate gymnasts' preference of a specific imagery modality. We assume, more vivid imagery enhances gymnastic jump performance.

METHODS: Women's artistic gymnasts were tested for their vividness of movement imagery using the Vividness of Movement Imagery Questionnaire (VMIQ-2, [2]); participants aged 14 to 24 years (n=30; mean 20 ± 3 years) were subdivided

into three groups (n=10) with imagery preferences respectively: external-visual (VMIQ-2 = 1.30 ± 0.32), internal-visual (VMIQ-2 = 1.53 ± 0.40), or kinesthetic (VMIQ-2 = 1.76 ± 0.88). Participants performed 6 stretched jumps with 450° turn. Crucial gymnastic-specific performance criteria such as jump height (optojump) as well as body position and landing (kinovea) were videotaped and analysed.

RESULTS: Findings following ANOVA indicated no significant differences, neither in performances between groups (i.e., jump hight: p=0.920, body position 1: p=0.394, landing 1: p=0.719) nor for expertise (p=0.768) or age (p=0.721). There were no correlations between imagery vividness and performance (jump hight (r=-.099; p=.603; n=30), body position 1 (r=-.048; p=.802; n=30), landing 1 (r=-.127; p=.505; n=30)), the expertise (r=-.087; p=.647; n=30) or age (r=-.107; p=.575; n=30).

CONCLUSION: Possibly missing group differences connected to the movement quality in gymnastic jumps can be explained because one may not be able to transfer the VMIQ-2 from general movements to gymnastic-specific performances (i.e., jumps). With each participant being able to solidly perform the jump, the lack of preference for a particular imagery modality may be due to similar expertise [4]. Further, absent performance differences depend on imagery intensity, causing similar imagery vividness for all participants. Alternatively, modality and vividness of motor imagery is very individual. Suppose imagery is to be considered for training, e.g., for different forms of coaching instruction, the preferred imagery modality must first be tested individually, to be adequately used.

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EFFECT OF CLASSICAL MUSIC ON BALANCE, EMOTIONAL STATE AND PERCEIVED EFFORT ON YOUNG PRECOMPETITIVE ARTISTIC GYMNAST AND TRAMPOLINE ATHLETES

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INTRODUCTION: Artistic gymnastics (AG) and trampoline (TR) are two Olympic sports where balance is a basic factor of successful execution [1]. Listening to music can elicit emotions, help recall memories, reduce stress, and improve exercise performance [2]. The purpose of the study was to examine the effect of classical music on balance, emotional state and perceived effort on precompetitive young artistic gymnast and trampoline athletes after a six-week training program.

METHODS: Thirty-six athletes (20 AGs and 16 TRs) were separate randomly into two equal groups; music (Experimental group: EG) and no music (Control goroup: CG). Trampoline athletes performed all exercises on a trampoline whereas artistic gymnasts performed their exercises on floor. During the 6 weeks, the athletes completed the questionnaire before and after each training session; and before and after evaluation test as well. Balance ability was assessed with Balance Error Scoring System (static balance) and Y- Balance test (dynamic balance). Before and after intervention the questionnaire RPE-FS with perceived fatigue scale and emotion scale was completed. A 2 x 2 x 2 ANOVA method with repeated measures on the third factor was used. In cases where an interaction between factors was found, the main effect was examined with the Bonferonni correction. A dependent samples t-test analysis was also performed to determine group differences on the dependent variables of emotional state and perceived fatigue.

RESULTS: A statistically significant improvement in static and dynamic balance in athletes of both sports ($p < .05$) was revealed with the percentage of improvement of AGs being comparatively higher than that of TRs. Also, there were significant differences in individual measures of emotional state and perceived fatigue in the examined sample.

CONCLUSION: EG on AGs showed greater improvement in static balance compared to TRs, whereas EG on TRs revealed greater improvement in dynamic balance compared to AGs. It was speculated that the nature of sport affect in a different way athletes balance. Conclusively, classical music differentiates the rate of performance improvement in pre-competitive young athletes in these two sports.

A STUDY OF ARRANGEMENT OF SIDE DISHES IN BENTO BOXES FAVORED BY JAPANESE AESTHETIC ATHLETES

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INTRODUCTION: Female aesthetic athletes experience a mental burden about their diets as a result of losing weight. The triad of female athletes (the interaction of three disorders: nutrition, menstruation, and bone decalcification) is complicated. In Japan, bento boxes typically contain rice and side dishes. However, no studies have examined whether the arrangement of side dishes in bento boxes can be adjusted. Therefore, this study aimed to use the technique of visual illusions to determine how the placement of side dishes in bento boxes can ensure peace of mind for aesthetic athletes.

METHODS: Participants comprised Japanese female college students from gymnastics, rhythmic gymnastics, cheerleading, and cheer dance clubs (N=92). They were divided into two groups: those whose weight had reduced (weight loss group, n=28) and those whose weight had increased, those who were maintaining their current weight, and those who were not concerned about their weight (other groups, n=64). A survey on their awareness of the total number of meals,

quantity of staple food items, number of side dishes, and presentation awareness was conducted using an anonymous questionnaire. In addition, we enquired about the preference of the two types of lunch boxes for three groups with the same type of food, amount, and area viewed from above but with different placements. The first, second, and third group consisted of a bento with rice on the left and on the right, a boxed lunch with triangular-shaped rice and inverted triangular-shaped rice, and rice that was placed inside and outside the bento box, respectively. Cross-tabulation of the data of the three groups and question items was performed using the chi-square test.

RESULTS: In the weight loss group, 86% of participants were not concerned about the amount of food they were eating ($p=0.001$). However, 75% had a lower intake of staple foods ($p<0.001$). Approximately 90% of the respondents were aware of eating several side dishes ($p=0.914$). Food arrangement awareness and preference were not significantly different between the two groups ($p=0.810$). Placement of the first group was preferred by around 50% on each side ($p=0.652$). In the placement of the second group, about 80% preferred the bento with triangular-shaped rice ($p=0.187$). In the third group, about 70% preferred bento boxes containing rice because the amount of rice seemed to be small ($p=0.216$).

CONCLUSION: Among aesthetic athletes, those who have lost weight are conscious of eating fewer staple foods. Therefore, the preferred arrangement of the lunchbox is one in which the quantity of rice appears to be less and the number of side dishes is large. It consists of a bento box with triangular-shaped rice placed inside the box. Thus, aesthetic athletes can eat without any mental burden by arranging food such that the amount of rice appears to be less than usual.

MUSCULAR ACTIVATION DURING THE DEMI-PLIÉ MOVEMENT IN ITS DIFFERENT ROLES IN CLASSICAL BALLET

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INTRODUCTION: Human movement activities as dance require coordination at the muscular, interlimb and brain level. A basic coordinated movement in dance is the demi-plié, which can be defined as a smooth bending of the knees, while maintaining turnout at the hips and the heels on the floor. Demi-plié acts as a springboard for jumps, and it is critical for high performance turns. However, due to differences in task goals, performing a demi-plié itself and to jump or turn, might have implications in its coordination. There is little scientific description of the demi-plié at the kinematic and muscular activity level, which raises questions regarding changes in coordination varying with the demi-plié task goal. Therefore, in the present study, we analyze EMG to demonstrate differences in muscle activation in relation to different task goals of the demi-plié itself and linked to 4 other ballet movements: demi-plié for vertical jumps (sauté), demi-plié for turning outward (pirouette en dehor), demi-plié for heel rises (relevé), and demi-plié for lateral displacement of the body (sissonne fermée de côté). We hypothesize that different movements linked to demi-plié will show differences in muscle activation.

METHODS: Six classical ballet dancers with at least 8 years of experience, performed the demi-plié on the 5 experimental conditions aforementioned. Participants wore soft ballet shoes, and had no injuries for 6 months prior to the experiment date. EMG data was acquired using 2 BITalino devices via bluetooth, each with 4 channels, placed in the rectus femoris, hamstrings, tibialis anterior, and gastrocnemius medialis of both legs, with sample rate of 100Hz. SENIAM recommendations were applied. Participants performed 5 repetitions of each ballet movement, in random order, with 5 minutes interval between conditions. A metronome at 64bpm was used to set the pace of the demi-plié performance. EMG data was filtered and rectified using Matlab software with personalized designed routine.

RESULTS: The tibialis anterior is active only during the descending phase, and the rectus femoris increase in the end of the descending phase, followed by decreasing activity as the ascending phase begins, with increase activation of the gastrocnemius. Both phases appear to be actively controlled by the quadriceps femoris. Gastrocnemius plays an important role to link other movements in the ascending phase of the demi-plié, reaching its peak contraction as the subsequent movement begins.

CONCLUSION: The descending phase demands great turnout of the hips, alignment between knees and toes, relying on minimum pelvic tilt for stabilizing posture and balance. The ascending phase is often in preparation for subsequent movements, requiring biomechanics adjustments for next steps. Muscle activation varies in both phases, respecting agonist-antagonist muscle function. We confirmed our hypothesis that there are differences in muscle activation when the demi-plié is performed itself and when it is linked to other ballet movements.

THE ACCLIMATION PROCESS OF THE PORTUGUESE RACE-WALKING TEAM IN PREPARATION FOR THE TOKYO 2020 OLYMPIC GAMES

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INTRODUCTION: The Walk Race competition of the 2020 Tokyo Olympic Games, was held in Sapporo during summer, were it was foreseen a temperature of 34ºC with high humidity (>70%) for the race time, which means a thermal stress indicator (WBGT)> 31ºC which falls already in the dangerous category. With this type of warning, the acclimation process becomes essential in an athletes sports preparation, not only to improve his/her sport performance but also to preserve the athlete's physical integrity.

METHODS: Two Portuguese Walk Race Team athletes, one male and one female, participated in this study. Both underwent three periods of acclimation compose by six days spaced 15 and 20 days apart respectively. Tests were performed in a climate chamber (CC) (4.5 x 4.5 x 3 m3) located at the Industrial Aerodynamics Laboratory (LAI). The indoor environmental conditions within the CC were imposed through control of the supplied air and the inner wall temperatures and

the tests took place under calm conditions, with air velocities inside the CC lower than 1.9 m.s-1. A treadmill (HP Cosmos) was used where maximum oxygen consumption tests were performed on the first day of each acclimation period using a gas analyser (Metamax cortex), in order to define the work intensity of the following acclimation sessions (60% of VO2 max). Before and after each session, body mass and urine density and temperature were acessed. In addition, heart rate and lactate concentration (Dr. Lange, Germany) and fluid consumption, loss of plasma volume and percentage of loss of body mass throughout each session were controlled

RESULTS: For the same percentage of VO2 max an increase of 13.33% and 14.02% in velocity was recorded, followed by the increase in efficiency, that translated into a decrease in oxygen consumption of 1.5 ml/kg/min and 1 ml/kg/min for the female and male athletes respectively. During the tests mean blood lactate concentration was 1.44mmol/l and 1.36 mmol/l, mean core temperature was 37.6±0.2ºC and 38±0.1 ºC, urine density before exercise 1011.88±3.09 and 1006.7±2.64, after exercise 1010.85±2.62 and 1007.1±2.84, sudation increased 1433ml and 397ml, while % of body mass loss was higher 1.34% and lower 0.08% for female and male athletes respectively. Furthermore, plasma volume loss was lower on the last acclimation period, from 7.01±2.72 to 5.75±0.95 and from 7.42±2.64 to 0.02±2.18 % for female and male athletes respectively.

CONCLUSION: In the acclimation process we found an increase in velocity at 60%VO2max with the same core temperature, and therefore higher efficiency. It was also verified, higher liquid ingestion, decrease in oxygen consumption, decrease in plasma volume lost and decrease in urine density trough the all acclimation process was also found.

In conclusion the physiological adaptations from the acclimation process are key towards performing in these extreme environmental conditions while preventing heat stress related constraints.

Conventional Print Poster

CP-AP16 Resistance Training I

DO EXISTING METHODOLOGIES ALLOW EQUALIZATION OF RESISTANCE TRAINING PROTOCOLS?

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INTRODUCTION: To compare the effects of resistance training modalities, studies equalize their training protocols by prescribing sessions with similar total training volumes (i.e., by intensity×volume calculations) or sessions with a given number of sets performed until momentary muscular failure. The aim of the study was to analyze the relevance of such methods for protocols equalization. A similar individual endpoint was used throughout the study, the exercise maximums were measured in varied resistance training sessions.

METHODS: 12 trained participants performed five sessions at 50 or 85% of one-repetition maximum (1-RM). Sessions' endpoints were determined by the inability to complete a set of at least 50% of the maximal repetitions number. Two sessions were performed with sets until failure and two sessions with sets prescribing 50% of the maximal-repetitions-number, each with 120s of inter-set recovery. The last session was performed at 85% of 1-RM with the inter-set pause reduced to match the density (exercise volume/pause duration) of the 50% 1-RM session with 50% of the maximal repetitions number. Sessions were quantified by using intensity×volume methods (including methods based on ratings of perceived exertion), and methods based on session equalization were applied through use of number of sets/repetitions completed until fatigue.

RESULTS: Sessions resulted in different number of sets until failure and repetitions number ($p<0.05$). Few differences were found in sessions' perceived exertion suggesting that each represented a similar effort. Intensity×volume methods were moderately correlated and reported marked differences between sessions. Sessions' density matching reduces differences in sessions volumes.

CONCLUSION: Despite similar sessions' endpoint sessions volumes markedly changed from one session to another. Equalization from total volume does not consider the slope of the intensity-volume relationship nor the influence of density on that relationship. Protocols equalization based on sets until failure hypothesize that a similar effort is generated whereas significant differences appeared in the ability to accumulate sets. The intensity-volume relationship and exercise density should be considered for equalizing training protocols suggesting to account for individual maximal tolerable volume in the considered exercise.

EFFECT OF REDUCED BALLISTIC TRAINING FREQUENCY ON UPPER BODY MUSCLE POWER, AFTER 12 WEEKS OF SYSTEMATIC BALLISTIC TRAINING

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INTRODUCTION: Systematic ballistic resistance training results in substantial increases in muscle strength and power as well as major improvements in various health indices [1]. However, athletes and sports enthusiasts are frequently forced to reduce their training frequency or completely abstain for training for certain periods due to sports-related injuries or lack

of time. Yet, it remains uncertain whether reducing ballistic training frequency might result in preservation of the training adaptations achieved during the systematic training period. The purpose of this study was to investigate the effect of ballistic training once per week or once every two weeks, on muscle power, after a period of 12 weeks of systematic ballistic training performed twice per week.

METHODS: Sixteen young moderately trained women (height 180±2, body mass 80±5), unacquainted with resistance exercise, followed 12 weeks of ballistic bench press training: Smith machine, 2 sessions per week, 4 sets X 6 repetitions, 60% of maximal strength performed explosively (throwing the bar into the air). The training load was increased by 5% each week after the initial 2 weeks of training. Then participants were assigned into 2 groups: group A trained once per week, while group B trained once every two weeks, for another 12 weeks, with the training intensity and volume used at the last training session of the initial 12 weeks. Maximum strength (1-RM) in bench press and muscle power in ballistic elbow extensions from prone position [(ballistic push up (BPU)] were evaluated before (T1), at the end of the 12 weeks of systematic training (T2), after 6 weeks (T3) and after 12 weeks (T4) of reduced training frequency. Statistical analysis was performed with repeated measures ANOVA, with Tuckey post-hoc test, and the level of statistical significance was set at $p \leq 0.05$.

RESULTS: BPU power and 1-RM increased after systematic training (from T1 to T2: 44.3±6.3% and 27.6±3.2%, respectively, $p<0.05$). BPU power decreased similarly in both groups after the first 6 weeks of reduced training frequency (T2-T3, group A: 10.6±2.8%, $p<0.05$, group B: 7.7±2.4 %, $p<0.05$). However, BPU power did not change during the last 6 weeks of reduced training frequency ($p>0.05$). In contrast, 1-RM decreased after the end of the reduced training frequency period only in group B (T2-T4: 7.7±2.4%, $p<0.05$).

CONCLUSION: These results suggest that muscle power of the upper extremities is significantly decreased when ballistic training frequency is reduced to one session every week or one session every 14 days. However, continuation of training with the same intensity and volume may preserve a large part of the muscle power adaptations achieved after the initial training period, in young moderately trained women.

1. Methenitis et al. (2023)

COMPARISON BETWEEN VOLUME LOAD PROGRESSION MODELS IN RESISTANCE TRAINING ON MUSCLE HYPERTROPHY: A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: It has been suggested that the progression of volume load (VL = sets x repetitions x load [kg]) may influence muscle hypertrophy. However, little is known about the causal relationship between the progression of VL and muscle hypertrophy. In a secondary analysis of studies from our group [1], we demonstrated that the model of progression by load (LOADprog) presented a higher VL progression and muscle hypertrophy than the model of progression by repetitions (REPSprog). Additionally, a correlation was demonstrated between VL progression and muscle hypertrophy. However, the absence of randomization makes it impossible to assign causality to the effects of the VL progression on muscle hypertrophy, especially when associated with a low sample size. Thus, this study aimed to investigate whether LOADprog promotes a higher VL progression and muscle hypertrophy than REPSprog. Additionally, we investigated whether there is a correlation between VL progression and muscle hypertrophy.

METHODS: This prospective, randomized controlled, single-blind, intrasubject study was registered at the National Clinical Trials (RBR-57v9mrb). Twenty men (24±3 years, 73.0±13.5 kg, 176±6.5 cm) and nineteen women (23±4 years, 62.6±8.4 kg, 163±5.4 cm) completed the study. Each participants leg was randomly allocated into LOADprog (4 sets of 9-12 repetitions maximum) or REPSprog (4 sets until muscle failure at 80% 1RM). Both RT protocols were performed unilaterally on the leg extension, 2-3 times a week for 10 weeks (24 sessions). The cross-sectional area of the vastus lateralis muscle (CSA) was assessed before (Pre) and after (Post) the RT period. For the analysis of the VL progression, the averages of the 1st and 2nd sessions (T1) and the 23rd and 24th sessions (T2) were used.

RESULTS: Mixed model analysis indicated only one main time effect for CSA ($F[1, 76]=99.93$; $P<0.0001$). The post hoc analysis revealed that both protocols significantly increased CSA from Pre (LOADprog: 21.34±4.71 cm2, REPSprog: 21.68±4.62 cm2) to Post (LOADprog: 23.53±5.41 cm2, REPSprog: 23.49±5.19 cm2). The mixed model analysis also indicated only one main time effect for VL progression ($F[1, 76]=265.5$; $P<0.0001$). Both protocols significantly increased VL from T1 (LOADprog: 1554±519 kg, REPSprog: 1439±520 kg) to T2 (LOADprog: 2531±853 kg, REPSprog: 2600±1019 kg; $P<0.0001$). There was no significant correlation between the relative change in VL progression and the relative change in CSA ($R=-0.12$; $P=0.29$).

CONCLUSION: LOADprog does not promote a higher VL progression and muscle hypertrophy than REPSprog in untrained individuals. Additionally, VL progression is not associated with muscle hypertrophy. Taken together, these findings suggest that both models of VL progression can be used for this population. Future studies should replicate and expand these findings by analyzing other muscle groups and a more extended training period.

ACUTE IMPACT OF BLOOD FLOW RESTRICTION ON STRENGTH-ENDURANCE PERFORMANCE AND TRICEPS BRACHII MUSCLE STIFFNESS DURING THE BENCH PRESS EXERCISE IN PHYSICALLY ACTIVE WOMEN

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AKADEMIA WYCHOWANIA FIZYCZNEGO IM. JERZEGO KUKUCZKI W KATOWICACH

INTRODUCTION: One of the training methods used during resistance exercise is blood flow restriction (BFR). This involves applying external pressure via a cuff to the most proximal area of the upper and/or lower limbs. The majority of studies investigating the impact of this method on strength-endurance performance were assessed on single-joint lower-body exercises using low training intensity, while only a few examined the effects of BFR on performance during high-intensity, multi-joint upper-body exercises. Therefore, the main goal of the present study was to evaluate the acute effects of blood flow restriction (BFR) at 80% of full arterial occlusion pressure on strength-endurance performance and stiffness of the lateral head of the triceps brachii muscle during the bench press exercise.

METHODS: The study included 12 physically active women (age: 22.5 ± 1.9 years; body mass: 64.1 ± 7.5 kg; bench press 1 repetition maximum (1RM): 46.7 ± 8.2 kg; resistance training experience: 2.4 ± 1.7 years). During the experimental sessions in a randomized crossover design, the subjects performed five sets of the bench press exercise at 70% 1RM until voluntary failure under two different conditions: without BFR (CON) and with BFR (BFR). The following variables were analyzed: the number of performed repetitions, time under tension, mean bar velocity, and stiffness of the lateral head of the triceps brachii muscle (via myotonometry).

RESULTS: The two-way repeated measures ANOVA didn't show a significant interaction and a main effect of condition for the number of performed repetitions (p=0.939; p=0.613), time under tension (p=0.805; p=0.097), and mean bar velocity (p=0,276; p=0.552). However, a significant main effect of the set to decrease the number of performed repetitions (p<0.01), time under tension (0<0.01), and mean bar velocity (p<0.01) across the workout was found. The three-way repeated measures ANOVA didn't show a significant interaction, main effect of condition, and set for triceps muscle stiffness (p=0.826; p=0.489; p=0.620; respectively).

CONCLUSION: This study shows that blood flow restriction has no acute effect on strength-endurance performance during the bench press exercise in physically active women. Despite no differences in performance between conditions in this study, BFR could potentially cause a significant increase in physiological, hormonal, and metabolic post-exercise responses, as indicated in previous studies.

SPATIOTEMPORAL DIFFERENCES ASSOCIATED WITH VERTICAL AND HORIZONTAL JUMPS IN ELITE ATHLETES.

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INTRODUCTION: Plyometric is a training method that aims to improve muscle power. In this method, different ways of analyzing intensity in unilateral and bilateral jumping have been reported (1). However, little has been on spatiotemporal differences in the variables associated with training intensity. These exercises are characterized by an abrupt stretching of previously tight muscles after the brake of a free fall . However, it is not known if the duration times between the eccentric phase (EPT) and the concentric phase (CPT) are similar between DJ over HDJ. It has been reported that DJ does not show significant differences in GCT and flight time (FT) as height increases, but it is unknown if this behavior is the same for HDJ. In this sense, the purpose of this study was to compare the differences in the spatiotemporal variables of the horizontal Drop Jump (HDJ) with the vertical Drop Jump (DJ) in elite jumpers and sprinters.

METHODS: Sixteen international-level athletes were recruited. All performed 2 DJ attempts with ascending order (DJ30, DJ40, and DJ50) and after 2h completed 2 HDJ attempts (HDJV30, HDJV40, HDJV50). A research-grade platform integrated with an infrared optical system allowed to analyze in real-time: GCT, FT, EPT, CPT, and time to maximum concentric peak (T-GRF-2).

RESULTS: It was found that T-GRF-2 can take 45-55 % of the total jump time, regardless of the type of exercise. In HDJ, anteroposterior forces require more time for force production relative to DJ (T-GRF-2 DJ30 = 0.109 ± 0.003 - HDJ30= 0.158 ± 0.003; DJ40 = 0.102 ± 0.003 - HDJ40= 0.134 ± 0.003; DJ50 = 0.115 ± 0.003 - HDJ50= 0.165 ± 0.003). The other associated variables also showed significant differences ($p \leq 0.05$) benefiting DJ.

CONCLUSION: DISCUSSION. The TGRF-2 for the DJ was better than that reported in one previous study (24). We found that the time to the concentric peak of the GRF can take 45-55% of the total time of the jump, which represents that the muscles still must continue force production 45-55% longer after reaching the concentric peak force. Also, our results show that in the HDJ the anteroposterior forces need a longer time to take the peak force production relative to the vertical forces. Other results of the EPT and CPT results show that for both exercises, EPT tends to be significantly lower than CPT. Likewise, EPT is significantly lower in DJ than in HDJ. For CPT, the behavior is not the same, where significant differences are observed only for some sets of heights.

CONCLUSIONS: The findings showed differences between DJ and DHJ. It is suggested that coaches use the DJ to enhance the fast stretch-shortening cycle exercise and the DHJ for slow-type exercises (3). Because of the characteristics of GCT, the HDJ might not favour fast stimuli during the maximal speed phase of sprinting. However, the start and acceleration phase can be favourable, where more TGRF-2 is needed, and contact times are more delayed than DJ.

EXPLORING THE ACUTE AFFECTIVE RESPONSES TO RESISTANCE TRAINING: A COMPARISON OF THE PREDETERMINED AND THE ESTIMATED REPETITIONS TO FAILURE APPROACHES

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INTRODUCTION: In resistance-training (RT), the number of repetitions is traditionally prescribed using a predetermined approach (e.g., three sets of 10 repetitions). An emerging alternative is the estimated repetitions to failure (ERF) approach (e.g., terminating sets two repetitions from failure). Despite the importance of affective responses experienced during RT, a comparison between the two approaches on such outcomes is lacking.

METHODS: Twenty women (age range: 23–45 years) without RT experience completed estimated one repetition maximum (RM) tests in four exercises. In the next two counterbalanced sessions, participants performed the exercises using 70%1RM. Participants completed ten repetitions in all three sets (predetermined condition) or terminated the sets when perceived to be two repetitions away from task-failure (ERF condition). Primary outcomes were affective-valence, enjoyment, and approach-preference and secondary outcomes were repetition-numbers completed in each exercise.

RESULTS: We observed trivial differences in the subjective measures and an approximately even approach-preference split. Under the ERF condition, we observed greater variability in repetition-numbers between participants and across exercises. Specifically, the mean number of repetitions was slightly lower in the chest-press, knee-extension, and lat-pulldown (~1 repetition) but considerably higher in the leg-press (17 vs. 10, $p<0.01$).

CONCLUSION: Both approaches led to comparable affective responses and to an approximately even approach preference. Hence, prior to prescribing either approach, coaches should consider trainee's preferences. Moreover, under the ERF condition participants completed a dissimilar number of repetitions across exercises while presumably reaching a similar proximity to task-failure. This finding suggests that ERF allows for better effort regulation between exercises.

SIX WEEKS OF UNILATERAL FLYWHEEL HIP EXTENSION AND LEG CURL TRAINING IMPROVES FLYWHEEL ECCENTRIC PEAK POWER BUT DOES NOT ENHANCE HAMSTRING ISOKINETIC OR ISOMETRIC STRENGTH.

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INTRODUCTION: Hamstring strain injuries are highly problematic and likely to re-occur. Although injury is likely multifactorial, evidence suggests development of eccentric strength may help performance and reduce likelihood of injury. The use of strength training with an eccentric emphasis and exercises based around both the knee and the hip joint have become more commonplace. Similarly, flywheel training has seen greater integration in sport for performance and rehabilitation and has therefore garnered greater research interest. Although bilateral leg curl and deadlift flywheel training have enhanced hamstring strength and showed interesting findings regarding injury prevention, little is known about unilateral hamstring flywheel training.

The present study aimed to determine whether unilateral flywheel hamstring training (a combination of hip extension and knee flexion exercises) enhances isokinetic, isometric, and flywheel measures more than a control condition.

METHODS: The study involved 11 male university athletes (age 22 ± 2 years; body mass 77.2 ± 11.3 kg; height 1.74 ± 0.09 m) with their legs randomly allocated to flywheel training or control. Eccentric knee flexion torque (60°.s-1), isometric torque (30° of knee flexion), and flywheel unilateral leg curl and hip extension peak power were measured before and after training. Training involved progressive increase in volume or intensity of knee flexion and hip extension exercises.

RESULTS: The intervention enhanced hip extension concentric ($p < 0.01$, $d = 1.76$, large) and eccentric ($p < 0.01$, $d = 1.33$, large) peak power more so than the control (significant interaction effect). Similarly, eccentric ($p = 0.023$, $d = 1.05$, moderate) peak power was enhanced for the leg curl. No statistically significant differences between conditions were found for isokinetic eccentric ($p = 0.086$, $d = 0.77$, moderate) and isometric ($p = 0.431$, $d = 0.36$, small) knee flexor strength or leg curl concentric peak power ($p = 0.339$, $d = 0.52$, small). Statistical parametric mapping analysis of torque-angle curves also revealed no significant ($p > 0.05$) time-limb interaction effect at any joint angle.

CONCLUSION: Unilateral hamstring flywheel training enhances flywheel eccentric peak power. However, coaches should consider strength to be task specific and not translate unanimously between tests. Specifically, no improvements in isokinetic eccentric or isometric (long-lever) hamstring strength were seen. Additionally, practitioners should aim to monitor and use mechanical outputs to guide training and periodisation as significant differences between exercises are evident. The large variation in eccentric overload seen between exercises (larger eccentric overload during leg curl in comparison to hip extension) and sessions supports the need to monitor mechanical outputs during flywheel training. We also present strength adaptations throughout the entire range of motion for the first time after flywheel training using statistical parametric mapping.

EFFECTS OF 8-WEEK HIGH-VELOCITY RESISTANCE TRAINING ON MUSCLE PROPERTIES AND MUSCLE FUNCTION: A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Muscle quality declines earlier than muscle mass [1] and affects muscle function independently of muscle mass [2]. It is critical to understand how muscle quality can be effectively improved to prevent and treat muscle dysfunc-

tion; however, measures to effectively improve muscle quality remain unclear. The present study aimed to investigate the effect of different training velocities on the improvement in muscle quality by comparing the effects of high- and low-velocity resistance training on muscle quality, mass, and function before and after an 8-week intervention.

METHODS: Thirty-three healthy young women (ages; 23.1 ± 2.2 years, height; 159.2 ± 5.7cm, body mass; 20.2 ± 5.8kg) were randomly assigned into two groups: the high-velocity resistance training group (HVRT group, n = 16) and the low-velocity resistance training group (LVRT group, n = 17). Each group underwent concentric knee extension resistance training with a load of 60% one-repetition maximum (1RM), with 10 repetitions per set for 4 sets, 3 times per week for 8 weeks. Before and after the 8-week intervention, quadriceps femoris muscle echo intensity (QFEI), muscle thickness (QFMT), isokinetic strength (60°/s and 300°/s), rate of velocity development (RVD) at 300°/s, and 1RM were assessed. Split-plot factorial design analysis of variance was used to compare the interaction between groups and time.

RESULTS: For QFEI, there was an interaction between groups and time ($p < 0.01$) and a main effect of time ($p < 0.01$). The HVRT group showed a significant reduction in QFEI after the 8-week intervention; however, the LVRT group did not. QFMT revealed only the main effect of time ($p < 0.01$), and both groups showed significant increases in QFMT after the 8-week intervention.

In the results on muscle function, RVD showed a group × time interaction ($p < 0.05$) and a main effect of time ($p < 0.01$), with a significant increase in RVD only in the HVRT group. Isokinetic strength (60°/s and 300°/s) and 1RM showed a main effect of time ($p < 0.01$), both groups showed significant increases in isokinetic strength and 1RM after the 8-week intervention.

CONCLUSION: Significant improvements in QFEI and RVD after 8 weeks of intervention were observed in the HVRT group compared with the LVRT group when performing RT at the same intensity and same number of sets and repetitions. These findings suggest that HVRT is more effective in improving muscle quality than LVRT.

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NEUROMUSCULAR RESPONSIVENESS DURING ACHILLES TENDON VIBRATION WHILE STANDING, IN RELATION WITH THE WALKING CAPACITY OF CHILDREN WITH CEREBRAL PALSY

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INTRODUCTION: Cerebral palsy (CP) is a neurodevelopmental disorder characterized by poor postural control and gait [1]. Although deficits in sensory input and processing are well documented in CP [2], the investigation of proprioception in posture and gait is rather limited. Vibration applied on the Achilles tendon (ATV) disturbs proprioceptive input, which can be used to investigate the contribution of proprioceptive inputs in postural control [3]. The purpose of this study was to assess postural and muscular responses in response to ATV while standing, and to investigate possible relation with walking ability in children with CP and typically developed (TD) children.

METHODS: Nine children with CP (12.5±1.7 yrs, 147.3±0.5 cm, 46.1±0.8 kg) and 16 children with TD (14.0±3.8 yrs, 161.2±1.2 cm, 54.8±0.9 kg) performed 10 m walking at comfortable and maximum speed tests, and 2 (for CP) or 6 (for TD) minutes walking (endurance test). Bilateral ATV was applied during standing on a force platform, with eyes closed, for 30 s, while the center of pressure (CoP), trunk acceleration (TrA) and electromyographic responses of the soleus (Sol), gastrocnemius medialis (MGas) and tibialis anterior (TA) muscles were analyzed for 5 s before/after the start and end of ATV. The rate of change of the variables after the start and before/after the end of ATV was expressed as the log2 ratio relative to values before ATV. The correlations between the performance in walking tests and the postural or electromyographic variables were examined with Pearson's r, whereas Spearman's rho was calculated when normal distribution was not granted.

RESULTS: None of the walking tests demonstrates significant correlation with changes in CoP or TrA at any time point of analysis ($p>0.05$). Performance at 10-m walking (comfortable) and endurance test was significantly correlated to the change in Sol and MGas activation after the onset of ATV and before the end of ATV ($p<0.05$). Furthermore, muscle activation did not correlate significantly for the instances before the start and after the end of ATV ($p>0.05$). Furthermore, change in TA activation was not correlated with the performance of any of the walking tests, whereas 10-m walking at maximum speed was also not correlated with any of the examined variables ($p>0.05$).

CONCLUSION: Although motor responses due to ATV were not related to performance in walking, the results of this study indicate that ATV activates more the muscles of children (CP and TD) with less walking capacity. Since walking capacity indirectly reflects the extent of motor deficit in CP, this knowledge may help us linking the effects of ATV with the clinical picture, which might be a useful tool to seek new intervention strategies in CP.

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BEYOND THE LUNGS: CAN O2 SUPPLEMENTATION BE BENEFICIAL FOR CEREBRAL OXYGENATION AND FATIGUE DURING EXERCISE IN FIBROTIC INTERSTITIAL LUNG DISEASE?

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INTRODUCTION: Cerebral hypoxia may exacerbate the perception of fatigue during exercise.[1] We previously demonstrated that activity-related hypoxaemia, a hallmark of fibrotic interstitial lung disease (f-ILD), dose-dependently impairs cerebral oxygenation in this population.[2] The prevailing view is that supplemental O2 may improve exercise tolerance in f-ILD by lessening the hypoxic ventilatory drive and dyspnoea.[3] It remains untested, however, whether part of the ergogenic effects of O2 may be attributable to improved cerebral oxygenation and perceived fatigue in this patient population.

METHODS: Fourteen patients with f-ILD (12 men, 72±8 years, 8 with idiopathic pulmonary fibrosis, lung transfer for carbon monoxide= 44±13% predicted) performed a constant-load (60% peak work rate) cycle test to symptom limitation under medical air (Tlimair). Fourteen controls exercised up to Tlimair of their individually (age- and sex-) matched patient. Later on, patients repeated the test on supplemental O2 (fraction of inspired O2= 0.41±0.08) up to their own Tlimair. Patients were blind to the gas mixture being delivered and arterial O2 saturation by pulse oximetry (SpO2) readings during each test. We used near-infrared spectroscopy and the rating-of-fatigue (ROF) scale to respectively assess prefrontal cortex oxygenation and perceived fatigue.

RESULTS: All patients developed severe exertional hypoxaemia (Tlimair SpO2= 80±8% after 16.9±4.2 min). They showed poorer cerebral oxygenation as indicated by larger deoxyhemoglobin (HHb) [2.9±2.6 (range: 0.0 to 10.8) vs -0.5±0.9 µmol from rest] and had greater perceived fatigue (ROF= 6.2±2.0 vs 2.6±2.3) vs controls under air ($p<0.001$). Reversal of exertional hypoxaemia with supplemental O2 (SpO2= 98±1%) led to a significant decrease in HHb (-0.4±1.3 µmol from rest; no longer differing from controls) and lower ROF scores (3.7±1.2; $p<0.001$ vs air) in patients. Supplemental O2-induced changes in HHb correlated with those in ROF scores throughout exercise in f-ILD (rrepeated-measures correlation= 0.56; 95% confidence intervals= 0.37 to 0.70; $p<0.001$).

CONCLUSION: The beneficial effects of O2 supplementation during exercise in f-ILD are not limited to "the lungs": reversing cerebral hypoxia to lessen perceived fatigue is relevant to enhance exercise tolerance in this patient population.

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THE USE OF THE SIX-MINUTE WALK TEST (6-MWT) TO SCREEN FOR SYMPTOMS OF ACUTE MOUNTAIN SICKNESS AND PREDICT SUSCEPTIBILITY DURING A LONG-TERM EXPOSURE IN NORMOBARIC HYPOXIA.

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INTRODUCTION: Individuals travelling to altitudes of >2000-2500 m are at increased risk of acute mountain sickness (AMS) and may benefit from undergoing a standardised screening assessment prior to departure. As such, a simple and time-efficient tool for predicting human physiological responses to altitude exposure (both simulated and true), is the 6-minute walking test (6-MWT). The 6-MWT also demonstrates acceptable construct validity when monitoring acclimatisation at terrestrial altitude of ~3400 m, however, it is unknown if this test can predict symptoms of AMS during a prolonged exposure to normobaric hypoxia. Therefore, the aim of this study was to: 1) compare the performance outcome and humans responses towards the 6-MWT between normoxia and normobaric hypoxia; and 2) investigate if the 6-MWT in normobaric hypoxia can predict symptoms of AMS during an 8-hour normobaric hypoxia exposure.

METHODS: Forty-four healthy participants (25 males, 19 females, 31±10 years, 73.9 ± 14.6 kg 174.1 ± 8.0 cm) visited the laboratories on three occasions to complete a normoxic and normobaric hypoxic 6-MWT, and then an 8-hour exposure to normobaric hypoxia at rest. Participants underwent a familiarisation trial and 30-mins rest in each condition before starting the 6-MWT, which was completed in a randomised order. Normobaric hypoxia occurred within an environment simulating an altitude of 4500 m (fraction of inspired oxygen [FiO2]: 12.5%).

RESULTS: A significantly impaired performance (668 ± 83 vs. 725 ± 90 m, $p<0.05$), lower pulse oxygen saturation (SpO2: 75 ± 8 vs. 97 ± 2 %, $p<0.05$) and higher AMS scores via the Lake Louise Questionnaire (1 ± 1 vs. 0 ± 0 arbitrary units, $p<0.05$) were observed following the 6-MWT in normobaric hypoxia compared to normoxia. During the 8-hour normobaric hypoxic exposure, a reduction in resting SpO2 (mean: 81 ± 4 %, end: 82 ± 6 %, pre-to-post change: -16 ± 6 %) and an increase in AMS scores were observed (mean: +1 ± 4, end: +2 ± 2, pre-to-post change: +2 ± 2 arbitrary units). Low corre-

lation coefficient values were found for post-test and pre-to-post test changes in SpO2 (r = 0.3 and 0.0) and AMS scores (r = 0.3 and 0.2) between the 6-MWT and 8-hour prolonged exposure in normobaric hypoxia, respectively.

CONCLUSION: The 6-MWT demonstrates impairment to performance, increased physiological strain and the occurrence of AMS symptoms in response to normobaric hypoxia compared to normoxia. However, it appears the 6-MWT is unable to predict AMS susceptibility, nor impairment to SpO2 during a prolonged exposure to normobaric hypoxia. Whilst the 6-MWT is useful for monitoring acclimatisation progress and provides a good tool for educational purposes to improve individuals' knowledge on the effect hypoxia has on performance and health outcomes prior to departing for an prolonged sojourn at altitude, it is not currently possible to be used in screening for, or predicting AMS susceptibility.

STRENGTH TRAINING OF THE LOWER EXTREMITIES MAY HAVE LARGER BENEFICIAL EFFECTS ON BRAIN HEALTH IN OLDER ADULTS WITH MCI THAN IN COGNITIVELY UNIMPAIRED OLDER ADULTS

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INTRODUCTION: Physical exercise is considered a potent countermeasure against various age-associated neurodegenerative processes. We assessed the effect of 12 weeks of resistance training (RT) on neurometabolites and gray matter volume in the hippocampus. This region has a high potential to be negatively affected by aging, specifically in the preclinical phase of dementia such as in older individuals with mild cognitive impairment (MCI).

METHODS: Complete randomized controlled trial data were obtained from 37 older individuals (60-85y old) of whom 11 were diagnosed as individuals with MCI and the remaining were cathegorized as cognitively unimpaired healthy controls (HC). Participants were randomly allocated to 12 weeks of lower body resistance training (n = 23; 7 MCI) or passive control (n = 14; 4 MCI). 1H-MRS spectra were acquired from the left hippocampus (HPC) using the PRESS sequence and neurpmetabolite levels were quantified with LCModel (version 6.3.1-R). Neurometabolites of interest were the ratios to creatine (Cr) of N-acetyl aspartate (NAA/Cr) and myoinositol (mIns/Cr) and NAA/mIns. Gray matter volume (GMV) of the right and left hippocampus were estimated from 3D T1-weighted images using FreeSurfer (v7.1.1). Main outcome measures were pre-to-post changes (expressed as % of baseline values of the three neuromatabolite ratios and right and left HPC GMV. Two-way ANOVAs with Group (Exercise versus Control) and Condition (MCI versus HC) were used to compare the effect of RT intervention or no intervention on % changes in the aforementioned outcome measures.

RESULTS: A significant main effect of Condition ($F(1,33) = 5.93$, $p = 0.020$, partial $eta^2 = 0.152$) was found for NAA/mIns ratio in the total sample, showing a pre-to-post increase of NAA/mIns ratio in HC (+ 10.4 ± 25.4 %) as compared to a decrease in MCI (- 7.2 ± 15.1 %). A closer inspection of these observation suggests a mean reduction of about 20% of NAA/mIns ratio in MCI who were not included in the exercise group whereas MCI who underwent 12 week of RT showed relatively stable NAA/mIns ratios. However, the Group main effect and the Group x Condition interaction were not significant (both $F(1,33) \leq 2.08$, $p \geq 0.158$). No other main effects or interactions were found (all $p \geq 0.071$). However, a trend with a Group moderate effect size (partial $eta^2 = 0.071$) was found for right HPC GMV suggesting that the RT group showed an increase in right HPC GMV (+ 0.44 ± 2.07 %) whereas a decrease (- 0.60 ± 1.52 %) was observed for passive controls.

CONCLUSION: We showed that a 12 weeks of RT intervention may be effective for slowing or preventing neuronal loss and possibly reduce the detrimental effect of age-related glial cell overactivity. These beneficial effects appeared to be more pronounced in MCI than in cognitively unimpaired older adults.

The study was supported by funds from the Research Council of Lithuania (Grant Number S-SEN-20-5).

THE EFFECT OF ROBOTIC WALKING ON SPASTICITY, PAIN, AND QUALITY OF LIFE IN INDIVIDUALS WITH CHRONIC SPINAL CORD INJURY: A PILOT RANDOMISED CONTROLLED TRIAL

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INTRODUCTION: The prevention and treatment of secondary complications is a key priority for people with spinal cord injury (SCI) and a fundamental goal of SCI rehabilitation. The conceptual basis for RLT appears promising; a rehabilitation modality that removes the need for intensive assistance from therapists, whilst facilitating safe and effective over-ground ambulation. However, small sample sizes and a lack of homogeneity across studies have resulted in an underpowered evidence base supporting the efficacy of RLT for SCI rehabilitation. Thus, this randomized control pilot study aimed to investigate the effects of RLT compared to ABT on pain, spasticity, and quality of life in individuals with incomplete SCI.

METHODS: Participants with chronic motor incomplete tetraplegia (n = 16) were recruited. Each intervention involved 60-minute sessions, 3x per week, over 24-weeks. RLT involved walking in an Ekso GT exoskeleton. ABT involved a combination of resistance, cardiovascular and weight-bearing exercise. Outcomes of interest included the Modified Ashworth Scale, the International SCI Pain Basic Data Set Version 2, and the International SCI Quality of Life Basic Data Set.

RESULTS: Neither intervention altered symptoms of spasticity. Pain intensity increased from pre-post intervention for both groups, with a mean increase of 1.55 [−0.82, 3.92] ($p = 0.03$) and 1.56 [−0.43, 3.55] ($p = 0.02$) points for the RLT and ABT group, respectively. The ABT group had an increase in pain interference scores of 100%, 50%, and 109% for the daily activity, mood, and sleep domain, respectively. The RLT group had an increase in pain interference scores of 86% and 69% for the daily activity and mood domain respectively, but no change in the sleep domain. The RLT group had increased perceptions of quality of life with changes of 2.37 [0.32, 4.41], 2.00 [0.43, 3.56] and 0.25 [−1.63, 2.13] points, $p = 0.03$, for the general, physical, and psychological domains, respectively. The ABT group had increased perceptions of general,

physical and psychological quality of life with changes of 0.75 [–1.38, 2.88], 0.62 [–1.83, 3.07] and 0.63 [–1.87, 3.13] points, respectively.

CONCLUSION: Despite the increased pain ratings and no change in spasticity symptoms, there was an increase in perceived QoL for both groups over 24-weeks. This dichotomy warrants additional investigation in future large-scale RCTs. This pilot trial offers promising evidence for the effectiveness of RLT for improving functional and ambulatory capacity, secondary complications and quality of life in people with incomplete SCI.

IMPACT OF EXERCISE ON CARDIOPULMONARY AND VASCULAR HEALTH IN OLDER ADULTS WITH INTELLECTUAL DISABILITY: A 6-MONTH RANDOMIZED PILOT STUDY

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INTRODUCTION: Older adults with intellectual disabilities (ID) are at high risk for cardiovascular disease. They have reduced physical fitness compared to their non-disabled peers, so exercise programs are essential to improve their health and quality of life.

This study aimed to compare the effect of two types of exercise programs [continuous aerobic training (CAT) and all-out sprint interval training (SIT)] on aerobic capacity and vascular health in older adults with ID.

METHODS: Twenty-four older adults (50.58±1.44 years) with mild or moderate ID of both sexes participated. Control (n=8), SIT (n=8) and CAT (n=8) groups were randomly formed. The SIT and CAT groups performed 72 sessions of 90 min, 3 times/week on cycle ergometers. The variables analyzed were: age, weight, height, body mass index (BMI), cardiorespiratory fitness (VO2), peak power, carotid-to-femoral pulse wave velocity (PWVcf), systolic (SBP) and diastolic (DBP) blood pressure. Vascular and arterial stiffness parameters were assessed by tonometry (SphygmoCor Xcel, AtCor Medical, Sydney, Australia) and VO2 by a stress test with metabolic analysis on a cycle ergometer. Descriptive values were obtained for all variables. A one-way ANOVA was used to compare age, height, weight and BMI. To analyze the effects of the interventions, repeated measures ANOVA with Boferroni post-hoc tests were used. Statistical significance was set at $\alpha<0.05$.

RESULTS: At the beginning, the age, height, weight and BMI were similar in all groups. The SIT group significantly decreased body weight (76.4 vs 73.8 kg) and BMI (29.7 vs 28.7 kg/m2) at the end of the intervention (all p<.05). The SIT group significantly increased VO2 peak (18.7 vs 21.7 ml/kg/min) and peak workload (101.5 vs 136.3 watts) achieved during the maximal stress test (p=0.019; p=0.001 respectively). These increases were significantly higher than those of the CAT group (p=0.042; p=0.046 respectively). PWVcf was lower at the end of the intervention in both active groups (CAT: 7.67 vs 6.61 m/sec, p=0.02; SIT: 7.91 vs 7.20 m/sec, p=0.04). Only the SIT group decreased the SBP (129.7 vs 121.3 mmHg, p=0.035). DBP decreased in both active groups (CAT: 79.7 vs 72.5 mmHg, p=0.02; SIT: 78.5 vs 73.0 mmHg, p=0.013).

CONCLUSION: Both exercise programs (SIT and CAT) positively impacted central arterial stiffness and blood pressure.

The SIT program promoted better aerobic capacity, peak power, body weight and BMI results.

All-out sprint interval training interventions may be a valid tool to improve the health of older adults with ID.

THE EFFECTS OF PRESCRIBED EXERCISE ON THE PHYSICAL AND COGNITIVE HEALTH OF ADULTS WITH DOWN SYNDROME

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INTRODUCTION: Down syndrome (DS) is the result of the presence of either the whole or part of an additional duplication of chromosome-21. The countenance of this additional chromosome can be linked to chronotropic and respiratory incompetence, neuromuscular conditions, immunological suppression, impaired decision making, verbal reasoning, processing, and executive function. Recent works showed that American adults with DS that they engaged in just 10.1 ± 13.5 min of moderate intensity activity, coupled with 1.7 ± 9.8 min of vigorous activity. Indeed, they were shown to engage in 412.7 ± 216.6 min of sedentary time per day. Additionally, the burden to the health care sector associated with DS equates to an additional $78,500,000 per annum. Therefore, the purpose of this study was to examine the effects of 8-weeks of prescribed exercise and/or cognitive training on the physical and cognitive health of adults with DS.

METHODS: Following ethics approval 84 participants (age 27.0 ± 8.0) from 5 countries volunteered and agreed to participate. Measures of physical fitness and cognitive function were obtained using a modified version of the 6-minute walk test, (completed twice) as well as a modified version of the talk test, while cognitive and executive function were assessed using the Corsi block test, Stroop task, and the Sustained-Attention-To-Response Task (SART) test. All tests were completed pre and post intervention. Based upon distance completed across the 6-minute walk test, participants were assigned to 8-weeks of either 3 x 30 min of walking (EXC), 6 x 20 min of cognitive training (COG), combined group of EXC and COG (COM) or no intervention (CON). Data expressed as mean ± SD.

RESULTS: Reputed measures ANOVA showed a significant increase (P< 0.05) in 6-min walk distance for both EXC (55.6 ± 66.4 m) and COM (51.7 ± 65.0 m). Number of correct responses in the SART showed significant (P= 0.000) increases for EXC (9.1 ± 5.0), COG (P= 0.000) (8.5 ± 7.5) and COM (P= 0.03) (10.0 ± 23.3). STROOP non-compatible correct responses increased by 6.1% (P= 0.02) for EXC and 35.3% (P= 0.001).

CONCLUSION: These findings show that prescribed exercise can have a profound effect on both the physical and cognitive health of adults with Down syndrome. The changes in cognitive function show evidence of for enhanced decision making and critical thinking.

EFFECT OF HATHA YOGA IN PATIENTS WITH EATING DISORDERS: A CLINICAL STUDY.

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INTRODUCTION: Eating Disorders (ED), such as anorexia and bulimia, affect about 10% of young people [1]. Physiological and psycho-cognitive comorbidities are commonly associated with ED, including interoceptive deficit [2]. Interoceptive awareness (IA) is the ability to identify, access, understand, and respond appropriately to internal cues (digestive system, muscle tension, heart rate, etc.) [3]. IA can be improved by mind-body practices such as meditation or yoga [2]. To our knowledge, the effect of yoga on IA has not yet been studied in ED patients. The aims of this study are 1) to assess the effect of yoga on IA of ED patients and 2), on body mass index (BMI), eating attitudes, mood, exercise motives and sleep quality, in a clinical setting.

METHODS: After 8-weeks of three Hatha yoga sessions per week, 11 inpatient participants (age = 25.91) completed the multidimensional assessment of IA (MAIA) scale, the eating attitude test (EAT-26), the hospital anxiety and depression scale (HAD), the exercise motivation inventory-2 (EMI-2) and the Pittsburgh sleep quality index (PSQI).

RESULTS: A non-parametric analysis showed a significant improvement in the MAIA score after the 8 weeks of yoga ($p<.05$), with a pre-program score of 63/160 and a post-program score of 84/160. Significant improvement were also found in BMI (18.37 to 19.44), EAT-26 score (39 to 25), HAD depression score (7 to 4) and EMI-2 body-related motivations score (7.75 to 6.56).

CONCLUSION: The decrease observed in the EAT-26 score as well as the increase in BMI confirmed that yoga is suitable for ED patients and does not affect treatment [2]. The decrease in the depression score confirmed the positive effect of yoga on mood observed in other studies [2]. The decrease in body-related motivations score suggests that yoga contributed to shift from an exercise-related mindset, to a less body-oriented goal. It shows a new vision of yoga for patients with ED and could be a new therapeutic lever to address problematic exercise in ED treatment. The increase in MAIA score revealed a positive effect of yoga on IA and highlights that IA may be an important target for yoga intervention in ED. However, these results need to be taken with caution, as the sample size remains small. Additional data are needed as well as a control group.

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CARDIAC AUTONOMIC MODULATION AND FITNESS RESPONSES TO A 6-MONTH MULTICOMPONENT SPRINT INTERVAL TRAINING INTERVENTION IN OLDER ADULTS WITH INTELLECTUAL DISABILITY: A RANDOMIZED CONTROL TRIAL

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INTRODUCTION: Persons with intellectual disability (ID) present many conditions and diseases, such as cardiovascular diseases, obesity, and diabetes [1]. Physical and functional improvements have been described after implementing aerobic and/or sprint interval training protocols in people with ID [2]. Nevertheless, whether these interventions may affect the cardiac autonomic modulation at rest, during and after a submaximal exercise test in older adults with an ID is unknown. Therefore, the aim of this study was to investigate if there is an enhancement in cardiac autonomic modulation (HRV, rest-to-exercise HR's delta and HR off-kinetics) after 6 months of two multicomponent interventions in older adults with an ID.

METHODS: In this randomized control trial, participants with ID (age: 50.58 ± 7.25) were allocated into three groups [multicomponent aerobic training group (MATG), multicomponent sprint interval training group (MSITG) and control group (CG)]. The programs included aerobic (on cycle ergometers), resistance, balance, and flexibility training. Participants trained 3 times/week, 75-90 minutes/session during 24 weeks. The MSITG performed bouts of 5 to 10-min of exercise consisting of 5 to 20-s all-out sprints followed by 15 to 60-s of low cadence recovery. The MATG performed aerobic bouts of 5 to 10-min and the intensity was progressively increased from 55% to 85% of the HR reserve. The 6-min walking test has been used to assess the submaximal exercise performance. The cardiac autonomic modulation was evaluated by using the linear and non-linear parameters of the HRV, the analysis of rest-to-exercise HR delta and HR off-kinetics. Models include DS as covariate and Bonferroni adjustments were used for comparisons.

RESULTS: A group x time interaction was observed for the variables Δ0-30s ($F(2)=3.694$; $p<0.05$) and physical capacity ($F(2)=6.115$; $p<0.01$). The MSITG showed a significant increase of HR deltas between rest and the first 30s of exercise

($p<0.05$) and a significant increase in aerobic capacity ($p<0.05$). In contrast, CG significantly reduced physical performance ($p<0.01$).

CONCLUSION: The MSITG improved the physical performance and the vagal removal at the beginning of the submaximal exercise. In addition, these results show an attenuation of the aggravation of autonomic reflex response capacity suffered by the influence of aging. These improvements could be due to the positive effects of high-intensity exercise on baroreflex function. The MSIT intervention could be used to enhance baroreflex sensitivity in older adults with ID.

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VERTICAL CENTER-OF-MASS BRAKING AND MOTOR PERFORMANCE DURING GAIT INITIATION IN HEALTHY ADULTS AND PARKINSON'S DISEASE PATIENTS: A COMPARISON BETWEEN FORCE-PLATE AND MARKERLESS MOTION CAPTURE SYSTEM

SIMONET, A.1,2,3, DELAFONTAINE, A.2,3,4, FOURCADE, P.2,3, YIOU, E.2,3

1 LADAPT LOIRET, CENTRE DE SOINS DE SUITE ET DE RÉADAPTATION 2 CIAMS, UNIVERSITÉ PARIS-SACLAY 3 CIAMS, UNIVERSITÉ D'ORLÉANS 4 UNIVERSITÉ LIBRE DE BRUXELLES, BELGIQUE

INTRODUCTION: Gait initiation (GI) is a locomotor task that is classically used in the literature to investigate stability control and motor performance (MP) in healthy subjects and neurological patients (1). The quantification of these biomechanical parameters requires the recordings from force-plate(s) (FP) and/or motion capture system (MCS). Conventional MCS necessitate 38 markers to compute whole-body center-of mass (CM) kinematics. It is therefore time-consuming and, as FP, requires highly trained operators (2). Markerless MCS is a recent innovative technology that facilitates motion analysis and that does not require any preparation of experimental participants. It may therefore drastically reduce the duration of experiments/data treatment, which may be relevant for researchers, clinicians and patients. This study questioned the ability of markerless MCS to evaluate accurately stability control and MP during GI in healthy subjects and patients with Parkinson's disease (PD). Values provided by FP were considered as the gold standards1 against which values provided by markerless MCS were compared.

METHODS: Ten young healthy adults (YH), 10 healthy elderly (EH) and 10 PD participated in the study. All performed series of GI at a spontaneous and fast velocity. Signals from FP and markerless MCS were simultaneously recorded to compute CM kinematics. Experimental variables were the peak of CM velocity along the anteroposterior axis and the "braking index" (BI), which correspond to indicators of MP and stability control, respectively. BI was computed as the ratio [peak downward CM velocity (VzMIN) minus vertical CM velocity at foot-contact]/VzMIN. BI reflects the capacity of participants to brake their CM fall under gravity (1). To investigate the agreement between the two systems, a Bland and Altman (BA) analysis was conducted for both variables under each velocity condition and group. Repeated-measures ANOVA with the Velocity (spontaneous vs. fast) and System (FP vs. markerless MCS) as within-subject factors, and the Group (YH, EH, PD) as between-subject factor were carried out. Newman-Keuls post hoc tests were conducted when necessary.

RESULTS: BA plots showed that the absolute and relative biases for MP and BI were virtually zero in each velocity condition and group. 95% of the relative MP differences between the two systems ranged between +10% and -10% for MP and +40% and -40% for BI. ANOVA revealed a significant main effect of Group and Velocity (but not System) for both variables ($p<0.05$), and a Group*Velocity interaction. Post hoc tests further showed that the two systems detected similar significant differences between groups and velocity conditions for both variables.

CONCLUSION: These results suggest that markerless MCS are sufficiently accurate to compare BI and MP across groups and velocity conditions, which might be useful in a research and clinical context.

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CP-SH06 Sport psychology

EXPLORING THE INTERPLAY BETWEEN ELITE ATHLETES AND SPORT EQUIPMENT IN THE QUEST FOR PERFORMANCE: A CASE STUDY IN SAILING

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Introduction

From a phenomenological perspective, it is classically assumed that when sport equipment is used by expert athletes, it is so well incorporated to the athlete's body that it becomes transparent, disappearing from the athlete's awareness. How-

ever, few studies have investigated the perceptual experiences of expert athletes using their equipment to challenge this assumption. These studies focus on small equipment such as backpacks or ice axes, showing that even these types of equipment can have a significant presence in elite athlete's experience. We pursued this exploration in the sport of windsurfing and more specifically in IQfoil (i.e. the Olympic windsurfing class). Indeed, in IQfoil, the size and characteristics of the equipment contrasts with those of the previous studies, creating a favorable situation of research to contribute to the understanding of the interplay between human and sport equipment.

Methods

We collected data during a training session of two elite IQfoil riders. Both had a long record of international victories and were part of the national team. We collected data in two steps: (a) in-situ audio-video recording of the training session; and (b) individual self-confrontation interviews. We conducted the data analysis using the Course of Experience framework methodologies to identify and categorize the meaningful elements of the riders' own worlds.

Results

The analysis revealed eight typical meaningful elements in the riders' own worlds: flight height, physical effort, position in the fleet, sail movements, sail power, speed variations, transmission balance, wind variations. These findings reveal that when riders try to optimize their speed, their attention is distributed between the environment (i.e., wind variation, position in the fleet), their relation with the equipment (i.e., transmission balance, physical effort), and the relation between the equipment and the environment (i.e., sail power, flight height, speed variation).

Discussion

Our findings contribute to the understanding of expert use of sport equipment in two complementary ways: (a) by contributing to apprehend distinctions between classes of equipment in function of their autonomy of movements in relation to the athletes' activity; and (b) by suggesting a fundamental distinction between the experience of using sport equipment in an activity of performance optimization versus in a daily routine activity.

QUALITATIVE AND QUANTITATIVE RESEARCH FOR SPORTSPERSONSHIP OF UNIVERSITY STUDENT-ATHLETES

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INTRODUCTION: The Multidimensional Sportspersonship Orientation Scale (MSOS) [1] has been often used to measure sportspersonship attitudes but is characterized by a small number of question items regarding negative attitudes. Other measures related to sportsmanship attitudes include the Moral Disengagement in Sport Scale (MDSS) [2], which measures only negative attitudes, and the Attitude to Moral Decision-making in Youth Sport Questionnaire (AMDYSQ) [3], which measures youth attitudes. On the other hand, there's none of the scales all-embracing measure sportspersonship attitudes among student-athletes in university. The Prosocial and Antisocial Behavior in Sports Scale (PABSS) [4] provides a balanced measure of sportspersonship behavior, however, the behavior is influenced by factors other than attitudes. That is, comprehensive research investigating both positive and negative aspects of sportspersonship attitudes is necessary. Therefore, the purpose of this study was to examine sportspersonship attitudes comprehensively among university student-athletes.

Method:

In study 1, a focus group interview was conducted to identify unsportsperson-like attitudes involving 5 (4 female and 1 male, Mage=24.6 ± 3.88) university students majoring in sport psychology in Japan. The statements were analyzed qualitatively and grouped into categories. In study 2, a 100-item online questionnaire was developed to measure sportspersonship attitudes of university student-athletes in Japan. We used 5 scales for question items developed based on study 1, MSOS, PABSS, AMDYSQ, and MDSS. A total of 488 (211 female, 274 male, and 3 unknown, Mage= 20.10 ± 1.14) athletes completed the questionnaire.

Results and CONCLUSION: The qualitative analysis of the interview data in study 1 resulted in 5 categories. The exploratory factor analysis in study 2 found 5 factors consisting of 43 items of sportspersonship. The 5 dimensions of sportspersonship consisted of 4 negative dimensions; selfish behavior, disturbing opponents, cheating, and revenge, and a positive dimension; respect for surroundings. The cluster analysis revealed that there are two types of sportspersonship among university student-athletes. Cluster 1 (N=321) is the athletes who agree to sportsperson-like attitudes but not to unsportsperson-like attitudes. Those who are in cluster 2 (N=167) tend to think sportsperson-like attitudes are bad, but unsportsperson-like attitudes are good. Furthermore, more males belonged to cluster 2 than females, suggesting that males possibly tend to judge agreeable to unsportsperson-like attitudes more than females in sport.

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THE TRANSFORMATIONAL PROCESS IN ATHLETES WHEN LONG-TERM COUNSELING LEADS TO IMPROVED PERFORMANCE AND PERSONALITY DEVELOPMENT

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Introduction

Psychological support for athletes through counseling deals not only with psychological problems related to performance enhancement (external issues) but also with the psychological issues of personality development and psychological maturation (internal issues). By clarifying the transformational process of counseling for the resolution of these two (internal/external) issues, the way in which psychological development in athletes is interrelated with their athletic and physical experiences in competitive situations.

Purpose

The aim of this study was to clarify the transformational process that occurs when counseling carried out for resolving problems in competition also leads to psychological development in athletes. In other words, the purpose was to understand the reciprocity between reality adaptation (performance enhancement) and individualization (psychological development) in athletes.

Methods

The narrative record of a client was carefully reviewed. His main complaint was of "a big gap between my performance in practice and competitions. And the bigger the competition, the less control I have over myself." The client was a male athlete in his 20s who specialized in target-shooting. His counseling sessions consisted of paid interviews of 50 minutes every two weeks, except for when he was unable to come due to competitions or training camps. The analysis of his interview records follows the synchronic (chronological) changes in his movement-narratives, internal- experience narratives, and performance-change narratives in 72 interviews conducted over a four-year period.

Results and Discussion

The interview material can be roughly divided into four phases: Phase I, in which the client underperformed in competitive situations; Phase II, in which the client showed awareness of mind and movement in competitive situations; Phase III, in which the client reconsidered the meaning of each movement; and Phase IV, in which the client discovered, established, and consolidated his unique style. In the counseling sessions, the client deepened his self-understanding and clarified important issues (Phase I and Phase II) by reflecting in front of his counselors on his movements during competitions. He then reconsidered the meaning of his own physical movements and went through a trial-and-error process to resolve his problems (Phase III), eventually leading to the establishment of his own style (Phase IV). The transition into each phase was not linear, but rather a series of forward and backward steps. This series of processes also promoted individualization (psychological development) in the client, resulting in improved and stable performance. It is considered that clients retelling their stories in counseling can bring about a qualitative change in athletic experience and facilitate the process of individualization.

ACCEPTANCE BY COACHES OF IMMERSIVE VIRTUAL REALITY FOR IMPROVING SPORT PERFORMANCE

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Under certain conditions, immersive virtual reality (VR) has shown its effectiveness in improving sport performance. However, the psychological impact of VR on athletes is often overlooked, even though it can be deleterious (e.g., decreased performance, stopping the use of VR). Mascret et al. (2022) have recently highlighted a significant intention of athletes to use a VR Head Mounted Display (VR-HMD) designed to increase their sport performance. Whatever their level and before a first use, they all initially considered it as quite useful (except for recreational athletes), quite easy to use, and quite pleasant to use. Coaches are also concerned by using the VR-HMD: If athletes accept the VR-HMD but coaches do not, there is a risk that the VR-HMD will never be used despite its potential benefits. In this context and based on the Technology Acceptance Model, this study aims to identify possible blockages by measuring coaches' acceptance of VR-HMD device before the first use.

After reading a short text introducing the VR-HMD and its benefits for improving sport performance, a total of 239 coaches, from different sports and from local to international level, filled out a questionnaire assessing perceived usefulness to improve training, perceived usefulness to improve athletes' performance, perceived ease of use, perceived enjoyment, job relevance, and coaches' intention to use it. Structural equation modeling analysis, one-sample t-tests, and one-way ANOVAs were used to examine the data.

The main results show that (1) coaches' intention to use the VR-HMD is positively predicted by perceived usefulness to improve athletes' performance, perceived enjoyment, and job relevance, but not by perceived ease of use, (2) coaches significantly consider the VR-HMD useful to include in their training and to improve their athletes' performance, easy to use, pleasant to use, and relevant for their job, and (3) no significant differences appear on the previous scores according to coaches' levels, except for job relevance: international and national coaches find the VR-HMD more relevant to their job than local level coaches. All these results highlight that the VR-HMD is rather well accepted by the coaches before a first use. No contraindication appears from this point of view for the coaches to use the VR-HMD for performance optimization purposes.

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EFFECTS OF SIDE-BY-SIDE PARTNER ON ENJOYMENT AND SPEED IN SELF-PACED TREADMILL RUNNING

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INTRODUCTION

The phenomenon in which performance is improved by the presence of others is called social facilitation (Zajonc, 1965), and the phenomenon that occurs in the situation of simultaneously performing the same task as others is called the co-action effect. This refers to one's performance being more on task, merely because there are other people doing the same task. According to Zajonc, perceiving the presence of others increases arousal and drive, and evokes a dominant response, which is promoted if the task is well learned and suppressed if it is unfamiliar. While there are many studies that have focused on performance in the presence of partner, few studies have examined the psychological effects necessary to facilitate physical activity. Therefore, in this study, we physiologically and psychologically examine the influence of the presence of a running partner on women who are not practiced runners and do not have a habit of exercising in terms of co-action effect.

METHOD

Subjects: 19 female university and graduate students (21.4 ± 1.5 yr.) who do not exercise regularly.

Tasks and conditions: Flat treadmill self-paced running for 30 minutes under two conditions (1) Solo condition: SC: running alone and (2) Partner condition: PC: running side by side with a partner.

Measurements: (a) Behavioral indices: total running distance, running speed, and rate of speed increase every 5 minutes (actual speed/initial speed), (b) physiological index: heart rate, and (c) psychological indices: Feeling Scale: FS, Exercise Enjoyment Scale: EES, Excitement, Anxiety, RPE (Borg's scale). Speed's change and heart rate were measured continuously and psychological indices were reported at the base line (B), every 5 minutes (R5-R30), and twenty minutes after the end (A20).

RESULT and DISCUSSION

The total running distance for 30 minutes in PC (3639.91m) was significantly longer than in SC (3471.38m) (Wilcoxons signed-rank test, $Z=-3.351$, $p<.001$). The running speed was always significantly higher in the PC (R5-R30). As a result of two-way ANOVA for heart rate, a significant main effect was shown for time factor ($F(2.105, 29.474)=58.387$, $p<.001$, $\eta 2=.807$). Perceived exertion: No significant difference between two conditions. The results suggest that under the PC, the participants ran longer distances and faster despite the same exercise load and the perceived exercise intensity.

Running in the PC was shown to be significantly more exciting than running in the SC at R20-R30, and A20. In the PC, excitement increased significantly at the end. Anxiety was rated higher in the SC than in the PC in R20-R30. In the PC anxiety reduced 20 minutes after the running and then after running low anxiety state lasted. Compared with the SC, the PC showed a significantly higher enjoyment (EES) at R25-A20. The SC was reported more comfortable (FS) at the beginning (R5), but after 30 minutes running (R30), a more comfortable feeling was reported in the PC.

CONCLUSION

Results show that excitement increased, and anxiety decreased at 20 minutes after running, and these effects persisted for 20 minutes after 30 minutes of running, leading to feelings of enjoyment. Running with a partner showed social facilitation. Furthermore, an improvement in positive emotions during running was observed. Since it is said that experiencing fun and excitement during exercise enhances intrinsic motivation (Teixeira et al., 2012), increased excitement due to the presence of a partner is thought to be effective in facilitating exercise behavior.

POSITIVE IMPACT OF SPORTS EXPERIENCES ON WORKPLACE PERFORMANCE: A STUDY OF FORMER ATHLETES AND THEIR MANAGERS IN JAPAN

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Introduction

The transition from athletic retirement to the workplace is a topic of growing interest among researchers. Transferable skills is pivotal in advancing an athletes career development and facilitating a smooth transition into the workforce (Bernes et al., 2009). A lack of comprehension exists regarding how the skills acquired from competitive experience have positively impacted their workplace performance. Therefore, this study aimed to identify the strengths that former athletes acquired through their athletic careers as perceived by both the athletes themselves and their managers in the workplace.

Methods

Semi-structured interviews were conducted with ten former athletes who had successfully transitioned to the workplace and six of their managers in Japan. Athletes played soccer, basketball, rugby, skiing, swimming, and track and field. Each interview lasted nearly 50 minutes and focused on the strengths that the athletes brought from their sports careers to their current workplaces, and the challenges they faced during the transition. Thematic analysis (TA; Boyatis, 1998) was used to analyze the interview data. The study was approved by the Waseda University Ethics Review Committee on Research with Human Subjects (Approval number: 2022-104).

Results

The results of the study revealed that the majority of the former athletes felt that their sports experience had a positive impact on their work lives. Several strengths were identified, including goal-setting, problem-solving, assertiveness, teamwork, patience, responsibility, ability to cope with changes in the environment, optimism, and expertise in exercise. Additionally, they found similarities between the workplace and athletics in goal-setting and problem-solving. When he was an athlete, he looked back on himself to find and solve problems to succeed. They established a good cycle to produce results and applied it to work. Managers highly valued the strengths of athletes, not only those mentioned above but also their positive impact in the workplace. Their enthusiastic attitude and approach to work could inspire their coworkers. From a managerial perspective, athletes were also seen as valuable contributors to a cohesive and productive team dynamic.

Discussion

This study contributes to the existing body of research on the transferable skills athletes bring to the workplace, offering unique insights. The strengths cultivated as athletes vary among individuals. For instance, some enhance their problem-solving abilities by observing others, while others improve their competitiveness through new and unique training methods. This demonstrates that even when facing a common challenge, individuals may approach it differently, leading to diverse skill sets in the workplace. Additionally, athletes and managers possess unique perspectives, highlighting the importance for athletes to be aware of and understand the highly valued strengths in the workplace.

MIRROR, MIRROR, AM I THE BEST PLAYER AT ALL? DEVELOPMENT OF PSYCHOMETRIC INSTRUMENTS ASSESSING FANTASY PRONENESS AND DEFLATED REALITY IN SPORT

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Background: Competitive sport offers an excellent environment for an individual to fulfil the lionization of the self as one can have tremendous opportunities to beat opponents, dominate the competition, or at least fantasize about being an exceptional performer. Competitive sport is also a rocky way – one would not become a 'talent' or an 'elite' without thousands of hours of deliberate practice and training in a relatively tiring and tedious environment, whereas investing greater effort and working harder do not necessarily lead to more positive outcomes or a more promising career. In this research, we developed and validated two relevant psychometric instruments, namely the Sport Fantasy Proneness Scale (SFPS) and the Deflated Reality in Sport Scale (DRSS), to assess the important but overlooked context-specific constructs.

Methods: We established a working definition for sport fantasy proneness and deflated reality in sport and generated an initial item pool of the SFPS and DRSS from well-established, relevant measures assessing the two constructs in general life domains, prior to a rigorous process of content validity assessment involving an expert panel. We then examined factorial, convergent, discriminant, and concurrent validity and measurement invariance, as well as internal consistency and test-retest reliability of the two new scales, through two cross-sectional samples (Study 1: Sample 1 N = 255, Sample 2 N = 260) and one longitudinal sample (Study 2: Sample 3 N = 118) of competitive athletes in the UK.

Results: Aligning with the conceptualizations in general life domains, one's disposition of engaging in sport fantasy and perception of deflated reality in sport both appear to be a unidimensional construct. Evidence supported the convergent, discriminant, and concurrent validity whilst demonstrating very good consistency, test-retest reliability, and measurement invariance of the two new scales. A weak, positive correlation exists for scores of the two new scales, and a mixed profile of sport fantasy proneness and sense of deflated reality in sport could exist (i.e., low-low, low-high, high-low, high-high). Thus, the two constructs may interactively influence training- and performance-related outcomes in sport.

Conclusion: The SFPS and the DRSS demonstrated robust psychometric properties in assessing athletes' sport fantasy and perception of deflated reality. The new scales provide researchers and practitioners with new, reliable instruments to examine new research questions and tackle issues relevant to the two important but previously overlooked psychological constructs.

INTEGRATIVE PROPERTIES OF SUBJECTIVE VERSUS OBJECTIVE SPORTS MONITORING

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INEFC PIRINEUS, UNIVERSITY OF LLEIDA

In sporting contexts, the use of objective monitoring tools and physical activity trackers based on collecting massive biomechanical, physiological and performance data has recently expanded. Objective monitoring integrates multiple internal and external variables through mathematical algorithms and makes predictions on the basis of artificial intelligence. Predicated on mechanistic assumptions, such algorithms cannot capture and assess properly athlete's states and consequently cannot promote athletes health and performance. Contrarily to these mechanistic assumptions, athletes are com-

plex adaptive systems, featured by nonlinear dynamic behaviours that cannot be accurately predicted from a particular variable or set of variables (Balagué et al., 2020). Furthermore, while focusing on collecting and processing large amounts of data, analysts, scientists and coaches may forget the outstanding potential of the human neurobiological system to continuously, and rapidly, integrate massive information about performer-environment interactions. Such integrative properties offer exceptional possibilities of subjective monitoring for outperforming any objective monitoring system. Understanding and valuing subjective-based monitoring strategies is crucial to enhance athletes' awareness and promote their self-consciousness, autonomy and self-regulation. Future research should investigate how to enhance this human potential to contribute further to athletes health and performance. This line of argument, based on a recent opinion article (Montull et al., 2022), is not intended to advocate for the elimination of objective assessments, but to highlight and discuss the integrative possibilities of subjective monitoring.

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THE CONSTRUCTION AND VALIDATION OF THE CHARTING PHYSICAL LITERACY JOURNEY MATRIX: A PILOT STUDY

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Introduction

Physical literacy is an attitude toward an individual's physical activity experience, including four attributes motivation, confidence, physical competence, and knowledge and understanding (Whitehead, 2019). Despite the assessment, evaluation, and measurement of physical literacy have been debated among academia (Edwards et al., 2018), the notion of the term 'charting' was suggested by the idealist perspective. Therefore, this study employed the philosophical-discussed Charting Physical Literacy Journey (CPLJ) Matrix and used the quantitative technique of questionnaire construction and validation. The CPLJ Matrix could then serve as an additional battery to reflect one's current perception of participating in physical activity.

Methods

A 60-item Matrix using a 5-point Likert scale was developed for the pilot study. A total of 276 participants (175 male, 96 female, and 5 unknown genders) were adults who were an average age of 26.62 ± 10.67. They were asked to respond to the statements of CPLJ Matrix through an online survey platform. After the normality and reliability data analyses, exploratory and confirmatory factor analyses were conducted through the employment of IBM SPSS Statistics and AMOS version 28 for Windows.

Results

The exploratory factor analyses discovered an 18-item, 2-factor scale with loadings ranging from 0.71 to 0.85, and Cronbach's alpha ranged from 0.92 to 0.94. The confirmatory factor analyses provided standardized estimates for all significant paths and showed that the construct reached acceptable fit indices for the model of $\chi2(134) = 484.032$, $\chi2/df = 3.612$, $p < .001$, CFI = .902, ILI = .903, TLI = .889, RMSEA = .097, SRMR = .077 (Hu & Bentler, 1999). The factor loading of all items ranged from 0.68 to 0.90 which is above the standard of 0.45, suggesting that observed variables sufficiently represented the latent variables.

Discussion

This study suggested an initial 2-factor (dismissing and maximising) matrix for individuals perceiving current physical activity experience with the consideration of four physical literacy elements. A matrix-shaped report was also generated through the system for participants' charting progress, which could reflect the fluctuation progress over the life span. While the research team is in the progress of translating the CPLJ Matrix into several languages (currently with nine languages), the direction of future study should expand the inspection to cross-age groups and cross-national levels.

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Conventional Print Poster

CP-AP17 Team Sports I

ACUTE EFFECTS OF A PRE-SEASON SPEED TRAINING PROGRAM ON SAND VS. HARD COURT IN PROFESSIONAL BASKETBALL PLAYERS

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INTRODUCTION: Basketball is known as a fast paced team sport, characterized by constant changes of direction as well as speed with acceleration and deceleration. Recently, sand as a training surface has gained in importance and an increasing amount of research is focused on the beneficial long-term effects on speed related training on sand [1; 2]. Considering that long-term effects are based on the acute internal and external loads, little research investigated the short-term effects of sand training. Therefore, the aim of this study was to compare the acute effects of a pre-season speed training on sand versus hard court on physiological load and neuromuscular performance in professional basketball players.

METHODS: Twenty-two healthy competitive male basketball players (age 24.8±3.9 years; height 193.3±8.7 cm; weight 93.5±12.9 kg) completed one training session on sand (n=7) or on hard court (n=15). Training sessions were part of a seven week pre-season training intervention and were realized during the sixth week of this intervention. Sessions were identically applied on both surfaces, lasted 40 min and consisted of four different speed related drills, including sprint and jumping exercises. Pre-training (PT), post warm-up (PW) and post exercise (PE) measurements were taken for counter movement jump performance (CMJ), blood lactate concentrations (LA), heart rate (HR) and ratings of perceived exertion (RPE). Data are presented with mean±SD. T-tests for independent samples were used to verify surface depending differences. Significant levels were set at $p<0.05$.

RESULTS: LA was significantly higher on sand compared to hard court PW (2.6±1.2 vs. 0.9±0.3 mmol/l, $p<0.001$) as well as PE (3.7±1.8 vs. 1.5±0.6 mmol/l, $p<0.001$). RPE values and HR were correspondingly higher on sand PW (139±7 vs. 121±12 b·min-1, $p=0.002$) as well as PE (153±12 vs. 137±15 b·min-1, $p=0.021$). No significant differences were found in CMJ performance on sand compared to hard court at PE (41.8±5.41 vs. 40.9±7.60 cm, $p=0.769$).

CONCLUSION: Training on sand comes along with a higher metabolic and cardiorespiratory load compared to hard court which can be attributed to a longer coupling time between eccentric and concentric muscular action, a longer foot contact time and a less efficient power output. This might have caused an increased energy demand on sand compared to hard court. Under this conditions a reduction in the elastic energy potentiation and muscle tendon can be expected but interestingly, neuromuscular performance is not affected. Future studies should investigate if these acute effects might be helpful to have positive long-term effects.

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CHANGES IN COUNTERMOVEMENT VERTICAL JUMP PERFORMANCE METRICS DURING A PROFESSIONAL MEN'S BASKETBALL GAME

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INTRODUCTION: While multifaceted in physical performance parameters influencing success, basketball is a sport that is largely dictated by an athlete's ability to efficiently use their stretch-shortening cycle. One of the non-invasive testing modalities used to quantify this neuromuscular phenomenon, as well as identify fatigue and athletes' readiness status, is the countermovement vertical jump (CVJ) performed on a force plate. Thus, the purpose of this study was to examine how some of the most commonly studied CVJ performance metrics respond to on-court competitive demands.

METHODS: Eight professional male basketball players ($\bar{x}$±SD; hgt=192.7±10.6 cm, wgt=88.9±12.4 kg; age=27.5±2.5 yrs) volunteered to participate in the present study. After arrival at the gym, all participants completed the standardized warm-up protocol consisting of a set of dynamic stretching exercises and 15 min of partner shooting. Upon completion of the warm-up, the baseline (BS) CVJ performance was assessed. Each participant stepped on a portable force plate system (ForceDecks Max, VALD Performance, Brisbane, Australia) sampling at 1000 Hz, and performed three maximum-effort CVJ without arm swing. The participants were instructed to hold their hands on the hips during the entire movement. Also, to minimize the possible influence of fatigue, each jump trial was separated by a 30 sec rest interval. Then, the participants proceeded with a simulated 5x5 basketball game (i.e., 4x10-minute quarters with Elam Ending). By following the identical testing procedures, each participant performed one CVJ post-first (P1Q) and third quarter (P3Q), and three CVJ post-second (P2Q) and fourth quarter (P4Q). Repeated measures analysis of variance with Bonferroni post-hoc adjustment was used to examine statistically significant changes ($p<0.05$) in the following force plate metrics: vertical jump height (VJH; impulse-momentum calculation), modified reactive strength index (RSI-mod; jump height/contraction time), and peak concentric force (PCF).

RESULTS: No statistically significant differences were observed in VJH [cm] (F[4,28]=2.947, p=0.110; BS=16.8±2.6, P1Q=17.0±3.0, P2Q=15.3±3.1, P3Q=15.5±3.4, P4Q=15.4±4.1), RSI-mod [m/s] (F[4,28]=1.347, p=0.291; BS=0.62±0.13, P1Q=0.66±0.12, P2Q=0.58±0.13, P3Q=0.57±0.19, P4Q=0.58±0.20), and PCF [N] (F[4,28]=1.381, p=0.284; BS=2408.3±412.7, P1Q=2539.0±372.3, P2Q=2441.8±414.6, P3Q=2449.1±400.4, P4Q=2411.6±335.5) across five testing time points.

CONCLUSION: The findings of the present study indicate that VJH, RSI-mod, and PCF did not exhibit notable changes during a simulated basketball game. Although further research including the amount of internal and external load that the athletes are exposed to is warranted, we can conclude that the aforementioned force plate metrics were either not sensitive enough to detect fatigue-influenced changes in the neuromuscular performance throughout a game span or that the athletes were already adequately trained to properly respond to on-court competitive demands.

ANTHROPOMETRY AND BODY COMPOSITION IN ELITE YOUNG BASKETBALL PLAYERS ACCORDING TO THEIR MATURITY STATUS

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INTRODUCTION: Basketball is a high-intensity team sport that requests both anaerobic ability (speed, vertical jump, explosive power, agility) and aerobic capacity [1]. Although power-quickness and strength appeared as great components in looking for future on-court performance, a study that analysed elite players involved in the NBA draft identified the length-size (set of anthropometric measures) component as the best predictor [2]. However, anthropometric features and somatotypes of players could vary with ageing and role [3, 4]. Examining maturational characteristics could help in selecting elite and non-elite basketball players [5]. So, coaches and trainers need to consider both chronological age and maturation in scouting and should compare adolescent players' progresses to appropriate profiles. Therefore, this study aimed to establish the anthropometric characteristics of adolescent basketball players and draw somatotype and bioimpedance vector (BIVA) profiles according to their maturation.

METHODS: Sixty-six adolescent basketball players of an elite team (Vitus Segafredo® Bologna 1927) from U12 to U15 were enrolled in a cross-sectional study design. All players performed many anthropometric measures such as weight, height, sitting height, upper and lower limbs length, nine circumferences, three diameters, nine skinfold thickness (Lange skinfold caliper, Beta Technonoly Inc., Houston), and Bio-impedance analysis (BIA 101 BIVA®PRO, Akern, Italy). Maturity status was estimated according to the Mirwald equation [6] and the subjects were classified according to their maturity status. %Body Fat (%BF), Fat Mass (FM) and Fat-Free Mass (FFM) were estimated by Slaughter equation [7]. One-way ANOVA was used to detect anthropometric changes between players who were classified as early (E), on time (OT) or late (L). The significance level was set at $P<0.05$.

RESULTS: Weight, Height, trunk length, thorax circumference, thigh circumference, total thigh area and thigh mass area showed significant differences between E, OT, and L in all the categories. Greater differences appeared in earlier players' FFM of U13, U14, and U15 than later and youths on time. Longer arm spam (U13: $F=9.94$, $p<0.01$; U14: $F=10.35$, $p<0.01$; U15: $F=8.02$, $p<0.05$) and upper limbs (U13: $F=9.94$, $p<0.01$; U14: $F=10.44$, $p<0.01$; U15: $F=8.36$, $p<0.01$) appeared in elder early players than in later and on time. Also, resistance was lower in U12 (641.4 ± 65.48), U13 (507.38 ± 54.01), and U15 (491.57 ± 45.45) early players than in later (677.75 ± 80.68; 648.07 ± 62.07; 570.65 ± 58.34), respectively.

CONCLUSION: The findings of this study confirmed that several differences could appear in adolescents with similar chronological ages with different maturation statuses, despite they competed at the same level. Coaches may monitor youths' maturation to get the best results.

[1] Hoffman (2020), [2] Teramoto (2018), [3] Gryko (2018), [4] Cui, (2019), [5] Torres-Unda (2013), [6] Mirwald (2002), [7] Slaughter (1988)

ATHLETIC PERFORMANCE DEVELOPMENT IN ADOLESCENT VOLLEYBALL PLAYERS IN SPORT ACADEMY

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INTRODUCTION: Volleyball is heavily based on fast and explosive movements which play a critical role in performance. Sex-specific differences that arise during puberty are known to have an effect on the training process of adolescent athletes. Therefore it's essential to track longitudinal athletic performance to evaluate development and progress, and effectiveness of the training programs. The aim of the study was to compare athletic development of adolescent male and female volleyball players over time in the Academy of Excellence in Sports at Wingate Institute.

METHODS: Athletic performance test data of female (FVB, n=86) and male (MVB, n=88) indoor volleyball players was collected between 2013 and 2022. Tests were conducted up to 3 times per year and longitudinal changes were analyzed. The test battery included speed (5m,10m), agility and power (countermovement jumps and medicine ball throws) tests. Data was grouped into 3 age categories: 14 years or less (U14), 15-16 (U16), and 17-18 (U18).

RESULTS: In FVB group, no significant differences were found between age groups in 10m (U14: 2.05+0.16, U16: 1.99+0.12, U18: 1.98+ 0.08) and countermovement jump (CMJ) (U14: 35.7+5.0, U16: 37.0+5.4, U18: 37.4+4.8), a similar trend was found for the other tests performed. Conversely, in the MVB group significant differences ($p<.01$) were found in 10m between the U14 to U16 and U18 groups (U14: 1.94+0.15, U16: 1.85+0.09, U18: 1.76+0.06). Significant differences ($p<.01$) were also found in the CMJ performance between U14 group to U16 and U18 groups (U14: 40.5+7.3, U16: 47.5+7.0, U18:

50.7+5.7). Similar differences were also found in the other tests performed. In both groups, when expressed as percentages, the rate of change was greater between U14 and U16 compared to U16 and U18 for CMJ (MVB: 17.2% vs. 8.0% respectively; FVB: 3.5% vs. 1.0%) and for 10m (MVB 5.7% vs. 3.6%; FVB 2.7% vs. 0.7%).

CONCLUSION: Males demonstrated a noteworthy development in the parameters that were tested. The greatest improvement was apparent between U14 and U16 groups, reflecting the training process during the first years at the academy and possibly the time where peak development occurred. However, no significant differences were apparent in the females. This could be due to the fact that on average they reach their peak height velocity and biological maturation earlier than males, which has been known to affect training adaptation and physical development. For the athletes tested this period most likely occurred prior to entering the academy.

These results compare with previous studies assessing physical development of adolescent male and female athletes, reporting a decline in the rate of performance development with increasing biological age and possibly increase in training experience. These findings emphasize the need for coaches to understand the effects of growth and maturation on athletic abilities, and highlights the importance of longitudinal monitoring of young players through their early development years.

THE INFLUENCE OF STRENGTH LEVEL ON SPORT-SPECIFIC SKILLS BETWEEN STRONGER AND WEAKER PROFESSIONAL HANDBALL PLAYERS

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INTRODUCTION: Handball is a complex team-sport that requires high-level of physical abilities and sport-specific skills in order to attain success [1]. Handball players spend a large part of their training in resistance training programs in order to enhance strength-power and as a consequence performance in the field [2]. However, the role of muscle strength on handball specific skills and whether stronger players may have a greater performance compared to weaker players remains largely unclear. The purpose of the study was to investigate the influence of muscle strength on handball specific skills and to examine the correlation between strength and handball specific skills.

METHODS: Twenty-one male professional handball players (height 1.81±0.08m; body mass 87.9±13.9kg), participated in the study. Experimental procedures were performed six weeks before the official initiation of the in-season period. Measurements included body composition, countermovement jump (CMJ), leg extension isometric peak torque (IPT) and rate of torque development (RTD), 0-20m linear sprint, T-Test agility, throwing velocity from 7 and 9 meters distance from the goal and one repetition maximum (1-RM) in bench press and squat. Players were separated into strong (SG) and weak (WG) groups according to their 1-RM strength in bench press and squat. T-Test was used to explore differences between SG and WG while r-Pearson correlation coefficient was used to investigate the relationship between variables. Statistical significance was set at $p \leq 0.05$.

RESULTS: No significant difference was found for body composition between SG and WG ($p>0.05$). However, SG had significantly higher CMJ height (21.5%, p=0.002), IPT (22.4%, p=0.008) and RTD relative to body mass from 0-100 to 0-250msec ($p<0.05$) compared to WG. Moreover, SG had lower 0-20 linear sprint (-6.3%, p=0.012) and agility time-trial (-7.3% p=0.001), while throwing velocity from 7m and 9m was significant higher for SG compared to WG (7.4%, p=0.011 and 8.2%, p=0.009, respectively). When all players considered as one group, 1-RM strength and IPT were significantly correlated with fat free mass (r=0.518-0.774), CMJ power production (r=0.649-0.823) and throwing velocity (r=0.639-0.819). In addition, RTD was significantly correlated with CMJ power (r=0.829), fat free mass (r=0.760) and throwing velocity (r=0.780 and 0.835).

CONCLUSION: The main finding of the study was that muscle strength has a significant influence in handball specific skills while stronger players may have a greater advantage in the field compared to their weaker counterparts. These results suggest that strength training should be a vital part for handball players as it leads to significant higher increases in performance.

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DEVELOPMENT OF THE KOREA HANDBALL ACADEMY PHYSICAL FITNESS TEST MODEL FOR YOUTH HANDBALL PLAYERS

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INTRODUCTION: The purpose of this study was to develop a Korea Handball Academy Physical Fitness Test Battery for youth handball players considering their characteristics using Delphi/AHP technique.

METHODS: After reviewing previous studies, this study held an expert meeting to draft a battery. To select physical fitness variables, 17 experts with more than 10 years of research or coach experience in the related field were invited. The content validity of each test item was verified through the 1st and 2nd Delphi surveys. A decision-making method based on the analytic hierarchy process (AHP) was used to assign weights to each factor in the final physical fitness test battery selected based on the results of the Delphi survey.

RESULTS: As a result, 10 physical fitness factors, length (CVR=1.00), weight (CVR=0.67), muscle strength (CVR=0.67), muscular endurance (CVR=0.83), cardiorespiratory fitness (CVR=0.83), flexibility (CVR=0.67), power (CVR=1.00), agility (CVR=1.00), speed (CVR=0.80), coordination (CVR=1.00) were determined. As test variables for physical fitness, height (CVR=0.83), am span (CVR=0.67), lean body mass (CVR=0.64), handgrip strength (CVR=0.83), push-up (CVR=0.67), 20m shuttle run (CVR=1.00), sit-and-reach (CRT=0.83), standing long jump (CVR=0.67), countermovement jump (CVR=0.67), ball speed (CVR=0.67), rollercoaster run (CVR=0.83), visual reaction (CVR=0.83), 20m sprint (CVR=0.83) and ball handing (CVR=0.67) were found to be valid respectively. Weight was calculated according to the relative importance of the variables.

CONCLUSION: The present findings indicate that the Korea Handball Academy Physical Fitness Test Battery can be used to evaluate the physical fitness of youth handball players and select players with potential power.

RELATIONSHIP BETWEEN RATE OF FORCE DEVELOPMENT (RFD) AND REACTIVE FORCE (RSI) WITH THE RISK OF INJURIES AND REHABILITATION PROCESS IN HANDBALL: A SYSTEMATIC REVIEW.

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INTRODUCTION: Handball is characterized as a team sport subjected to high intensity actions that require high physical demands on the player. It is a sport that includes physical efforts such as massive changes in movements and impacts and frequent contact between athletes that are related to the development of repetitive injuries (1-3). Previous studies indicate the importance of studying parameters such as the concentric and eccentric Rate of Force Development (RFD) and Reactive Strength Response (RSI) in order to improve sport performance and decrease the development of sport injuries. This is due to the direct and indirect relationship with the elastic energy of the muscle-tendon system (4, 5). Therefore, the purpose of this study was to analyze the benefits of strength training program on injury risk and the rehabilitation process in order to improve the sport performance in handball.

METHODS: A systematic review was conducted in PubMed, Scopus, Web of science and Sport Discus databases. The PRISMA methodology was considered in order to achieve more specific results. We included published studies in which strength variables will be included in training programs for handball teams with the aim of reducing the development of injuries or accelerating the process of rehabilitation. In addition, we focus on studies that include RFD and RSI parameters in lower limb training programs.

RESULTS: A total of 11 studies were included in the final systematic review. The selected studies were published between 2015-2023 and varying follow-up from 1 week to 12 months. In all the studies, programs for the prevention and rehabilitation of lower limb injuries were included in elite category female and male handball players. It was observed that RFD and RSI parameters are essential markers in elite handball teams. Training focused on eccentric actions such as change of direction, jumping or landing have shown an increase in power, muscle activation and leg stiffness level. A decrease in functional asymmetries, obtaining better results compared to with concentric and isometric training for injury prevention and rehabilitation programs was reported. Furthermore, they demonstrate the effectiveness of plyometric training, specific exercises, and a rest period after the competition season in rehabilitation programs for sports injuries.

CONCLUSION: Plyometric and eccentric exercises based on the improvement of RDF and RSI are fundamental in training programs of elite handball players due to the results observed increasing sports performance and optimizing rehabilitation programs for lower limb injuries. A multidisciplinary work focused on an individualized way taking into account the characteristics of each player is essential in elite handball teams to reduce the risk of injuries and accelerate the rehabilitation process.

PHYSIOLOGICAL AND BIOMECHANICAL LOADS IN SMALL SIDED FIELD HOCKEY GAMES

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INTRODUCTION: When assessing training load, a distinction can be made between physiological and biomechanical load [1]. The physiological load of field hockey is known to vary with different formats of small sided games (SSGs) [2]. However, little is known about the biomechanical loads of field hockey SSGs. Therefore, the aim of present study was to gain a more thorough understanding of biomechanical loads in field hockey SSGs in comparison to physiological loads.

METHODS: Two different SSGs (small: 5 versus 5, ~100 m2 per player; large: 9 versus 9, ~200 m2 per player) were performed by sixteen female elite field hockey athletes of the Dutch U-21 team during two experimental training sessions. Players were equipped with a global navigation satellite system worn between the scapulae, which measured player position, and three inertial measurement units on the pelvis and thighs, which measured lower body kinematics. The effects of SSG format on a variety of physiological (i.e., distances covered in various speed ranges) and biomechanical (i.e., mean absolute acceleration/deceleration, and time spent in several demanding body postures) load metrics were assessed using linear mixed models (significance level of $p<0.05$).

RESULTS: The physiological loads were higher for the large SSG. In contrast, most biomechanical load metrics were higher for the small SSG.

CONCLUSION: This study has shown that changing SSG format affects physiological and biomechanical load differently. Physiological loads appear to be higher for large SSGs, whilst biomechanical loads seem to be higher for small SSGs.

[1] Vanrenterghem et al. (2017)

[2] Gabbet (2010)

DYNAMICS OF TRAINING AND COMPETITION DEMANDS IN TOP-CLASS MALE RINK HOCKEY: A CASE STUDY OF THE 2021 RINK HOCKEY EUROPEAN CHAMPIONSHIP

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INTRODUCTION: To improve players' performance in team sports such as rink hockey, it is important to manage the training process ensuring positive adaptation according to competitive demands. Therefore, monitoring training load (TL) to appropriately adjust between stress and recovery during training microcycles and minimize the risk of developing non-functional overreaching is crucial to develop athletes' physiological adaptations. This research aimed to investigate the training load through external (EL) and internal load (IL) dynamics across the preparation and competition of a top-level national team during the 2021 Rink Hockey European Championship.

METHODS: An observational study was carried out during the preparation and competition phases of the 2021 Rink Hockey European Championship from the 1rst until the 20th of November 2021. A non-experimental descriptive method was used to characterize the training sessions and training matches during the two (2) preparation weeks (TW-2 - two training weeks preceding the competition and TW-1 – one week before the competition) and the competitive games of the competition week (CW). The preparation weeks were characterized by training sessions (TMD-3, TMD-2, TMD-1) and 2 training matches (TMD). In total, players participated in 12 rink training sessions, 4 training matches, and 3 international competitive games during the three weeks of the study. A two-way mixed design ANOVA was utilized to compare EL and IL across microcycles during training sessions and competitions. A Spearman-Rho correlation test was used to understand the relationship between players' EL and IL during training sessions and competitive matches.

RESULTS: In general, results revealed significantly higher values between training match day -3 (TMD-3) to TMD-1 for Player Load (PL) ($p \leq 0.05$) distance covered (DT) and high-speed skating (HSS; ≥18 km) ($p \leq 0.001$). Competition weeks (CW) also revealed significantly higher values in comparison with training weeks (TW-2 and TW-1). Interestingly, during competition, high impacts (Himpt; 8-10 g) ($p \leq 0.001$, $r=0.64$) and decelerations (DEC; [-10 -3]m/s2 (n)) ($p \leq 0.001$, $r=0.43$) had a greater influence on players' session RPE (s-RPE) than in training weeks.

CONCLUSION: Our results suggest that training sessions do not represent the game demands, for example, HImpt and DEC appear to induce physiological impacts in players, but the same does not occur in the training sessions. Such results highlight the need to understand the competitive dynamics of the sport and the use of the most appropriate metrics to monitor the preparation process.

PLAYING POSITION EFFECTS ON TECHNICAL AND PERFORMANCE CHARACTERISTICS IN MALE FUTSAL PLAYERS

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INTRODUCTION: Futsal or five-a-side indoors soccer is an intermittent high-intensity sport characterized by high physical, technical, and tactical demands. Although there are several studies evaluating the effects of playing position on technical and performance characteristics in soccer, there is limited evidence in futsal. Therefore, the current study aimed to examine the positional differences in terms of technical and performance characteristics in male futsal players.

METHODS: Sixty-two futsal players were randomly allocated into four groups: control group (n=16, age: 23.6±0.7 y), wingers (n=18, age: 23.1±0.5 y), defenders (n=16, age: 22.4±0.4 y) and pivots (n=12, age: 24.1±0.5 y). Technical (i.e., passes, dribbles, ball touches shots, headers, possessions) and performance characteristics (final 3rd court entries, heart rate, total distance covered, sprint distance) were measured during the match. Also 30-meters sprinting time, countermovement jump (CMJ), delayed onset muscle soreness (DOMS) of the knee flexors/extensors and dominant knee joint range of movement (KJRM-DL) were measured before, immediately after, and 24h, 48h, 72h, 96h, 120h, and 144h post-match. A mixed-model ANOVA was used for statistical analyses.

RESULTS: Wingers touched significantly more times the ball but performed significantly less headers compared to pivots and defenders ($p<.05$). Defenders received less passes but lost the ball significantly less times and performed significantly more headers compared to wingers and pivots ($p<.05$). Wingers had significantly higher HR in both halves of the game. Overall, wingers covered significantly longer distance during the game and more so in the first half and were standing and walking less compared to the other groups ($p<.05$). The distance covered significantly reduced in the second half in all groups ($p < .05$) with wingers indicating a more marked decrease (6.3%). Similarly, wingers performed significantly more sprinting whereas defenders sprinted significantly less ($p<.05$). Performance in 30-m sprint and CMJ significantly decreased immediately after the game and retuned to baseline at 72h later in wingers and pivots. Defenders returned to baseline at 144h and 96h respectively. DOMS symptoms peaked 24h after and returned to baseline 96-120h post-match in both dominant lower limb flexors and extensors. KJRM-DL decrease peaked at 24h (with wingers experiencing the larger decrease) and returned to baseline 72h post game ($p<.05$).

CONCLUSION: Futsal playing positions have different technical and performance demands. Wingers touch the ball more frequently, sprint and cover significantly more distance and this is reflected in their higher HR compared to the other positions. Sprinting, jumping and KJRM-DL performance is significantly impaired in the first 24h whereas DOMS symptoms

significantly increase in all positions. It seems that DOMS lasts longer in defenders and KJRM-DL is more prominent in wingers. This evidence can be used to improve current futsal training practice.

Conventional Print Poster

CP-AP18 Football I

INFLUENCE OF REDUCED FIELD AREA ON TACTICAL BEHAVIOUR IN 11VS11 FOOTBALL PRACTICE GAMES

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INTRODUCTION: The behaviour of players in team sports is substantially influenced by the ecological context in which they are constantly perceiving and acting [2]. Thereby, the collective behaviour of the competing teams is shaped by the environmental conditions like the available playing area. In football practice, it is common for coaches to adjust the environmental layout in comparison to the formal 11vs11. For example, practice games are played on smaller goals or without goals at all, with fewer players or additional players for the team in possession, or with defined zones that arise with specific tasks. In practice the most common training adjustment is called Small-Sided-Game. This notion is defined by the reduction of the field area and area per player in the chosen practice game design [1, 4]. Therefore, the present study aims to examine the adaptions of collective tactical behaviour as a consequence of a reduction of the field area in a 11vs11 practice game.

METHODS: Four different field conditions were played and examined. Each condition was played with eleven players per team. Each team played five attacks per condition (a total of 40 attacks). Every attack started with the goalkeeper in possession. Conditions were played in the following order: 105m long x 68m wide (325 m2 per player, formal); 86m x 56m (219 m2 p. p., large); 74m x 48m (162 m2 p. p., half) and 59m x 38m (102 m2 p. p., small), respectively. Each player was equipped with a GPS unit (Catapult) to collect positional data and calculate the parameters distance-to-nearest-opponent, convex hull, and relative field usage [3].

RESULTS: The mean areas of the convex hulls were formal: 1412±139, large: 1210±115, half: 978±81.6, and small: 672±76 square meters. Significant differences were found across all conditions with an ANOVA ($F=88.16$; $P<0.001$; effect size=0,88) and post hoc ($P<0.001$) test. Thus, significant differences across all conditions were also found for the 'distance-to-nearest-opponent' parameter. Relative field usage also showed significant differences ($F=40.4$; $P<0.001$; effect size=0.72). This value was significantly lower in the formal game than in all three smaller field conditions ($P<0.001$).

CONCLUSION: Our findings suggest that scaling of the field sizes has a significant impact on the collective behaviour of teams practicing 11vs11 and should be chosen with care by the practioners. As the findings show, not only distances between the players and the convex hull change, but also the relative field usage. Reduction of field size results in less space outside the convex hull and therefore less opportunities left for players to find goal-directed solutions.

CHANGE OF DIRECTION AND CHANGE OF DIRECTION DEFICIT IN DANISH ELITE FEMALE AND MALE SOCCER PLAYERS PERFORMING 505 AND ARROWHEAD TESTS

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INTRODUCTION: In soccer, the ability to 'cut' and change direction during running is considered an important factor and occurs frequently during a game (1). The basic ability of players to change direction (without ball possession) is often evaluated through sprint running involving one or multiple changes of direction (COD) tests with time as an outcome (CODt), i.e. the 505t or the arrowhead test (AHt). A recent approach to this is to eliminate the linear sprint by calculating the change of direction deficit (CODd) in the 505 (505CODd) (2). The present study investigates this approach in elite Danish female soccer players. The same approach of using CODd in combination with AHt (AHCODd) is investigated in elite Danish male soccer players.

METHODS: Two groups participated, with one group being further divided in three age-groups. The groups consisted of 21 top-level female players (EW; age: 19.6±4.9 years, height: 171.6±7.3 cm, bodyweight: 61.8±6.1 kg) and 48 elite male players (EM). The EM group contained players at different age groups; under-17 (EM17; n=17, age: 15.5±0.5 years, height: 180.5±6.7 cm, bodyweight: 70.4±7.9 kg), Under-19 (EM19; n=14, age: 17.2±0.7 years, height: 181.0±7.9 cm, bodyweight: 68.8±7.76 kg) and senior (EMS; n=17, age: 23.5±4.17 years, height: 183.5±6.0 cm, bodyweight: 78.6±5.7 kg).

All groups performed a 30 m sprint test, with EW also recording a 10 m split time. Additionally, EW performed the 505t and 505CODd. The male players performed the AHt and the AHCODd. For CODd calculations 10m and 30m linear sprint time was subtracted from 505t and AHt, respectively.

Split and final times were recorded using infrared photocells. Witty (Microgate, Bolzano, Italy and Ci; Brower Timing, Draper, UT, USA, for EM and EW respectively).

All time comparisons were performed using one way ANOVA. Correlation between CODt and CODd was performed with 'Pearson's r correlation' or 'Spearman Signed Rank Test' and all male players were pooled for correlation analysis.

RESULTS: Across groups EMS was significantly faster in the 30 m sprint compared to EM19 and EM17 and EW was significantly slower than all other groups ($p < 0.05$). For EW, positive correlation was found for 10 m sprint and 505t ($r = 0.67$), and an insignificantly negative relationship between 10 m sprint and 505CODd. For EM 30 m sprint and AHt correlated ($r = 0.68$), and an insignificantly negative relationship between 30 m sprint and 505CODd.

CONCLUSION: In Danish elite soccer players, the present study shows high correlations between CODt and linear sprint times, in both male and female players, indicating that linear sprint ability, and not COD is evaluated in the COD tests used. The results therefore support similar results in experienced cricketers (2) however, the observed insignificant negative relationship between linear sprint time and CODd needs further research on order to qualify player performance.

1. Taylor (2017); 2. Nimphius (2016)

TRAINING AIMS FOR SMALL-SIDED GAMES: THE EFFECTS ON SMALL-SIDED GAME DESIGN AND LOCOMOTOR DEMANDS IN WOMEN'S ACADEMY SOCCER

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INTRODUCTION: Small-sided games (SSGs) are training formats played in a soccer practice and played with the intention to induce physical, technical, and tactical training stimuli[1,2]. Coaches use varying pitch dimensions, team sizes, and playing rules to emphasise a desired training outcome. Where manipulations in SSG constraints shape the demands for players, it remains unclear what the influence is of the intended training aim on the design and consequently the demands in SSGs. Therefore, the aim is to investigate the effect of the intended training aim on the SSG design and players' locomotor demands.

METHODS: Training plans and locomotor demands of an under-21 women's academy team were monitored. Eighteen players played a total of 186 SSGs during 64 practice sessions over five months. Training plans were completed by the coach before the training and included the intended training aim (i.e., physical, technical and/or tactical), pitch size (as the relative pitch area [RPA]), team size, and duration for each SSG. Locomotor activities were obtained with player tracking technology (Catapult S7, Melbourne, Australia) during the training and analysed on total distance (TD), high-speed running distance (HSRD; 12.5-19.0km/h), very high-speed running distance (VHSRD; 19.0-22.5km/h), sprint distance (SD; >22.5km/h)[3], and accelerations and decelerations (ACC-DEC). Locomotor variables were normalised for the SSG duration. Differences in the training design and locomotor demands were evaluated for training aim (ANOVA with post-hoc tests with Bonferroni corrections; $p<.05$).

RESULTS: The intended training outcome had a significant effect on the SSG design and demands ($p<.001$). SSGs with a technical aim were played in a smaller RPA, with less players, and for a shorter duration than in SSGs with a (combination of) tactical and physical aim ($p<.05$). Further, SSGs with a physical aim demanded greater TD, HSRD, VHSRD, and SD from the players than with a (combination of) technical and tactical aim ($p<.05$). In SSGs with a technical aim, players covered less TD, HSRD, VHSRD, and SD, but performed more ACC-DEC than in SSGs with a (combination of) physical and tactical aim ($p<.05$).

CONCLUSION: The training aim significantly influenced how coaches designed SSGs prior to practice and consequently affected the players' locomotor demands. SSGs with small pitch sizes and number of players and a short duration are typically played for a technical outcome, but also evoked more ACC-DEC. In contrast, SSGs with greater pitch sizes and number of players and a longer duration are often used for physical and tactical outcomes. This induced greater running demands and aligned with the physical aim of the SSG[2]. Coaches' intentions for a SSG determine the format, and will consequently stress the locomotor demands, alongside technical and tactical demands[1].

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2. Bujalance-Moreno et al., J Sports Sci, 2019, 37(8)

3. Bradley & Vescovi, Int J Sports Physiol Perform, 2015, 10

DIFFERENTIAL EFFECTS OF SMALL-SIDED GAME LOAD ON NEUROMUSCULAR AND PERCEPTUAL-COGNITIVE PERFORMANCE OF YOUTH SOCCER PLAYERS

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INTRODUCTION: Physical and psychological load of small-sided games (SSGs) can affect players' neuromuscular and cognitive performance [1,2]. The question remains which of load variables are responsible for the impairment of performance in youth soccer players. This study investigates players' neuromuscular and perceptual-cognitive performance i) response to SSG, ii) relationship with external load and perception of fatigue.

METHODS: Sixteen academy soccer players (13.6±0.5y, 163.4±5.9cm, 50.4±7.1kg) underwent SSG 4v4 + GK (40x25m) consisting of six 4-min intervals separated by 1-min recovery. Exercise intensity was monitored by the tracking system Polar Team Pro (Polar, Kempele, Finland). Before and after SSG a 100-mm visual analog scale (VAS-F) determined subjective perception of fatigue, followed by planned (PA) and reactive (RA) agility tests, countermovement jump (CMJ), divided attention task (DA), and go/no-go task (GNG). Paired t-test and Wilcoxon signed-rank test were used to analyze performance changes. Individual pre-post differences (Δ) were aligned with load variables to calculate Pearson's (r) or Spearman's (rs) correlation coefficients.

RESULTS: Players achieved 87±4% HRmax with a relative distance covered of 92±7 m/min. Subjective perception of fatigue increased after SSG (41.56±14.02%, p=.001). Further, CMJ height decreased (-6.67±6.64%, p=.014, d=.56), whilst PA time (3.71±2.50%, p=.002, d=.97), RA time (6.60±7.36%, p=.003, d=1.78) and errors in GNG increased (46.43±138.3%, p=.039, d=.59). There were no significant changes in DA task errors (3.66±16.81%, p=.362, d=.22) and speed of response in GNG task (-3.36±8.04%, p=.119, d=.29). Additionally, significant correlation was found between ΔPA and ΔVAS-F (r=.60, p=.014), and moderate between ΔPA and low to medium intensity decelerations (r=.48, p=.061). ΔRA correlated significantly with ΔCMJ height (r=-.54, p=.031) and moderately with ΔGNG errors (rs=.47, p=.123). Sprinting distance (≥21 km/h) and maximal speed in SSG correlated with ΔCMJ height (rs=.66, p=.006; r=.54, p=.032) while high-intensity accelerations correlated with ΔPA (r=-.76, p=.002).

CONCLUSION: Fatigue induced by SSG load affects youth players' agility, explosive strength, and decision-making in visual inhibition task. PA time was associated with fatigue perception and low to medium intensity decelerations. In addition, there was a relationship between explosive strength decrement and RA time. This variable was moderately associated with increased errors in GNG task. However, players who covered a longer sprinting distance and achieved higher maximal speed in SSG had smaller decrement in CMJ height, and those producing a higher number of high-intensity accelerations had smaller increase in PA time. High-intensity actions in SSG may, to some extent compensate for neuromuscular performance decline in young players.

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2. Mitrotasios et al. (2021). Facta Universitatis 19(2), 139-153

TRAINING LOAD COMPARISON BETWEEN SMALL, MEDIUM, AND LARGE-SIDED GAMES IN PROFESSIONAL FOOTBALL

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INTRODUCTION: Football training aims to develop physical capacities, tactical and technical skills to compete during matches. In the latest years, sided-games, which are categorized as small (SSG), medium (MSG), and large (LSG) formats, have been commonly used by coaches for simultaneously training these capacities and skills. This study aimed to assess if internal and external load parameters were different between sided-game formats, secondly, if these parameters were influenced by players' positions, and finally, if load parameters were different among sided-game types (from 2vs2 to 10vs10) in professional football players.

METHODS: Twenty-five male professional football players of the same club were enrolled in this study (age = 27 +- 9 years and body mass = 78 +- 14 kg) during the 2022-23 season. Sided-games were categorized in formats as SSG (n =145), MSG (n = 431), and LSG (n = 204). Players were divided into roles such as central backs (CB), fullbacks (FB), central midfielders (CM), attacking midfielders (AM), and strikers (ST). STATSports 10 Hz GNSS Apex units were used to monitor external load parameters such as distance, high-speed running (HSR), sprinting distance, accelerations, and decelerations. The internal load was quantified using the rate of perceived exertion (RPE).

RESULTS: The linear mixed model analysis found differences between formats ($p < 0.001$) for RPE, distance, HSR, sprinting, accelerations, and decelerations. Differences were found between positions for HSR ($p = 0.004$), sprinting ($p = 0.006$), and decelerations ($p < 0.001$). Moreover, a significant difference was found between sided-game types ($p < 0.001$) for RPE, distance, HSR, sprinting, accelerations, and decelerations.

CONCLUSION: This study found that some specific sided-games formats were more suitable to load some parameters than others, specifically, the distance, HSR, and sprinting distance covered were greater during LSG compared to MSG or SSG. The number of accelerations and decelerations was higher in MSG compared to SSG. The players' positions influenced some external load metrics, specifically, HSR and decelerations but not RPE or distance per minute. LSG 8vs8 was found to be the most demanding drill for distance covered and LSG 10 vs 10 was found to be the most demanding drill for HSR and sprinting. On the other hand, acceleration and deceleration demands were greater in MSG 5vs5 and MSG 6vs6 compared to other formats.

ASSESSING THE INDIVIDUAL RELATIONSHIP BETWEEN PHYSICAL FITNESS IMPROVEMENTS AND EXTERNAL LOAD MATCH PERFORMANCE IN MALE PROFESSIONAL FOOTBALL PLAYERS – A CASE STUDY

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INTRODUCTION: Coaches and practitioners may interpret improvements in physical capacity via fitness tests as coinciding with improvements in external load match performance, based on the assumption of a causal relationship between these variables. However, numerous factors, including reliability and validity of different measures, must be considered before making such an interpretation (1,2). Currently, there is limited research investigating these match related effects following an improvement in relevant physical fitness assessments. The aim of this study was to investigate if a meaningful improvement in physical fitness tests following an in-season strength training period can be related to and affect external load match performance at an individual level in professional male football players.

METHODS: Eight professional football players (25.4 ± 3.1 yrs, 184.1 ± 3.4 cm, 79.3 ± 2.2 kg) completed an in-season 10-week strength intervention period and participated in >2 matches with >60 min playing time pre- and post-intervention, to be included in the analysis. Physical fitness tests were undertaken pre- and post-intervention and included: 10-, 30-m and

peak speed sprint times, countermovement jump (CMJ) and leg press power. External load match performance was recorded pre- and post-intervention and included: total distance, peak speed, high (19.8-25.2 km/h) and sprint (>25.2 km/h) intensity running distance, PlayerLoadTM, and high intensity events (>2.5 m/s) consisting of accelerations, decelerations and change of directions. Physical fitness improvements had to exceed the measurements typical error (TE) and the smallest worthwhile difference (SWD) to be considered meaningful (1,2). A non-overlap of all pairs analysis (NAP; 3) was performed to assess external load match performance pre- and post-intervention and Bayesian pairwise correlation analysis was performed to assess the relationships between changes in physical fitness and external load match performance.

RESULTS: Three players displayed meaningful improvements in 2-5 physical fitness tests. However, NAP analysis showed positive effects in external load match performance for all 8 players. Kendal's Tau correlation analysis showed evidence (Base factor >3) for only one correlation (peak speed – decelerations, τ = -.62) between the changes in physical fitness and external load match performance, while the remaining comparisons were unrelated.

CONCLUSION: Our findings suggest that improvements in physical fitness may not necessarily translate to improved external load match performance. Further research is required to understand the potential relationships between physical fitness improvements and changes in football external load match performance.

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PHYSICAL PERFORMANCE DIFFERENCES BETWEEN GROUP AND FINAL STAGES IN THE 2022 FIFA WORLD CUP

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INTRODUCTION: Soccer is a sport characterized by a great number of high-intensity actions where players must display great sprinting abilities, leg muscular power, and technical skills in order to be successful. The aim of this study was to compare the physical performance of finalist teams in the 2022 FIFA World Cup Qatar, between group and final stages.

METHODS: A total of forty matches (n=24 matches in the group stage and n=16 matches in the final stage) of the 2022 FIFA World Cup were analyzed. All data were accessed through the official FIFA website considering the official statistic report of each analyzed match. For group stage analysis only successful teams (teams cleared to the final stage) were considered. A total of eight physical metrics were considered: total distance covered, total distance in different intensity zones (zone 1: 0-7 km/h; zone 2: 7-15 km/h; zone 3: 15-20 km/h; zone 4: 20-25 km/h; zone 5: more than 25 km/h), number of high-speed runs (i.e., HSR – performed between 20-25 km/h) and number of sprints. All variables were normalized to game time.

A mixed-effects model was used to compare the variables behavior between the different World Cup stages. The significance level was set to $p < 0.05$ for all statistical analyses.

RESULTS: Significant differences were found for all physical metrics analyzed between final and group stages ($p<0.001$). In all variables teams cleared to the final stage presented higher levels of physical performance during group stage comparing to final stage ($p<0,01$) meaning high total distance covered, distance covered in all intensity zones (zone 1, zone 2, zone 3, zone 4 and zone 5), and high number of sprints and high-speed runs, in group stage.

CONCLUSION: Our finding suggest that teams perform differently along the championship. From the group stage to the final stage, mean team values decreased in all variables of performance, in distance covered and in high intensity actions. A possible reason to this decrease in performance is the cumulative fatigue, since the game calendar imposed a match at every 3 days, hampering a full recovery between matches. However, more information regarding the athlete perception of fatigue, objective measurements of fatigue and recovery are needed to support this suggestion. Another topic of interest is specific climatic characteristics of this particular world cup (Qatar), as it was a championship characterized by high temperature and humidity. Therefore, the knowledge about the physical behavior in different stages of FIFA World Cup Championships should be considered in the future.

PREVALENCE OF POOR SLEEP QUALITY, SLEEPINESS, AND INSUFFICIENT SLEEP DURATION IN SOCCER PLAYERS

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INTRODUCTION: It is well-known that sleep is essential for optimal recovery and performance for athletes. Despite that, they are often exposed to some sport and non-sport factors that can negatively affect sleep. Therefore, this study aimed to analyze sleep habits in soccer players, describing the prevalence of poor sleep quality, excessive daytime sleepiness, habitual sleep duration and self-assessed sleep needs.

METHODS: The study included 682 soccer players (n = 73 females) of various age groups (mean age: 18.5 ± 7.0; range: 51 years old). The participants completed the Pittsburgh Sleep Quality Index (PSQI), the Epworth Sleepiness Score (ESS), and answered the question: "how many hours of sleep do you need to feel rested?". For each player, a sleep deficit index (SDI) was calculated by subtracting their habitual sleep duration (reported in the PSQI) from self-assessed sleep needs. It was

considered relevant if the SDI was ≥ 1 hour. The groups were defined and compared based on sleep recommendations for each age category: 8-13 years old; 14-17 years old; ≥18 years old. Correlations were computed between the PSQI and ESS scores and sleep duration.

RESULTS: Excessive daytime sleepiness was present in 71% of the players (8-13 years old: 22%; 14-17 years old: 79%; ≥18 years old: 87%), 28% reported poor sleep quality (8-13 years old: 8%; 14-17 years old: 18,5%; ≥18 years old: 44%), 29% did not achieve the minimum recommended sleep duration (8-13 years old: 39%; 14-17 years old: 36%; ≥18 years old: 20%), and 44% had an SDI ≥ 1h (8-13 years old: 25%; 14-17 years old: 42%; ≥18 years old: 48%). Significant differences were found in sleep duration, PSQI and ESS scores between age groups ($p<0.01$). Negative correlations between sleep duration and PSQI ($rs=-0.55$, $p<0.01$) and ESS ($rs=-0.32$, $p<0.01$) scores were found. There was a positive correlation between PSQI and ESS scores ($rs=0.40$, $p<0.01$).

CONCLUSION: The results showed that the ≥18 years age group, in general, had poorer sleep quality, more prevalence of excessive daytime sleepiness, and higher prevalence of not achieving the amount of sleep that satisfied individual needs, compared with younger players. An extremely high proportion of players aged 14-17 and ≥18 years had excessive daytime sleepiness (79% and 87%, respectively). It was found that players with poorer sleep quality had a higher level of sleepiness during the day, and shorter sleep duration was associated with lower sleep quality and greater sleepiness. These results showed that a large proportion of players suffer from sleep disturbance. Since sleep is crucial for optimal recovery and subsequent performance, athletes should be aware of the importance of adopting behaviors that could result in better sleep.

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INTERSTATE TRAVEL HAS MINIMAL IMPACT ON MEAN AND INDIVIDUAL SLEEP VARIABILITY IN ELITE MALE AUSTRALIAN FOOTBALLERS

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INTRODUCTION: Regular travel is an expectation for professional athletes competing at national or international level. Travel fatigue and jet lag symptoms are likely consequences for athletes engaged in frequent domestic travel. Recurrent time zone crossings may result in disruption to sleep behaviours, impacting recovery and subsequent performance. We conducted a pre-registered examination of sleep metrics in elite male Australian Football players, from the same professional club, over two weeks and compared players who travelled for interstate competition (away fixture) to those who remained at home (home fixture).

METHODS: Using wrist-worn actigraphy, nightly sleep metrics including sleep duration (minutes), sleep efficiency (%) and sleep onset (time of day) were recorded in 15 athletes (22.7±3.5 years) over 13 consecutive nights. Data collection aligned with the start of the competitive season where the team had consecutive away and home fixtures, enabling a quasi-randomisation based on club player selection. Players travelled eastward on Day 3 (Night 4: GMT+8 to GMT+10.5) and returned on Day 4 (Night 5), the evening of match day. The subsequent home fixture was played on Night 12. Raw accelerometer data analysis was performed using GGIR with resulting metrics analysed using a location-scale model within a multilevel framework, to estimate the effect of travel on mean-level and intra-individual variability of sleep indices. Results are reported as mean and 95% credibility interval (CI).

RESULTS: Overall, players averaged 500 minutes of sleep per night (95%CI = 489, 510), with 86% sleep efficiency (95%CI = 83.7, 88.8) and fell asleep (sleep onset) at 22:30 (95%CI = 22:12, 22:42). Inferentially, players who travelled interstate (n=7) for competition slept for shorter periods (-0.04, 95% CI = -0.43, 0.31), had a later sleep onset (+0.38, 95%CI = -0.52, 1.24) but had a greater sleep efficiency (+3%, 95% CI = -6.70, 12.98) compared to those who remained home (n=8). Players who travelled interstate experienced less variability in sleep duration (-0.08, 95% CI = -0.45, 0.27) and efficiency (-0.74, 95% CI = -2.37, 0.93), but experienced greater variability in sleep onset (+0.39, 95% CI = -2.15, 2.98) compared to those who remained at home.

CONCLUSION: Existing research on sleep dynamics within sport have typically relied on mean-level estimates, yet this limited focus is insufficient due to the complexity of individual sleep behaviours. Integrating both mean-levels and intra-individual variability estimates of sleep indices, we observed small, statistically inconsequential effects of travel on sleep metrics, most likely due to the small sample. Nevertheless, the inclusion of intra-individual variability alongside mean-level estimates of sleep metrics, both statistically and visually, provides a holistic approach to understanding sleep behaviours in the context of elite sport. This would further enable the development of personalised interventions to optimise sleep hygiene in athletes.

Conventional Print Poster

CP-SH07 Sociology and management

ENVIRONMENTAL CHALLENGES, OBSTACLES AND WISHES IN EQUESTRIAN SPORTS: CONSUMPTION, LACK OF POWER, AND KNOWLEDGE

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Introduction

Addressing issues under the umbrella of the climate crisis is arguably the business of every sector and every individual. Sport science research has, however, been focused on how the human body has been affected by the environment (eg., Timpka et al., 2020; Gale et al., 2020; Sandford, et al., 2021) rather than vice versa and the environmental effects of (mega) events (McCullough, 2017). Less is known about behavior and attitudes regarding environmental issues in the sport sector (cf. Mistra Background Paper, 2018). In collaboration with riding schools, federations and higher education institutions in the sector, this study aims to gain a deep understanding of how people in equestrian sport perceive environmental challenges, obstacles and solutions.

Methods

Data consists of 30 semi-structured interviews with representatives of riding schools, >400 responses to an online survey (still open), educational plans and environmental policies from riding schools, federations and higher education institutions in Sweden and Norway. In the survey, respondents answered multiple choice and free text questions on perceptions of main challenges, obstacles, and solutions to an environmentally sustainable equestrian sport. Free text answers were focused and analysed using data-reduction, coding, and conclusions. The material was organized in three categories: challenges, obstacles and wishes. To validate the data analysis, we circled back to the original answers to control that chosen parts matched the context and answers in a representable way.

Results

Results show that people in equestrian sports identify consumption as a main challenge to a pro-environmental transformation of the sports. A main obstacle is the 'lack of power', in relation to becoming a part of environmental improvement and structural change. Furthermore, they answered that this obstacle could be met by knowledge.

Discussion

Similar to what Beames et al has shown regarding adventure sports (Beames et al 2019; Beams et al 2022), consumption patterns is seen as a main challenge to an environmentally sustainable equestrian sport. Representatives of riding schools describe an increased consumption of supplies, for example in relation to seasonal trends. Respondents single out 'lack of power' as the obstacle, saying the board and the industry must be open for a transformation for a positive change to happen. However, action is being taken, for example by repairing instead of buying new, and arranging opportunities for consuming second hand riding clothes and supplies. To overcome the obstacle, the respondents wish for increased knowledge reaching all levels in equestrian sports; from riding classes to the board, and with contribution and follow up-initiatives by higher institutions.

ATTITUDES TO ENVIRONMENTAL CHANGE IN EQUESTRIAN SPORTS

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Attitudes to Environmental Change in Equestrian Sports

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Introduction

Studies show that the equine sector emits more carbon dioxide than domestic aviation, the main issues being food and transport (Müller, 2021). Other studies show that nutrient leakage from manure piles and paddocks and pastures are major problems (Blomberg &Välimaa, 2016). These challenges are important to overcome to develop a sustainable equestrian sport. The purpose of this study is, first, to understand obstacles to a pro-environmental sport and, second, how interventions can be built to transform the sport using the COM-B model for behavior change. The presentation will focus on the obstacles.

Method

Data consists of survey answers (>400) and 30 semi-structured interviews in Norway and Sweden. The COM-B model was used to analyze the data. Trustworthiness was ensured through several processes being (reflexivity, audio traits, dependability, conformability)

Results

In the COM-B model for behavior change capability (C), opportunity (O), and motivation (M), are three key factors capable of changing behavior (B) (Barker et al 2016). Results of this study show that although stakeholders in equestrian sports are aware of and motivated to change their behavior (M), they lack knowledge and skills (C). In addition, they point to challenges related to economy and simultaneously fulfilling other sustainability goals (O). Furthermore, although motivation for change is present it is expressed as something they have to do (rather than want to do). There are, in other words, obstacles to change in all three categories.

Discussion

Knowledge of obstacles to change related to the COM-B model can, in conjunction with the 'behavior change wheel' (Michie, S et al 2014) be used as a base for interventions. To initiate successful interventions, it is important to identify the categories of intervention that should be included in the behavior change strategy such as education, persuasion, incentivization, coercion, enablement, training, restriction, environmental restructuring, and modelling. As a result of this study, we would suggest that the Equestrian Sport Federations and local governments in Sweden and Norway start with interventions targeted at education and enablement.

ANALYSIS OF TENNIS CADDIES CULTURE

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Introduction

Tennis caddies refer to the personnel who provide corresponding services such as ball picking and ball supply for players under the guidance of the referee in accordance with tennis rules in tennis tournament. As a part of the tournament, especially the Grand Slam, tennis caddies have developed a distinctive caddie culture over the centuries, which is a combination of material, institutional, spiritual and behavioral culture. In modern tennis, the use and number of caddies is directly determined by the level of the tournament. There are no caddies at the lower levels of the game, but the larger the tournament, the greater the number of caddies used.

Methods

To explore the different cultural phenomena of tennis caddies contained in large-scale tennis tournaments, the methods of literature review and comparative research are used to compare Chinese and western tournaments, including material culture, system culture, spiritual culture, behavior culture and other aspects of the tennis caddies.

Conclusions

Western culture is thick with a strong sense of independent innovation and emphasis on tradition and change with the time. China is also seeking for innovation and change after introducing and absorbing the western tennis caddies culture.

Discussion

To form a tennis caddies culture with Chinese characteristics, it is suggested to promote tennis culture from aristocratic style to civilian and popular style, improve the level of public tennis culture and etiquette, build brand names, solidify characteristics, pay attention to the cultivation of humanistic spirit, form a diversified competition culture, and improve the status of tennis caddies.

GENDER-EQUAL ON THE COURT. THE VALUE SYSTEM OF FEMALE AND MALE KORFBALL PLAYERS

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INTRODUCTION: Korfball is the world's only mixed team game with ball where players (4 females and 4 males) play the same roles in the court during the match (Crum, 2021). As sport is a carrier of universal values and players are expected to strive for excellence, perfection, respect, friendship and fair play and korfball is gender-equal discipline, therefore the aim of this study is to determine the hierarchy of the value system of Polish female and male players, and factors and experiences influencing the perception of the discipline.

METHODS: The participants were 27 players of Polish Senior National Team in korfball, including 14 women (23.21 ± 3.98 years old) and 13 men (26.92 ± 5.91 years old). The research was conducted during the National Team training camp in the 2021/2022 season. The study involving human participants was reviewed and approved by Ethics Committee of the Wroclaw University of Health and Sport Sciences, Poland (No. 10/2022). Written informed consent to participate in this study was provided by the participants' or the participants' legal guardian/next of kin.

The Rokeach Values Survey (RVS) in Polish adaptation and the author's questionnaire "Values in Korfball" were used to determine the hierarchy and importance of values of the athletes. The RVS consists of two lists of values: 18 terminal and 18 instrumental, which respondents ranked according to importance, from the most important for them (rank 1) to the least (rank 18) (Jaworska, Matczak, Bitner, 2011). The questionnaire consisted of 13 complementary questions about korfball experiences.

All statistical analyses were carried out using IBM SPSS Statistics. The results were analyzed for the group by gender, age, place of residence, education and training experience. Non-parametric Mann–Whitney U-test, Kruskal-Wallace Test and Spearmans rank correlation coefficient were applied.

RESULTS: Health and Family Security were the most important terminal values for players, both women and men. National Security and Equality were significantly higher in the hierarchy of women and Pleasure was more important for men. The korfball players' highly regarded instrumental values like Honest, Responsible and Loving (Ambitious, Honest, Loving for women; Honest and Responsible for men). A statistically significant difference was found only for Forgiving, which was more valued for women than men. Mature Love and A Comfortable Life were significantly more valued for athletes with higher education (also True Friendship), living in cities and working. For studying players Equality was significantly more important. For male players the importance of 4 values increases with the years of play: Self-Respect, Wisdom (terminal), Capable and Courageous (instrumental).

CONCLUSION: There is a lack of similar research in sport sciences, thus more research is needed to determine if gender-equal factor influences the value system of players comparing to the others team or individual sports.

GENDER-SPECIFIC CHARACTERISTICS OF PHYSICAL PERFORMANCE DURING SPEED AND STRENGTH EXERCISES

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INTRODUCTION: Performing specific speed and strength exercises, such as a squat with a barbell, requires the athlete to have an impeccable technique of performing a motor action from a biomechanical point of view and high indicators of the athletes balance function coefficient. That is why, the purpose of this study was to identify elite athletes` gender-specific characteristics of physical performance during speed and strength exercises.

METHODS: The method of expert evaluations was used to determine the modern problems of female elite sports (n=20). To determine the model characteristics of the optimal psychophysiological state and balance function of elite male versus female athletes during physical exercises, two independent groups, including 17 women (age 20,11± 3,12) and 24 men (age 19,83± 3,06), were compared.

The participants were elite athletes from different sport games, including: basketball (women, n=10 and men, n=14), handball (women, n=3 and men, n=5) and volleyball (women, n=4 and men, n=5). Mathematical and statistical processing and data analysis were carried out using the computing and graphic capabilities of the computer programs "Statistica".

RESULTS: The analysis of the literature in modern sports science and the results of the interviews with 20 experts made it possible to highlight the main gender problem in sports that is: transferring male athletes` training models and loads to the female preparedness. The statistical analysis of the psychophysiological tests` results showed that, for men, it is an attention predominance, and for women, is mobility and strength of nervous processes, respectively. The female athletes in the group were 5,88 cm shorter in height and 19,08 kg lighter in weight. Statistically significant differences with $p < 0.01$ were observed in male athletes' dynamometry of the dominant (53,54±4,75 kg) and non-dominant (50,67±5,26 kg) hands compared to female athletes who presented with a dominant hand strength of 30,59±3,54 kg and a non-dominant hand strength of 29,06±3,42 kg. Based on the comparison of stabilograms of two samples, we determined the degree of visual stability in standing using the Romberg coefficient, with significant differences in the results for men (173% ± 2,62) versus women (216% ± 2,32). The higher the percentage, the better the athlete was coordinated and/or trained. As for the ratio of the quality of the equilibrium function of elite athletes without and with visual control, significantly higher indicators were observed for women (0,98 ± 0,02) compared to the group of men (0,78 ± 0,06).

CONCLUSION: The present research results provide new information and scientific insights into the need to build different approaches in planning special physical loads for female compared to male athletes. The outcome of the expert evaluation is expected to affect recommendations on efficient speed and strength training design (e.g. exercise "squat with a barbell") for women versus men to be further investigated in ongoing research.

META-SYNTHESIS OF WOMEN'S EXPERIENCES OF GENDER-BASED INTERPERSONAL VIOLENCE IN SPORT

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Introduction: Violence against women and girls in sport is a pervasive issue, with prevalence rates of interpersonal violence ranging from 26% to 74% across psychological, physical, and sexual violence. This is despite sport being championed as a site for women's empowerment and equality, and as a key setting for addressing the drivers of gender-based violence. Whilst prevalence studies show a high rate of interpersonal violence, they rarely examine gender-based violence beyond sexual violence, and often focus on elite or youth sport populations. There is a need to examine all forms of gender-based violence in sport and to seek to understand women's diverse lived experience to inform appropriate policy and practice responses. Our meta-synthesis reviewed and synthesised qualitative studies that had explored women's experiences of gender-based interpersonal violence in sport.

Methods: We searched five databases across four categories of search terms: gender-based violence/abuse/harassment; sport/exercise; woman/female; qualitative. We followed a meta-ethnographic approach. We developed an interpretation of a selection of studies, using reflexive thematic analysis to create a new interpretation (third-order construct) beyond the individual studies reviewed. We applied a feminist socio-ecological lens to our analysis, remaining cognisant of gendered power as it runs through and between the socio-ecological levels.

Results: We included 25 records representing 24 studies. Participants experienced many forms of gender-based violence: sexual, physical, psychological, economic, drug and technology facilitated, perpetrated by coaches, intimate partners (sometimes one and the same), peers and their own family. These often appeared as composite forms of abuse, intersecting and overlapping. We co-constructed five themes: the normalisation of abusive behaviours in the sports context; sport family violence; women's status in a patriarchal system; women's safety work; and organisational impotence and hostility.

Discussion: Women described a variety of forms of abuse, often composite and over time, perpetrated by a broad range of abusers that included people from within and outside of sport. Across the studies, women's experiences of abuse could be mapped within and across the individual, relational, organisational and cultural levels of the socio-ecological model, with (lack of) power being a central factor in women's experiences within each level as well as flowing between the levels. We also constructed a fifth level pertaining to the context of gender-based violence in sport – that of the sport family. This sits between the relational and organisational levels as the sport context provides both intense familial relationships as well as a patriarchal familial organisational structure that facilitates and silences the abuse. These foundational insights will be key to developing appropriate prevention and response initiatives to gender-based violence in sport.

Conventional Print Poster

CP-SH08 Coaching

HOW IS MUSCLE TYPOLOGY ESTIMATED AND USED IN SPORT SCIENCE PRACTICE? A QUESTIONNAIRE IN 446 COACHES.

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GHENT UNIVERSITY

INTRODUCTION: On average, most humans dispose of an equal number of slow-twitch and fast-twitch muscle fibers. However, a large inter-individual heterogeneity in muscle typology exists, having important implications for talent identification and training individualization. Though, it is unclear to what extent these muscle typologies are used in coaching practice. We expect that the invasiveness of the gold standard to measure the muscle typology, a muscle biopsy, lowers the use in the daily guidance of athletes. We assume that coaches circumvent this problem by using non-invasive estimators of the muscle typology. Yet, it is unclear which estimators are used and for which purposes coaches use muscle typology information.

METHODS: An online questionnaire was sent to coaches and members of the scientific/medical staff through e-mail and social media in 4 languages and was completed by 446 respondents from 49 nationalities. The survey examined opinions regarding muscle biopsies, how the muscle typology is estimated and its perceived importance for coaching. Differences according to coaching group (individual (n=290); team sport (n=104) and multiple (n=52; coaching both individual and team sports)) were further analyzed using Chi-square tests.

RESULTS: The majority of respondents were high level coaches as 57% trained world class or elite athletes. Forty percent of all coaches already used the muscle typology in coaching practice. Furthermore, 50% would use this information if they would be able to measure it. Despite high interest, only 18% of the coaches thought their athletes would be willing to undergo a muscle biopsy. Therefore, other non-invasive techniques were used. In general, 65% used their experience/observation during training and competition to estimate the muscle typology, moreover individual coaches used their experience more than team sport coaches (68% vs. 51%; P=0.009). Jump tests were the second most used method to estimate the muscle typology (56%). Team sport coaches relied more on these tests than individual coaches (68% vs. 48%; P=0.001). Strength tests (33%), visual inspection of athletes' morphology (25%) and muscle biopsies (13%) completed the top 5. Interestingly, more than 80% of the coaches use the muscle typology to individualize training volume (87%) and intensity (84%). Moreover, more than half of the coaches used muscle typology to individualize duration of recovery (62%), training frequency (60%), taper strategy (54%), to decide on tactical issues (54%) and to identify talent (49%).

CONCLUSION: Previously, it was acknowledged that muscle typology is relevant for talent orientation, but this questionnaire shows that coaches value its importance even more for training individualization. As muscle biopsies are probably not ideal in elite athletes, coaches use other methods to estimate the muscle typology. Some of the used non-invasive estimators of muscle typology are not sufficiently supported by science, opening opportunities for further research and education.

TALENT SELF-ORIENTATION IN YOUTH SOCCER

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INTRODUCTION: Talent orientation is one of the early step stones in many talent identification (TID) models and national TID campaigns derived from these models. In the recent years the development of expert-level performance in sports was primarily discussed against the background of two different pathway: the early specialization approach and the diversification approach.In regard to the timing of the training start and the layout of the early phase of training activities many researchers advocate the strategy of a late specialization in one particular sport combined with a broad sampling of

different sports.At the same time, numerous sport academics claim for the opposite that is an early orientation of youth athletes towards a specific sport that fits best to their personal talent make-up, because longer learning time, more appropriate personal dispositions and early success contribute to the optimal development of exceptional performance and expertise.This study examines the way in which young soccer players manage the conflict between specialization and diversification.

METHODS: To clarify the specific patterns of the early sports sampling strategies between the poles of early specialization and diversification the competition performances of 276 youth soccer players were systematically documented in the sports they played from the U6 to the U21 age group. Univariate ANOVAs and regression analyses were used to analyze whether later successful athletes differed from non-elite soccer players in their self-orientation strategies.

RESULTS: ANOVA showed that three sampling strategies during childhood and adolescence lead to different performance outcomes at early adult age. A high level of the soccer performance is seen at the less frequent strategy of participating in one or more other competitive sports before taking part in soccer competitions. Nevertheless, the highest performing soccer players, are those who had focused almost exclusively on playing soccer from the beginning.

CONCLUSION: Thus, the results are in line with the latest differentiated model of talent development, and confirm that successful youth soccer players prefer early and in-sport specialization.

THE EFFECT OF THE GOSEONG-GUN SOOMCHI COMPLEX MARINE HEALING PROGRAM ON IMPROVING LUNG HEALTH

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INTRODUCTION: The study to verify the effectiveness of the Soomchi combined marine exercise healing program by analyzing the physical composition of the subjects, their blood lipids, and the effects of the program on their lung health-related variables, and heart rate variability variabvariables.

METHODS: In the experiment, the Soomchi combined marine exercise healing program was conducted for 5 hours a day, 5 days a week. on 15 participants. The results of their body composition, blood lipids, lactic acid, blood pressure, PEF, FEV1 and maximum oxygen intake were analyzed before and after the subjects completed the Soomchi program. For the statistical analysis, the mean and standard deviation (M±SD) of each variable were calculated using SPSS version 20 and an independent t-test was conducted to test for the amount of change in the participants before and after the Soomchi combined marine healing program. All significant levels were set to α=.05. As a result of the experiment

RESULTS: First, no statistically significant differences were found in the changes in body composition after the 5-day combined marine healing program was completed

Second, regarding the changes in blood component after the program was conducted, statistically significant differences were found in the lactic acid ($p<.05$). That is, the experimental group showed a significant decrease in lactic acid after the program whereas the control group showed a significant increase.

Third, systolic blood pressure decreased significantly and while in PEF and FEV1 increased significantly in the experimental group after the program.

Fourth, the LF of the control group significantly decreased after 5 days

CONCLUSION: After the five-day soomchi lung health marine exercise healing program, there was a group difference in the amount of change in lactic acid, a fatigue substance in the blood, and the experimental group significantly decreased after the program.

There was a significant difference between groups in the change in systolic blood pressure, PEF, and FEV1 of lung health variables. Systolic blood pressure in the experimental group decreased significantly after the program, and PEF and FEV1 in the experimental group increased significantly after the program.

As a result of heart rate variability analysis, LF was significantly decreased after 5 days in the control group.

In summary, this study showed positive physical changes in lung health variables (blood pressure, PEF, FEV1) and heart rate variability (LF), a stress-related variable, after participating in the Soomchi Lung Health Marine Healing Program. It can be said that the effectiveness of the program has been demonstrated.

However, the fact that there was no change in body composition and blood lipid variables was that the breath health marine healing exercise program was lacking for a period of time, and it is believed that there will be clear effects when implemented in the long term, so it is suggested to implement a long-term marine healing program in the future.

HOW VARIABILITY COULD SHAPE PERCEPTUAL-MOTOR EXPERTISE IN 4X100 M RELAY?

EGIZIANO, M.1, CHOMIENNE, L.1, BOSSARD, M.2, VERHULST, E.3, KULPA, R.3, MASCRET, N.1, MONTAGNE, G.1

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INTRODUCTION: The optimization of perceptual-motor expertise is a very challenging issue for both coaches and athletes. A recurring question that can be asked is to what extent training sessions must be performed in stable conditions, in which the athlete is exposed to task constraints mimicking those encountered in competition, or conversely under extremely variable conditions, to be more effective? In this study we were interested in a very specific skill, namely the synchronization of runners' race in 4x100 m relay. Relay performance is based on the ability of the team to coordinate the

race of the athletes to maximize the speed of the baton exchange. To optimize the passing of the baton, athletes can place a go-mark on the ground approximately 8 m from their starting position to initiate their run when the giver crosses this mark. This synchronization task is not trivial and relies on the ability of athletes to anticipate the passage of the partner on the go-mark. Moreover, to our knowledge, no feedback-based procedures were proposed to train this task. The aim of our study is precisely to investigate the influence of the variability of training conditions on athletes anticipation abilities, in an immersive virtual environment.

METHODS: The athletes were equipped with a virtual reality headset to be immersed in a virtual stadium at the receiver's position. They were instructed to initiate their race when the avatar of their partner passed over the go-mark. A learning protocol including a pre-test, an acquisition phase and both retention and transfer tests (assessments done under conditions different from those for which they had been trained) have been used. Two groups of participants, namely 'stable' and 'variable', practicing athletics at a regional level, have been tested. The first group performed the task under stable conditions, i.e., with the go-mark always placed at the same distance and in the presence of an avatar always arriving at maximum speed. The second group performed the task under variable conditions, i.e., with a variable go-mark position and in the presence of an avatar whose speed varied. Both groups received systematic extrinsic feedback about their performance after each trial in the acquisition phase. Several dependent variables have been used to characterize the participants' behavior, including the timing error and the gaze strategies.

RESULTS: The results revealed that the 'stable' group learned the task better than the 'variable' group when tested in the reference task. Conversely during the transfer tests, the 'variable' group outperformed the 'stable' group.

CONCLUSION: These results reveal the added value associated with the use of variability in practice conditions to acquire robust perceptual-motor skills.

FEMALE ATHLETE CONSIDERATIONS: IMPROVING COACH KNOWLEDGE AND CONFIDENCE VIA AN ONLINE SHORT COURSE

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INTRODUCTION: With a growing awareness and recognition of female-specific considerations when training athletes, there is a requirement for coaching and support staff to be educated on current best practice guidelines when working with female athletes. The aim of this study was to assess the effectiveness of an online short course aimed at improving the knowledge of coaching and support staff working with female athletes.

METHODS: This study used a mixed-methods survey design, where participants completed three instances of an online survey (pre-course, post-course, and 6 months post-course) before and after an online 8-week short course involving both content delivery and an applied practice block. Questions involved both quantitative (numeric) and qualitative (textual) responses. Open-ended survey questions were analysed thematically to explore two a priori themes of 'Course expectations' and 'Changes in practice'. The data were explored inductively within these pre-determined thematic areas. Finally, overall course feedback was analysed deductively to provide guidance for future course delivery.

RESULTS: Of the 92 participants who completed both pre- and post- surveys, 72% (n=66) were female and 67% (n=62) were from a team sport. The perceived knowledge and confidence of participants both improved following the course ($p<0.001$) and were still above pre-course values 6-months post ($p<0.001$). Two sub-themes were generated within the 'Course expectations' theme: Empowering [me] to empower and support [them], and Sharing knowledge and experiences. Within the 'Changes in Practice' theme the subthemes Relaxing into it and Embedding support structures were observed. Feedback from participants indicated that they enjoyed learning from a variety of content experts as well as each other, and that the online learning format was suitable.

CONCLUSION: Future educational courses aimed at coaching and support staff are encouraged to apply our learnings to design and deliver programs in a way that is accessible and aligned with the learning styles and preferences of these individuals. When delivering specific education regarding supporting female athletes, directly targeting and encouraging men to participate may also be beneficial.

TO AGREE UPON VOCABULARY FOR THE GENERAL ADAPTATION SYNDROME AND SUPERCOMPENSATION MODELS

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INTRODUCTION: Words to describe aspects of training are often used incorrectly or inconsistently. The original General Adaptation Syndrome model by Selye (1950) talked of "stressors" that produce "defence", "damage", "actions" and "reactions" [1] but Yakolev (1967) used "stimulus", "fatigue", "compensation" and "supercompensation" [2] and Fry (1998) "stimulus", "resistance" and "adaptation" [3]. Other words included in training models include "depletion", "restitution", and "involution" [2, 4]. Some of these words don't have a precise scientific meaning, and some don't have a scientific meaning at all.

METHODS: Published training models, and other terms used to describe training, were surveyed, and the most common and precise terms were used to build a new training model.

RESULTS: A training model is proposed that precisely defines the following terms:

Training: A period of physical activity that has a goal of improving or maintaining physical function

Rest: A period without training

Fatigue: A process that occurs during training; a disturbance in a system's homeostasis resulting in a reduction in performance

Recovery: A process whereby the reduction in performance due to fatigue returns to normal

Adaptation: A process of change by which the body becomes better suited to a task

Effect: The improvement in performance that results from adaptation

De-training: The process by which effects wear off due to lack of training

Dose: A quantity of training

Overload: A training dose sufficiently high to cause adaptation

Stimulus: Training is a stimulus, and in this context stimulus and training are synonyms

Response: The response to a training stimulus is fatigue, recovery and adaptation. "Response" therefore means the processes of fatigue, recovery and adaptation.

Note that training and rest are time periods, and fatigue, recovery, adaptation, response and de-training are processes.

CONCLUSION: This model provides clear definitions of terms commonly used in exercise science, and can help those of us in the exercise science community to speak the same language and communicate effectively.

1. Selye (1950) 2. Yakolev (1967) 3. Fry (1998) 4. Zatsiorsky & Kraemer (2006)

DISCREPANCIES BETWEEN INTENDED AND ACTUAL TRAINING LOAD – REASONS AND IMPLICATIONS FOR PERCEIVED STRESS AND RECOVERY

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INTRODUCTION: Coaches strive to enhance performance of their athletes by prescribing an effective and well-balanced training program. The intended training load sometimes deviates with the perceived training load by the athletes (Otter et al 2022). However, underlying causes and possible consequences are still unknown. This study aimed to explore 1) reasons for differences in training load 2) discrepancies between intended training set by the coaches and actual training perceived by junior speed skaters and their relationship with changes in stress and recovery.

METHODS: First, nine speed skaters and their coach were interviewed about their methods for determining duration and intensity of training sessions, in order to explain any potential mismatches. Second, during a 4-week training period, 2 coaches and their 23 speed skaters monitored the intended and perceived training intensity (RPE) and duration (minutes) for each session. Coaches filled it out prior to training sessions and athletes after each session. Both intended and perceived training load were calculated by multiplying RPE by duration. Perceived stress and recovery levels were measured using RESTQ-sport questionnaires before and after the 4-week period. Differences between intended and perceived training load and perceived stress and recovery were calculated over the 4 weeks.

RESULTS: Overall, there were large individual variations in (mis)matches between intended and perceived training load. Results from the interviews revealed that there were several causes for differences in training load between coaches and athletes such as discrepancies in the interpretation of the RPE scale, personal and external influences of the athlete and deviance in expected and actual fitness. The second part analyzed 438 planned training sessions and 378 actual training sessions. The planned training sessions had a moderately longer duration per week (52:37h) compared to the perceived duration (45:16h), with skaters completing 4±6 sessions less. Perceived training load was lower than intended for both skating (-532±545AU) and strength (-1276±530AU) sessions, due to lower RPE scores for skating (-0.6±0.7) or shorter/fewer sessions for strength (-04:13±02:06h). Differences in intended-perceived training parameters had a strong positive correlation with changes in RESTQ-sport for success ($r=0.57$), physical recovery ($r=0.58$), self-regulation ($r=0.60$), and personal accomplishment ($r=0.59$). All described differences and correlations were significant ($p<0.05$)

CONCLUSION: These findings show that speed skaters demonstrate a (mis)match with the coach's intended training load for different reasons. In general, there is a relationship between the mismatch in training load and the perception on recovery scales of the RESTQ-sport. This implies that athletes who approach or exceed intended training load perceive more personal accomplishment, physical recovery, success and self-regulation.

Reference

Otter RTA et al. (2022) Int. J. Environ. Res. Public Health, 19

DIFFERENCES IN PROFICIENCY LEVEL OF THE STRADDLE VAULT MOVEMENT IN JAPANESE ELEMENTARY SCHOOL CHILDREN

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INTRODUCTION: Gymnastics is positioned in the physical education curriculum of some countries, but it has been pointed out that the childrens proficiency and the quality of instruction may depend on the experience or knowledge of the teacher (Kovač et al., 2020). In Japanese elementary schools, it is not uncommon for a homeroom teacher to teach all subjects, and he/she doesn't necessarily have expertise in exercise instruction. Therefore, we focus on the straddle vault of the vaulting box exercise, and aim to clarify the actual state of the skill proficiency of children in Japanese elementary school.

METHODS: The subjects were 486 children aged 9-12 from four elementary schools in Japan. There were 120 3rd graders (5 classes), 127 4th graders (5 classes), 129 5th graders (5 classes), and 110 6th graders (4 classes). We evaluated the childrens proficiency using five proficiency movement patterns of the straddle vault (Sano et al., 2022). The straddle vault movement was filmed by two video cameras from the front and side, and the images were evaluated by two evaluators based on the following six evaluation points: (1) Adjusting; free leg flexion, (2) Rebound jump, (3) Push-off, (4) Rotating backward, (5) Closing legs, (6) Stopping firmly. Latent class analysis was applied to the evaluation results to extract five proficiency patterns of the straddle vault, and the pattern with the highest membership probability was judged as the proficiency level of the subject. In order to investigate the difference in proficiency between grades, we compared the composition ratio of patterns by chi-square test and residual analysis. Additionally, the composition ratio of pattern of each class within the same grade was compared by Fishers exact test. Significance was set $P<0.05$.

RESULTS: As a result of the latent class analysis, five proficiency patterns (Failure vaulting, Arm dependent vaulting, Unstable landing vaulting, Stable vaulting, and Strong push-off vaulting) were extracted. A significant difference was observed in the composition ratio of proficiency patterns among grades ($X2=46.9$, $P<0.01$, Cramers $V=0.18$). Residual analysis revealed that there were many Failure vaultings in the 3rd, many Arm dependent vaultings in the 4th and 5th, and many Unstable landing vaultings in 6th grades. Furthermore, as a result of comparing the composition ratio of the pattern between each class in the same grade, a significant difference was observed among the classes in 3rd, 4th, and 5th grades. Especially among the 4th grade, there was a wide range of percentages: 3-35% for Failure vaulting, 6-42% for Arm dependent vaulting, and 8-47% for Stable vaulting.

CONCLUSION: The proficiency of the straddle vault in elementary school children is influenced not only by grade, but also by class (instruction by the homeroom teacher). It is thought that sharing more specific and practical evaluation and instruction methods will be effective for improving the quality of instruction and learning of movements in physical education.

THE EFFECT OF AN 8-WEEK STRUCTURED FOOTBALL TRAINING PROGRAMME ON SELF=PERCEIVED LEVELS OF SKILL, PSYCHOLOGICAL AND PHYSICAL ACTIVITY RELATED MEASURES IN HONG KONG BOYS

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INTRODUCTION: Hong Kong is facing the public health concern of childhood obesity (Huang et al., 2018). Involvement in team sports promotes a more active lifestyle, enhances physical fitness and improves clinical health (Hills et al., 2015). Very few studies in Asia have placed emphasis on the use of team sports, such as soccer, among youth groups as an intervention strategy to increase physical activity levels, as well as physical and psychosocial status.

METHODS: Male Participants from the Hong Kong Football Association development programme were recruited. Pre- and post-programme evaluation was conducted. Questionnaires were composed of 19 questions, including football and psychological-related items. In the post-programme evaluation, 5 additional questions on the effectiveness of the football participation were added. Measures of self-perceived football skills, interest in sports, life satisfaction, self-esteem, self-efficacy and the Physical Activity Rating for Children and Youth (PARCY) were also assessed. The Cantril Ladder of Life was adopted for self-rating of life satisfaction. The Rosenberg Scale was adopted to assess the participants' self-esteem. Enjoyment levels and self-efficacy was assessed by using the 7-item PA Enjoyment scale (Motl et al., 2001), and 8-item PA Self-efficacy Questionnaire (Motl et al., 2000). Semi-structured focus group discussions were conducted to obtain more in-depth feedback. Paired sample t-tests were adopted for the statistical analysis.

RESULTS: 641 participants from 3 rounds with mean ages of 11.6, 9.6 & 9.6 respectively, completed all evaluations. Numbers of weekly football sessions in the past month of averaged 1.1 to 2.1 at pre- and 1.6 to 2.7 at post-programme evaluation. The reported mean duration for each session ranged from 68.8 to 76.1 minutes at pre- and 67.1 to 76.5 minutes at post-programme evaluation. In round 3, the average duration for each session dropped by 5.5 minutes at the post-programme stage. In all rounds, "improvement in football skills" and "having fun" were the 2 most important reasons that maintained football participation. Most players reported themselves as "beginner" at the pre-programme stage for rounds 2 & 3. After the scheme ended, the percentage of "beginners" decreased by 4 to 12 points for all the 3 rounds.

Enjoyment scores in round 3 decreased by 2.9 points ($p=0.026$). In the same round, a 2.7-point increment ($p=0.03$) was detected in players with low/moderate PA level at the pre-programme stage. All samples perceived a higher level of football skills at the end of the scheme. For those whose initial PA levels were not high, improvement was also found at the post-programme stage.

CONCLUSION: This football programme enhanced indicators for each of football-, psychological- and physical activity-related measures. This offers practical implications as an indicator for the optimisation of physical and psychological health through a soccer training programme and a strategic application of sports-programme promotion.

EXPLORING THE USE OF STORIES TO TRANSLATE KNOWLEDGE ABOUT SELF-REGULATORY PROCESSES DURING GOAL STRIVING IN RUNNING

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Introduction

Despite substantial growth in literature on sport psychology, a 'gap' between research and practice has been identified as a longstanding issue in this field, and more broadly in sport science. To address the research-practice gap, alternative ways are needed to increase the transfer and uptake of research in practice. Research-informed stories have showed promise as a knowledge translation tool in sport and physical activity, yet little research has explored how athletes, coaches, and sport psychology consultants (SPCs) act on stories that seek to translate sport psychology knowledge. The aim of this study was to explore the utility of evidence-based stories as a KT tool for sharing knowledge about self-regulatory processes during goal striving in endurance running.

Methods

Guided by the knowledge-to-action model (Graham et al., 2006), we developed evidence-based vignettes portraying athletes' stories in running races and shared these stories with runners, coaches, and SPCs. We explored participants' responses to, and the impact of, the stories, through a longitudinal, integrated methods approach. Eleven runners, three of whom were also running coaches, and two sport psychology consultants (SPCs) read and/or listened to the four research-informed stories and subsequently completed a qualitative survey and two semi-structured interviews exploring their short-term and long-term responses to the stories. Data were analysed using reflective thematic analysis.

Results

Our reflexive thematic analysis yielded five themes: "bridging the gap between research and practice", "the stories (did not) resonate with me", "stories stimulate reflection", "a portal to new ways of knowing", and "putting knowledge into action". Collectively, these themes portrayed how the stories were useful for translating knowledge into practice, the reasons why, and how the stories acted on participants.

Discussion

The participants' perceptions of, and responses to, the vignettes were overwhelmingly positive and suggested this form of representation is a promising approach to translate sport psychology knowledge into action in runners, coaches, and SPCs. Our findings methodologically extend past research in sport on the use of stories as a KT tool by examining the impact of stories on athletes, coaches, and SPCs over time. By generating data at three timepoints over a 6-month period, the current study demonstrated both the conceptual (i.e., changes in levels of knowledge) and instrumental (i.e., changes in use of mental strategies, use of stories by coaches with athletes) use of knowledge presented in the stories. Overall, the findings demonstrate that stories hold potential for translating sport psychology research into practice and enhancing the likelihood that knowledge users benefit from research findings.

Conventional Print Poster

CP-AP19 Paralympics I

UPPER LIMB STRENGTH ASYMMETRY ON A BALLISTIC ERGOMETER BETWEEN SEATED PARALYMPIC ATHLETES AND ABLE-BODIED ATHLETES

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INTRODUCTION: Upper limb asymmetry could increase the risk of injuries in able-body athletes [1] as in manual wheelchair users [2] on strength asymmetry particularly. Paralympic sitting athletes overused their upper limbs in daily life and physical activities, so they could developpe more strength asymmetries than able-bodied people. In this study, we hypothesize that Para-athletes are more asymmetric in strength than able-bodied athletes.

METHODS: Paralympic athletes (PA) were composed of wheelchair tennis, basketball, rugby, and cycling athletes (n = 54, 17 women and 37 men) divided into two groups (with abdominal capacities (PAAC), n = 31 (10 women and 21 men), and without abdominal capacities (PANAC), n= 23 (7 women and 16 men). Able-bodied athletes (AB) were judokas and sports court athletes (n = 42, 13 women and 29 men). was performed seated on a frictionless sledge and consisted of measuring the force during ballistics push-ups at 4 load levels. The force of the right and left upper limbs was measured using two Kistler force plates. The Instantaneous Symmetry Index (ISI) was calculated, according to the method proposed by Chénier et al. (2017) [3] and applied to the push phase for all loads. T-test was used to compare ISI between groups.

RESULTS: The mean strength asymmetry from all loads, calculated with ISI value was significantly higher in men PA compared to AB (respectively 0.057±0.038 and 0.033±0.013; p = 0.001) but also in both paralympic groups (PAAC (p = 0.003) and between AB and PANAC (p = 0.045). However, there is no significant difference between PAAC and PANAC (respectively 0.056±0.031 and 0.058 ± 0.046, p = 0.884). No significant differences were found between all women populations (PAAC 0.054±0.026 or PANAC 0.050±0.014, and AB 0.048±0.043 , p >0.05). Finally, there is no significant difference between PA and AB males and females (respectively p = 0.703 and 0.231).

CONCLUSION: With a graded load push-up exercise, this study aimed to compare the strength symmetry with ISI between the upper limbs of paralympic and able-bodies athletes. Our main results show that in the men's group, PA present greater asymmetry than AB, which is not observed in the women's group which tends to be more asymmetrical than men. But this result may be due to a smaller woman population in all subgroups. The abdominal capacities do not seem

to be the reason for a lesser asymmetry given the non-significant differences between PAAC and PANAC. From push-up exercise, ISI applied to the force is relatively low compared to results on wheelchair propulsion from Chénier et al. 2017 (ISI = 0.2±0.09), but we observe for PA an ISI greater than 0.05 regardless of gender. This value could be an interesting indication threshold of the asymmetry with this index on this test to pay attention to para-sports practice.

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EPIDEMIOLOGICAL STUDY OF SPORTS INJURIES OF CHINESE WINTER PARALYMPIC ATHLETES IN DAILY TRAINING

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INTRODUCTION: There are quite few injury studies in Paralympic winter sports athletes compared to abundant ones in healthy winter sports athletes. Thus, the present study aims to investigate injury epidemiology in Chinese para-athletes preparing for the 2022 Paralympic Winter Games and provide necessary reference information for para-athletes participation safety and injury prevention.

METHODS: We monitored daily training of 174 athletes from para ice hockey, snowboarding, alpine skiing, cross-country skiing and biathlon, who have been preparing the 2022 Beijing Paralympic Winter Games, with monitoring periods varied from 20-68 days(a total of 8,307 athlete days), and each team had professional medical support staff that performed data collection.

RESULTS: 78 out of 174 handicapped athletes (44.8 per cent) reported 123 cases of injuries with a rate of 14.8 cases per 1,000 training days. In terms of sports, we found that injury incidence of snowboard skiing was the highest (62.0%) among sports, corresponding to injury prevalence of snowboard skiing, which had also been the highest among sports, in Pyeongchang Winter Paralympic Games in 2018. We assume this might be caused by the difficulty finishing the moves, specifically, athletes might be highly likely losing body control when completing certain moves. Para ice hockey had the highest injury incidence (IR 25 per 1,000 training). We suppose this might be because the duration of daily monitoring was too short (only 20 days). In terms of sex, the injury prevalence of female athletes (46.4%) was slightly higher than that of men (44.1%), while the injury incidence of women (15.3 per 1,000 training days)was also slightly higher than that of men. In terms of age, the injury prevalence (48.5%)and the injury incidence (15.2 per 1,000 training days)of athletes aged 26-34 were both the highest. In terms of course of sports injury, athletes with chronic injury had higher injury prevalence, which might be due to training overload, leaving athletes with insufficient time for recovery. In terms of types injury, the highest injury percentage was the overuse (63.4%), followed by contusion (13.8%) and sprain (11.4%). In addition, skin abrasions were regularly observed in training, and common causes include contact with venues, prosthetic limbs and equipment during training.

CONCLUSION: In the course of preparation for the 2022 Beijing Winter Paralympic Games, the injury prevalence of snowboard skiers ranked first, which needs immediate attention. The rate of Athletes seeking for medical help due to overuse was relatively high, which indicated that athletes might not be fully recovered before the next training day. The injury prevalence of female athletes was slightly higher than that of male athletes, indicating that female athletes had higher risk of acquiring injury, which needs immediate attention.

DEVELOPMENT OF IMU SYSTEM FOR MEASURING 100-M RACING WHEELCHAIR KINEMATICS

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INTRODUCTION: Wheelchair racing is one of the major sports events particularly in the Paralympics games. Kinematics analysis of racing wheelchair propulsion (RWP) is critical for improving performance and preventing injury. Previous study investigated RWP kinematics during 100-meter race using 2 video cameras (1). As technology advances, inertia measurement unit (IMU) has currently gained popularity in wheelchair research (2-3) due to its portable, low-cost, and easy to implement. However, no previous study has employed IMU sensors to measure RWP kinematics in the field. Therefore, the purpose of this study was to develop IMU system to measure spatiotemporal parameters during 100-meter distance.

METHODS: Ten wheelchair racing athletes were volunteered to perform 100-meter race simulation. IMU sensors were attached to the wheelchair frame and both wrists to collect acceleration data for the analysis of RWP kinematics. Furthermore, the traveling distance was measured using an Odometry Measurement Unit (OMU) equipped with an adjustable mechanism for attachment to various sizes of front wheel forks. The acceleration data and traveling distance were collected simultaneously at a sampling frequency of 100 Hz. Three simulated race trials were collected and analyzed. Spatiotemporal data including push frequency, propulsion and recovery phase were obtained from IMU data. Data from a total of 100 meter and each 20-meter interval were analyzed. Repeated measure ANOVA was performed to determine significant differences among the five phases. Holm post hoc tests were completed when a significant main effect was found.

RESULTS: Significant main effect was found in push frequency ($p<0.001$) and propulsion phase ($p=0.02$), except for recovery phase. Post hoc analyses revealed that there was significant increase in push frequency and propulsion phase when going from first 20 to 20-100 m ($p<0.05$). Similarly, significant increases were also noted with propulsion phase during 0-20 m, however, only when compared to 20-80 m ($p<0.05$).

CONCLUSION: This study displays the feasibility of IMU system for measuring RWP kinematics in the field. The result shows high push frequency and long propulsion phase in the first 20-meter because athletes need to overcome the inertia from the stationary and gain more velocity. This data can be used to provide feedback to coach and athletes.

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DIETARY INTAKE AND SERUM VITAMIN D LEVELS AMONG WHEELCHAIR USERS WITH INITIAL LOW BONE MINERAL DENSITY

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INTRODUCTION: Wheelchair users may face nutritional challenges due to reduced mobility and complications associated with their disability. The potential nutritional deficiencies, and low mechanical loading of bones, may lead to an increased risk of low bone mineral density (BMD) and consequently osteoporotic fractures. Furthermore, adequate energy intake, vitamin D and calcium are important factors in prevention and treatment of low BMD. Therefore, the aim of this study was to investigate dietary intake in relation to serum levels of vitamin D (S-vitamin D) and BMD among wheelchair users with an initial low BMD of the lumbar spine (Z-score<0.0).

METHODS: Prior to a 24-week Randomized Controlled Trial (RCT) on the effects of resistance training on bone health, energy, calcium and vitamin D intake, S-vitamin D, BMD and body composition were assessed in 8 wheelchair users (4 females/4 males; 3 athletes; 36 (22-47) yrs;72.9 (58.9-84.6) kg). Dietary intake was assessed with 3 unannounced 24-hour dietary recalls within a 2-week period. BMD (lumbar spine and hip) and body composition were measured by Dual-energy X-ray absorptiometry (DXA) and S-vitamin D by a fasted, venous blood sample. The subjects answered the "International Physical Activity Questionnaire – Short Form", which estimated individual physical activity level (estPAL), and the Cunningham equation was used to estimate resting metabolic rate (estRMR). Estimated energy requirement was calculated by estRMR and estPAL. Due to non-normality, data are presented as median (25th-75th percentiles), and Spearman correlation analyses were performed with significance level $\alpha=0.05$.

RESULTS: Daily energy intake (EI) was 2517 (1727-3458) kcal and 61 (54-68) kcal/kg lean body mass (LBM). The EI/estRMR ratio was 1.8 (1.5-2.1), which for all subjects was above their estimated energy requirements. None of the EI parameters correlated with Z-score of lumbar spine or hip ($P>0.05$). Both calcium intake (1305 [751-1500] mg/d) and protein intake (1.4 (1.1-1.8) g/kg/d) were in line with dietary recommendations. Daily vitamin D intake was 16 (7-27) ug/d, and 38 % of the subjects had an intake below Norwegian recommended daily intake (RDI; 10 ug/day). The 3 subjects with the lowest hip Z-scores used vitamin D supplements. As such, vitamin D intake was negatively correlated with hip Z-score (rsp=-0.79, $P=0.02$), S-vitamin D was 42 (35-56) nmol/l and 75% of the subjects presented suboptimal values <50 nmol/l. There were no significant correlations between S-vitamin D and Z-score of lumbar spine or hip ($P>0.05$), or with vitamin D intake ($P=0.18$).

CONCLUSION: Despite a sufficient energy and calcium intake, 1 of 3 had vitamin D intakes below RDI, and suboptimal S-vitamin D levels were present in 3 of 4 wheelchair users with initial low BMD. Further research is needed to conclude whether vitamin D is the driving nutritional factor for bone health in wheelchair users.

SLEEP IN PARALYMPIC ATHLETES AND ITS RELATIONSHIP WITH INJURIES AND ILLNESSES

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INTRODUCTION: The popularity of Paralympic sports has grown exponentially in the past years. With more athletes competing at high levels, injury rates have become a worrying issue (1). A recent systematic review warned about the high prevalence and incidence of injuries found in para athletes (2) and achieving optimal recovery in the training process is important in improving physical performance (3). To evaluate sleep characteristics of Paralympic athletes and investigate the relationship of sleep with health problems, including injuries and illnesses, in Paralympic athletes.

METHODS: This was a transversal study with 20 Paralympic athletes who had competed at the highest level of Brazilian competitions in the following modalities: athletics, swimming, and weightlifting. A specific database of health problems recording was collected in conjunction with the medical team for two weeks through the Brazilian version of the Oslo Sports Trauma Research Center questionnaire (OSTRC-BR) concurrently with the evaluation of chronotype, sleep quality, sleep complaints and sleep behavior. The sleep-wake patter was monitored using a wrist activity monitor in conjunction with self-report sleep diaries for 15 consecutive days.

RESULTS: Sleep latency (r=-0. 46; p=0.04) and duration of naps (r= -0.46; p=0.04) were associated with occurrence of health problems; insomnia (r= -0.46; p= 0.04), frequency of insomnia, Pittsburgh Sleep Quality Index score (r= 0.45; p=0.04), and frequency of awakenings at night (r= 0.58; p= 0.01) were associated with severity of health problems on week 2; frequency of movements during sleep was associated with OSTRC-BR cumulative score (r= 0.58; p=0.00); and frequency of nightmares was associated with OSTRC mean score. A high prevalence of poor sleep quality and poor sleep behavior was also found.

CONCLUSION: Paralympic athletes tend to report poor sleep quality and to have a poor sleep behavior. Some sleep complaints such as insomnia symptoms, awakenings at night, movements during sleep and poor sleep quality were associated with the occurrence and severity of health problems We recommend practitioners consider the sleep characteristics of athletes in their injury prevention planning for Paralympic athletes.

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HANDCYCLING WITH CONCURRENT LOWER BODY LOW-FREQUENCY ELECTROMYOSTIMULATION INCREASES ACUTE OXYGEN UPTAKE IN ELITE WHEELCHAIR BASKETBALL PLAYERS: AN ACUTE CROSSOVER TRIAL

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INTRODUCTION: Acute increases in oxygen uptake (VO2) during exercise are crucial for aerobic training adaptations and depend on the amount of muscle involved. VO2 capacity is limited during wheelchair handcycling due to restricted muscle involvement of the impaired lower body muscles. Handcycling with concurrent complementary low-frequency electromyostimulation (LF-EMS), applied to major lower limb muscles might lead to relevantly increased passive muscle involvement with higher oxygen uptake in elite wheelchair basketball (WCB) athletes.

METHODS: The squad of the German national WCB team (n=12, age: 25.6 ± 5.6 years, height: 1.75 ± 0.16 m, mass: 74.0 ± 21.7 kg, classification: 2.92 ± 1.26 a.u. (1.0 - 4.5 from least to most mobility)) completed 2×5 minutes of handcycling (60 rpm, ¾ bodyweight as resistance in watts) (HANDCYCLE) and handcycling with concurrent EMS of the lower extremities (EMS_HANDCYCLE). During EMS_HANDCYCLE, LF-EMS (impulse frequency: 4Hz, impulse width: 350µs, continuous stimulation) was applied to gluteal, quadriceps and calf muscles. The stimulation intensity (buttocks: 69.5 ± 22.3 mA, thighs: 66.8 ± 20.0 mA, calves: 68.9 ± 31.5 mA) was individually adjusted based on reported comfort tolerance for 5 minutes.

RESULTS: Large and significant mode-dependent differences in VO2 responses were found between HANDCYCLE and EMS_HANDCYCLE (17.60 ± 3.57 vs. 19.23 ± 4.37 ml·min-1·kg-1, p = 0.001, ηp2 = 0.69). Furthermore, ΔLactate was significantly lower in HANDCYCLE compared to EMS_HANDCYCLE (0.04 ± 0.28 vs. 0.31 ± 0.26 mmol·l-1, p = 0.036, ηp2 = 0.37). Although perceived effort did not differ between conditions (2.7 ± 0.9 vs. 2.9 ± 0.9 a.u., p = 0.293, ηp2 = 0.100), discomfort was rated lower during HANDCYCLE compared to EMS_HANDCYCLE (1.4 ± 1.3 vs. 3.9 ± 2.1 a.u., p = 0.002, ηp2 = 0.58).

CONCLUSION: Concurrent and complementary LF-EMS of the lower extremities during submaximal handcycling notably increases acute oxygen uptake and thus may serve as an additional cardiocirculatory training stimuli for improvements in aerobic capacity in wheelchair athletes. Future studies on tissue response and preservation when concurrently using LF-EMS in the long term are suggested.

A STATISTICAL APPROACH TO SELECT WHICH PLAYERS TO PUT ON THE FIELD DURING A WHEELCHAIR BASKETBALL CHAMPIONSHIP.

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INTRODUCTION: Game performance in Wheelchair Basketball (WB) is represented by season statistics in terms of winning records, average points from both field-goals and free throws, rebounds, assists, and steals per match. How to optimize the factors contributing to the success of game performance and how to select players are primary concerns of the coaches and the technical staff. In order to explore the factors contributing to the success of the match, Cluster Analysis was applied in WB game performance data.

METHODS: Data related to a complete regular season of the top Italian WB Championship 101 athletes of 8 different teams and 56 matches) were considered for analysis. Based on seven scores of the athletes' performance normalized by the time spent by each player in the field during each match (i.e., the number of free-throw points made [FTM], number of two-point field-goals made [P2M], number of three-point field-goals made [P3M], total points made per match [PTS = FTM + P2M + P3M], number of steals [ST], number of rebounds [REB] and number of assists [AS]), the suitable number of clus-

ters was determined by the hierarchical ward clustering method. The k-means clustering technique with the defined number of clusters was then performed to determine cluster membership for each participant.

RESULTS: Based on data related to the first round of the Championship (i.e., 28 matches), two cluster solution to explaining about 35% of the total variance was considered to produce the optimal cluster size for detailed groups whilst maintaining meaningful differences between the clusters. Cluster 1 was composed by high performing athletes, while Cluster 2 is composed by low performing athletes. Based on data related to the second round of the Championship, the regression analysis conducted with the performance of each team (winning or losing), showed that teams where players belonging to the Cluster 1 had played more time during the second round of the championship were also those with the better team performance (Adjusted R-squared = 0.48 and P = 0.035).

CONCLUSION: The results of the present study provided a practical tool for WB coaches based on statistical techniques to support their tactical decisions in order to answer the coach's question: "By what criteria can I select which players to put on the field during a WB championship?".

THE EFFECTS OF PRE-COOLING ON CORE TEMPERATURES AND PHYSIOLOGICAL INDICATORS IN BLIND MARATHON RUNNERS USING ICE SLURRY INGESTION - A CASE STUDY OF JAPANESE ELITE ATHLETES

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INTRODUCTION: The Tokyo 2020 Games were held in a hot environment, and blind marathon runners, such as athletes in other events, needed to prepare for the heat during the event. Although body cooling strategies to control excessive increases in core body temperature are extremely important to ensure safety and high exercise performance in hot environments, the thermoregulatory responses and effects of body cooling in visually impaired marathoners in hot environments remain unclear. The purpose of this study was to investigate the effects of pre-cooling with ice slurry ingestion on the core temperatures and physiological and subjective indicators in blind marathon runners during outdoor distance running in hot environments.

METHODS: Four elite blind marathon runners (2 males and 2 females; age, 41 ± 17 years; height, 158.2 ± 9.0 cm; weight, 49.4 ± 7.8 kg; T11–T12 classes), aiming to compete in the Tokyo 2020 Games, participated in this study before the Games. During the training camp in early September 2019 (Wet Bulb Globe Temperature (WBGT), 29.9 ± 1.4 °C), two 15–30 km running sessions were performed. All runners ingested 7.5 g· kg −1 of ice slurry (ICE), or an ambient temperature sports drink (CON) during the 30-minute warm-up before running. The two conditions, ICE and CON, were performed in a crossover fashion, with the two runs spaced three days apart. Core body temperature (gastrointestinal temperature, Tgi), skin temperature (Tsk), and heart rate (HR) were measured before warm-up (Pre), after pre-cooling (Post Pre-cooling), at the start, and at the 5, 10, 15, 20, 25, and 30 km distance points. Body weight (used to calculate sweat loss and dehydration rate) was measured before and after running. An effect size (Cohens d) was calculated to indicate the degree of difference in each physiological index between the two groups. The standard effect size was set as small (0.20), medium (0.50), and large (0.80).

RESULTS: The average time per kilometer was similar in both conditions (ICE, 0:04:30 ± 0:00:42; CON, 0:04:33 ± 0:00:39; d = 0.07). The decrease in Tgi from Pre to Post Pre-cooling was greater for the ICE group than that for the CON group (ICE, Δ-0.86 ± 0.2 °C; CON, Δ0.05 ± 0.4 °C; d = 2.88). However, the difference in Tgi between the two groups disappeared at the 5-km mark from the start of the race. The other physiological parameters, such as Tsk, HR, total water intake volume, total sweat loss, and dehydration rate, were similar in both conditions.

CONCLUSION: The results of this study showed that pre-cooling by ice slurry ingestion decreased core temperature, but had little effect on the skin temperature, HR, or dehydration rate of blind marathon runners. The difference in the core temperatures between the CON and ICE groups observed during precooling disappeared at the 5-km mark of the run. Therefore, in addition to pre-cooling, it would be necessary to consider the introduction of cooling during marathon races.

QUANTIFICATION OF PULLING FORCE DURING A INCREMENTAL ROWING TEST IN PARA-ATHLETES: PILOT STUDY

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INTRODUCTION: The scientific literature identifying the physiological and biomechanical factors of performance in able-bodied rowers allows for the characterization of expectations in both novice and high-level rowers (Lawton 2012, Smith 2012). This work allows the identification of indicators associated with cardiorespiratory, muscular, and gestural capacities during muscle, boat, and rowing tests. Despite this work, few have focused on the development of pulling force during rowing tests. Indeed, only Curtler (2016) reports a decrease in strength when the athlete is found to be able to use only their arms, or only their arms and trunk compared to the arms, trunk, and legs condition. Although not focused on para-athletes, this study questions the impact of muscle deficit on athletic performance. The objective of this study is to characterize the pulling force developed by the national and elite para-athletes during incremental rowing VO2 max Test.

METHODS: 6 para-rowers of national and elite level perform a 3-minute incremental test with 30 seconds of recovery on a rowing machine (RowErg, Concept C2, USA). The pulling force is recorded during the test (K-Pull, Kinvent, France). The temporal parameters of the cycle as well as the maximum pulling force and its onset were calculated for each cycle at

each level. The percentage difference between the penultimate and the last level was calculated for each biomechanical parameter [median Q1-Q3].

RESULTS: The 6 athletes achieved 4 or 5 validated landings. Concerning the biomechanical performance parameters, we observed a 13% [10-15] decrease in cycle time between the penultimate and the last stage, which was accompanied by a 13% [10-14] increase in cadence. Logically, the pull phase increases (5% [5-7]) less than the return phase decreases (17% [12-22]). While the pull force also increases (5% [4-8]), the analysis of the onset of peak force remains almost identical at all levels (14±1.3%). This last parameter underlines that despite the different motor deficits, the athletes have the capacity to develop a quasi reproducible force at each cycle of each level.

CONCLUSION: This pilot study identifies that the adaptations of the performance parameters are in agreement with the literature. The analysis of the pulling force highlights a low variability of the appearance of the peak in the cycle. These results seem to indicate a technical reproducibility of the para-rammers independently of their level of motor deficit. This last point may allow the identification of the expected level of motor expertise.

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VALIDITY AND RELIABILITY OF PREDICTION EQUATIONS BASED ON ANTHROPOMETRIC INDICES TO ESTIMATE BODY COMPOSITION IN ATHLETES WITH AN AMPUTATION

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INTRODUCTION: Body composition needs to be monitored in athletes with amputation because these parameters are related with their performance and health. The most common method of evaluation is the prediction equations based on anthropometric indices. However, they assume body symmetry; this is not the case of athletes with amputation. Consequently, the use of anthropometry and the prediction equations might not be adequate. Therefore, the aim of this study is to explore the validity and reliability of predictive equations based on anthropometric indices to estimate body composition in athletes with unilateral lower limbs amputation, compared with the gold standard Dual-energy X-ray absorptiometry (DEXA).

METHODS: Body composition was measured in 28 paralympic athletes with unilateral amputation using DEXA and anthropometry at the same day. Wilcoxon test was used to estimate the differences between DEXA and prediction equations. Pearson's correlation coefficient was estimated to determine the association between techniques. Absolute agreement was assessed using the Intraclass Correlation Coefficient (ICC).

RESULTS: Statistically significant differences ($p<0,001$) were found in all of the variables between DEXA and the predictive equations. Anthropometry significantly overestimated fat mass by 3.38 Kg, fat mass index by 1.23 Kg/m2, lean mass index by 5.70 Kg/m2 and bone mass by 12.15%. Also, anthropometry significantly underestimated fat percent (by 10.6% with Slaughter, by 8.87% with Faulkner and by 13.44% with Carter equation), lean mass by 11.78 Kg and lean mass percentage by 26,72%. Only fat mass index had an excellent agreement between the equations and DEXA (ICC= 0.81). Lean mass (ICC= 0.63) and fat percent estimated with Slaughter (ICC= 0.47) and Faulkner (ICC= 0.49) had good agreement. For the other variables, this agreement was poor. Very strong correlations were found for fat mass index (r= 0.82) and lean mass (r= 0.86), and strong associations for fat mass (r= 0.79), fat percent (r= 0.7 for Slaughter, 0.64 for Faulkner and 0.79 for Carter) and lean mass index (r= 0.69 compared to Appendicular muscular mass index given by DEXA) between instruments. Other variables reported weak to moderate associations.

CONCLUSION: Prediction equations based on anthropometric indices are valid to measure fat mass, fat mass percentage (Slaughter, Faulkner and Carter equations), fat mass index, lean mass and lean mass index compare to DEXA on athletes with lower limb unilateral amputation. But this method is not valid for the estimation of lean mass percentage, fat free mas index and bone mass percentage. The precision of the equations is excellent only for fat mass index compared to DEXA, which means that they will give biased results for the rest of the parameters. Therefore, we do not recommend to use of the traditional equations based on anthropometric indices for the estimation of body composition in athletes with unilateral lower limb amputation. Specific equations for them should be developed.

Conventional Print Poster

CP-MH16 Ageing II

EFFECTS OF TAI CHI AND CONVENTIONAL EXERCISE ON SUBJECTIVE SLEEP PARAMETERS IN OLDER ADULTS WITH CHRONIC INSOMNIA AND DEPRESSIVE SYMPTOMS: PRELIMINARY RESULTS OF A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Insomnia occurs in nearly 50% of older adults, and has been associated with several chronic diseases, including heart disease, osteoporosis and depression. Depression and insomnia are highly comorbid, as sleep difficulties can arise prior to or after the onset of a depressive episode. Exercise has been endorsed by international guidelines as an effective treatment for insomnia and depression. However, whether different exercise modalities induce differential responses on subjective sleep remains to be elucidated. In this study, we present the preliminary findings of a randomized controlled trial designed to compare the effects of conventional exercise and Tai Chi versus control on subjective sleep quality in older adults with chronic insomnia and depressive symptoms.

METHODS: In this three-arm randomized controlled trial, thirty-six older adults (67±5y) with a diagnosis of chronic insomnia and depressive symptoms were randomly assigned in a 1:1:1 ratio to a conventional exercise intervention consisting of aerobic and strength training (EX), a Tai Chi intervention (TC), or a Health Education control (HE) for 12 weeks. Outcomes included the Pittsburgh Sleep Quality Index (PSQI), and sleep efficiency, sleep onset latency and total sleep time assessed through a sleep diary. Generalized estimating equations were used to compare the changes in sleep parameters from baseline among groups, where a P value <0.05 was considered statistically significant. Data are presented as means±SD.

RESULTS: At the end of the intervention, the PSQI values were significantly reduced in all groups (TC, -3.3±3; EX, -2.9±3; HE, -2.6±3; Time effect, P=0.04) but no differences were observed among groups (Time x Group, P=0.5). No significant Time (P≥0.25) or Time x Group (P≥0.11) interactions were observed for sleep efficiency, sleep onset latency and total sleep time, although all interventions improved sleep efficiency (TC, 14%±21; EX, 11%±16; HE, 9%±10), sleep onset latency (TC, -35±47min; EX, -38±85min; HE, -11±29min) and total sleep time (TC, 100±107min; EX, 58±102min; HE, 64±81min) from baseline.

CONCLUSION: Our preliminary findings suggest that exercise, Tai Chi and health education are effective for improving subjective sleep quality in older adults with chronic insomnia and depressive symptoms. Participants in the intervention groups experienced greater improvements on sleep quality when compared to control, however these differences did not reach statistical significance. Further analyses based on a larger sample size are needed.

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ACUTE EFFECTS OF ECCENTRIC VERSUS CONCENTRIC EXERCISES ON EXECUTIVE FUNCTION OF OLDER ADULTS

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INTRODUCTION: Cognitive function could be improved acutely after performing a bout of aerobic and/or resistance exercise [1]. It is possible that muscle contraction types in the exercise affect the acute changes in the cognitive function differently. For example, Fang et al. [2] reported greater movement-related cortical potential during eccentric (lengthening) than concentric (shortening) muscle contractions. However, no previous studies have compared between eccentric and concentric exercises for acute changes in cognitive function. We tested the hypothesis that eccentric exercises would improve cognitive function greater than concentric exercises. Thus, we compared descending stair walking (DSW) and ascending stair walking (ASW), as well as eccentric resistance exercise (ERE) and concentric resistance exercise of the knee extensors (CRE) for changes in some cognitive function test scores before and after the acute exercise bout performed by older adults.

METHODS: Twenty healthy older (66-75 y) adults performed DSW, ASW, ERE and CRE for 20-25 minutes each with a week interval between exercises in a randomised order. They performed Stroop test, symbol digit modalities test, digit span test and two types of trail making test (TMT-A, TMT-B) before and after sitting for 20 minutes (control condition), two occasions before the first exercise session, and before and after each exercise bout. Two exercises (DSW vs. ASW, ERE vs. CRE) were compared for changes in the cognitive function scores before and after the exercise by two-way repeated-measures ANOVA to test the hypothesis that DSW and ERE (eccentric exercises) would increase the scores greater than ASW and CRE (concentric exercises).

RESULTS: A significant ($p<0.05$) improvement of the test scores was found from the first to the second control sessions, and after sitting for 20 minutes. No further improvement of the scores was evident from the second control session to the baseline of the next four exercise sessions. When comparing pre- and post-exercise test scores, no significant changes were observed for Stroop, symbol digit modalities and digit span tests. However, TMT-A (-16.1±4.7 ~ -22.9±10.1 s) and TMT-B (-20.3±10.3 ~ -30.4±22.1 s) showed improvement ($p<0.05$) from pre- to post-exercise, without significant differences among the four exercise sessions.

CONCLUSION: These results showed that the exercises did not improve cognitive function except for the TMT performance. However, a similar improvement of the TMT scores was also found in repeating the tests in 20 min, thus the effect was not likely due to the exercise. Contrary to the hypothesis, no significant difference between eccentric and concentric exercises existed for post-exercise changes in cognitive function, and cognitive function was not improved by an acute exercise for older adults whose cognitive function was not impaired.

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ACUTE PROGRESSIVE WHEELED MOTORIZED SLED-PUSH EXERCISE IN OLDER ADULTS: FEASIBILITY AND PHYSIOLOGICAL QUANTIFICATION

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INTRODUCTION: The potential of the novel XPO Sled Trainer (XST) - a wheeled motorized sled-push device, has not been systematically tested in older adults. This study examined the feasibility and physiological effects resulting from an acute progressive sled-push exercise session using the XST device in older adults and compared it to a walking session.

METHODS: Thirty-six older adults (Age: 69.2±4.7 years; BMI: 27.3±5.9 kg/m2; 61% women) were randomly allocated into the sled-push (SLP; n=18) or walking (WKG; n=18) group. We assessed: heart rate (HR) using a HR monitor, blood pressure (BP), blood lactate (LAC) using handheld blood lactate meter device, and rate of perceived exertion (RPE) using the Omni scale. The protocol involved participants pushing the XST device, which provides low rolling resistance at low speeds with an instant and automatic equivalent increment in resistance with increased speed, six times on a 30-meter course with 2-minute rest periods in between. The exercise for the SLP was based on normal average speed for pushing the sled with the motor disconnected (i.e., no resistance). Normal average speed was then used to create three different exercise intensity/speed zones: subnormal (75 and 85%), normal (100%), and supranormal (125%); with the 100% and 125% speed being completed twice each and the average used for the analysis. An online metronome connected via Bluetooth to a speaker was used to pace and monitor speed during each of the six trials. Data were collected during all 2-minute rest periods. The WKG condition performed the same task but without the sled. Data were analyzed using Mixed-Factor ANOVAs with significance level set at $P<0.05$, with holm correction.

RESULTS: No adverse events occurred during the exercise sessions, and participants of both groups successfully completed the exercise protocol as prescribed. Mixed-factor ANOVAs revealed a significant group x speed interaction for HR $F(2, 66) = 25.92$, $P<0.001$, $\eta p2=0.44$, systolic BP $F(2, 68) = 8.81$, $P=0.001$, $\eta p2=0.21$, blood LAC $F(2, 68) = 19.61$, $P<0.001$, $\eta p2=0.37$, and a significant main effect for group $F(1,34) = 32.92$, $P<0.001$, $\eta p2=0.49$ and velocity for RPE $F(2,68) = 48.27$, $P<0.001$, $\eta p2=0.59$. Test of simple effects for speed showed that the SLP group demonstrated significantly ($P<.001$) higher HR (subnormal: mean difference (MD)=22.28 b·min-1; normal: MD=36.1; supranormal: MD=40.41, systolic BP (subnormal: MD=11.1 mmHg; normal: MD=13.5; supranormal: MD=18.1), and blood LAC (subnormal: MD=1.1; normal: MD=1.9; supranormal: MD=3.5) compared to the WKC for all three defined speed categories.

CONCLUSION: The findings support the viability and safety of the XST exercise in older adults. Such exercise modality demonstrated an intensity driven modality that may have potential to elucidate positive adaptations in the cardiovascular system of older adults. In addition, our findings demonstrated that the XST session resulted in higher physiological demand compared to walking as demonstrated by the assessed parameters.

AGE- AND SEX-RELATED DIFFERENCES ON MUSCLE STRENGTH OF THE TIBIOTARSAL JOINT AND ITS ASSOCIATION WITH PHYSICAL AND FUNCTIONAL FITNESS

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INTRODUCTION: Ageing, even without chronic conditions, is associated with several changes and declines in neural and musculoskeletal systems (1). Along with low physical activity levels in older populations, these declines might lead to distinct losses of physical and functional fitness between older men and women (2). Moreover, studying physically active older and young adults may help to understand the isolated impact of ageing. This study aimed to evaluate the impact of age and sex on muscle performance of plantar flexion and dorsiflexion of the tibiotarsal joint and their association with physical and functional fitness.

METHODS: The sample included 42 participants: 22 young (11 men, 22.09 ± 2.02 years; and 11 women, 22.27 ± 3.35 years); and 20 older adults (10 men, 68.60±4.99 years; and 10 women, 63.50 ± 12.65 years). Participants were evaluated for muscle performance of the plantar flexors and dorsiflexors of both tibiotarsal joints (peak torque and work) and physical and functional fitness. The assessments included normal and fast gait speed at 4 and 10 metres (GS), time up and go (TUG), handgrip (HG), sit to standing tests (STS-5r and STS-30s), and functional reach test (FR).

RESULTS: Regarding physical fitness, only a main effect of age was observed in TUG, HG, STS-5r and -30s, and FR ($P \leq 0.017$). For muscle performance, all evaluated variables (peak torque and work) showed age main effect ($P < 0.001$). A main effect of sex was observed in HG and STS-30s ($P \leq 0.038$). An interaction age*sex was observed in fast GS during the

4- and 10-meter tasks (P ≤ 0.030), with older women being slower than older men and younger women (P ≤ 0.031). Peak torque and work of the tibiotarsal joint flexors were both moderately to strongly correlated to TUG, STS-5r and STS-30s (P ≤ 0.043).

CONCLUSION: Age-related muscle performance decline appears to affect men and women similarly. Some functional and physical tests (HG and STS-30s), which is associated with better muscle performance, were affected by sex but not by age (except for GS). Both GS test (4- and 10-metres) showed no association with muscle decline, being worse in older women. Since physical activity levels are affected by age (2), developing public strategies to promote physical activity and strength training is necessary for older adults, especially women.

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HIGH INTENSITY INTERVAL TRAINING HAS POSITIVE EFFECT ON FUNCTIONAL MOVEMENT IN OLDER ADULTS.

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INTRODUCTION: One of the most important exercise training goals, particularly for older adults, is the preservation of functional movement: fundamental movement patterns that require a balance of mobility and stability (including neuromuscular/motor control) used in the performance of basic locomotor, manipulative, and stabilizing movements (Cook et al., 2014). While functional movement has been positively associated with physical activity and increases in muscular power, it is not clear whether high intensity interval training (HIIT) or moderate intensity continuous training (MICT) are more effective for preserving and promoting functional movement. A large body of research has determined that both types of exercise programme are effective for improving measures of aerobic and anaerobic fitness in older adults. However, the effect of the two exercise modalities on functional movement has most often been a secondary outcome, with a range of observational techniques applied for measurement.

METHODS: A search strategy of terms locating studies of HIIT interventions, functional movement outcome measures, and older adult population samples was executed on seven digital databases. Randomized and pair matched trials of > 2 weeks were considered for inclusion. Studies of participants with neurological impairment or studies using combined exercise modality were rejected. Standardized mean difference for functional movement outcome measures were calculated. A meta-analysis of the included studies and sub-groups was performed along with study quality (risk of bias and publication bias) evaluation.

RESULTS: A total of 18 studies were included for random effects model pooled analysis. HIIT showed a medium, statistically significant favourable effect on functional movement versus non-intervention control (ES = 0.60 95% CI [0.24, 0.95] p = 0.001). However, sub-group analysis of HIIT versus MICT on functional movement showed a trivial effect in favour of HIIT (ES 0.13, 95% CI [-0.06, 0.33] p=0.18) and did not achieve statistical significance.

CONCLUSION: This meta-analysis indicates that HIIT interventions in older adults may be effective at promoting improvements in functional movement, though it is unclear whether HIIT is superior to MICT. Most importantly, the results indicate that future research should utilize more standardized HIIT protocols equalized to the comparator for work, time, or energy expenditure, include HIIT interventions on healthy, physically active populations and measure functional movement with more comprehensive assessments than those designed to assess the frail elderly.

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MECHANISM OF AEROBIC EXERCISE IMPROVING SOCE-MEDIATED CORONARY CONTRACTION IN AGING RATS

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INTRODUCTION: Studies have shown that aging can cause the dysfunction in vasoconstriction. Store-operated Ca2+ entry (SOCE) and its constituent proteins Orai and STIM play a critical role in the regulation of vascular tone. The present study aimed to explore the effects and the underlying mechanism of aerobic exercise on SOCE-mediated coronary contractile function in aging rats.

METHODS: Ten young rats were set as the Young group. Twenty aging rats were randomly divided into the Old group and Old+Exercise group, with ten rats in each group. Old+Exercise group received 11 weeks of treadmill aerobic exercise intervention. The SOCE-mediated coronary artery contraction of rats in each group was detected by isometric tension measurement. The expressions of Orai and STIM in the coronary smooth muscle of three groups were detected by the immunohistochemical method. The expressions of microRNAs were screened by transcriptome sequencing technology.

RESULTS: There was no significant difference in the vasoconstriction induced by high potassium solution among three groups. In the vasoconstriction induced by endothelin-1, compared with the Young group, there was a significant en-

hancement in the coronary artery contraction in the Old group, and this effect was restored after 11 weeks of aerobic exercise training in aging rats. Furthermore, SOCE-mediated coronary contraction in Old group was significantly higher than that in the Young group, and this effect was significantly inhibited by exercise training in aging rats. Our immunohistochemical results showed that, the expression of Orai2 was abundant in myocardium and coronary smooth muscle layer. Compared with Young group, the expression of Orai2 protein in Old group and Old+Exercise group was significantly lower. Additionally, the expression of Orai2 in Old+Exercise group was significantly lower than that in Old group. The expression of Orai3 protein in Old group was significantly lower than that in Young group, and the expression of Orai3 in Old+Exercise group was higher than that in Old group. The expression of STIM1 in Old group and Old+Exercise group was significantly lower than that in Young group, and the expression of STIM1 in Old+Exercise group was higher than that in Old group. However, the expressions of Orai1 and STIM2 in the smooth muscle layer of coronary artery were low. High throughput sequencing of rat serum was executed and a total of 114 different expressions of microRNAs was found, in which rno-miR-298-5p was the target microRNA of Orai2, novel_miR_1079 was the target microRNA of STIM1, and rno-miR-27a-5p was the target microRNA of STIM2 and Orai3.

CONCLUSION: Aerobic exercise can effectively improve the abnormal enhancement of coronary artery contraction induced by aging, which is related to the down-regulation of SOCE-related proteins Orai and STIM. The microRNAs may be involved in the regulation of the expression of Orai and STIM. Among them, rno-miR-298-5p, rno-miR-27a-5p, and novel_miR_1079 are potential target microRNAs of Orai and STIM.

THE EFFECT OF 10WEEK FOREST WALKING EXERCISE ON KNEE STABILIZATION IN MIDDLE-AGED FEMALE

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INTRODUCTION: The purpose of this study was to compare the indoor resistance exercise group using elastic bands and the forest exercise group using forest slopes for middle-aged female in order to investigate the effect of walking exercise on muscle strength improvement in forest environment.

METHODS: Twenty-four female were randomly assigned to an indoor group (n=11, mean±SD: age 53.38±10.78 years, height 160.54±4.99cm, body mass 61.71±5.69kg) and a forest group (n=13, mean±SD: age 56.73±7.06 years, height 162.55±4.55cm, body mass 63.14±10.04kg). In the indoor group, the exercise was performed mainly on the lower extremity using an elastic band, and the forest group performed a walking exercise to uphill and downhill the sloping forest environment. Both groups were carried out twice a week for a total of 10 weeks. The RPE intensity was gradually increased to 13-14 intensity for the first 1-2 weeks, 15-16 intensity for 3-6 weeks, and 16-17 intensity for 7-10 weeks. Before the start of exercise and after the end of the exercise period, Biodex System 4 was used to perform left and right extension and flexion at 60°/sec speed five times in total, and the knee strength measured at 30° was analyzed by Two-way mixed design ANOVAs. If there was a significant difference, it was post-hoc by the bonferroni method.

RESULTS: There was no significant difference in right extension according to group and time (group: p=.827, Time: p=.813), and there was no interaction effect (p=.111). There was no significant difference in the right flexion according to the group (p=.789), but there was a significant difference according to the time (p=.027), and there was an increase in the forest exercise group (p=.020). There was no significant difference in left extension(p=.281), significant difference in time(p=.002), and increased in forest exercise group(p=.005), and no interaction effect(p=.507). There was no significant difference in the left flexion according to the group (p=.476), and there was a significant difference according to the time (p=.000), and both the indoor exercise group (p=.007) and the forest exercise group increased (p=.002). There was no interaction effect (p=.833).

CONCLUSION: Walking exercise in forest environment is thought to have brought improvement of knee muscle strength by giving load to uphill and downhill lower extremities, and it was confirmed that forest walking exercise can be suggested as an activity to improve muscle strength for middle-aged female knee stabilization.

EFFECTS OF MICROCURRENT THERAPY WITH RESISTANCE EXERCISES ON STRENGTH, FUNCTIONAL CAPACITY, AND MUSCLE THICKNESS IN MIDDLE-AGED ADULTS: A PILOT STUDY

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INTRODUCTION: Microcurrent therapy (MCT) is a non-invasive method that transmits a sub-sensory electrical current through the skin within the range of milliamperes (1-999mA). MCT has been suggested as an effective treatment for sarcopenia. The aim of this study was to analyse the effects of adding MCT to a resistance exercise programme on strength, functional capacity, and muscle thickness in middle-aged adults.

METHODS: The study involved a double-blind randomised controlled design. Eight participants (mean ± SD: age 54.4 ± 7.4 years, BMI 23.1 ± 3.8 kg/m2, height 168.7 ± 12.3 cm) were randomly assigned into a microcurrent (MCT, n = 4; 1 man and 3 women) or a sham (SH, n = 4; 1 man and 3 women) group. All participants completed a 6-week resistance training programme with elastic bands (2 sessions per week, 12 workouts). Participants performed 3 sets of 12 to 15 maximal repetitions, with 1.5 to 2 min of rest between sets, of the following exercises: shoulder press-squat, biceps curl, back squat, lateral pull down, deadlift, triceps extension, lunge, and upright row. The rating of perceived exertion (RPE) was determined by the OMNI-Resistance Exercise Scale (OMNI-RES) for elastic bands (0-10 scale) to determine the increment of

the training load over the 6-week intervention period. An RPE of 6 to 7, 7 to 8, and 8 to 9 rated immediately after the completion of each set was required during weeks 1, 2, and 3 to 6 respectively. If participants did not reach the required RPE after 12 reps, they were instructed to (i) increase the number of reps up to 15 and (ii) if this was not enough for obtained the wanted RPE, they had to increase the resistance offered by the elastic band by reducing its grip width or changing it to a less viscoelastic band. Participants wore a microcurrent or a sham device on their dominant upper arm during the 3 hours immediately after the workout or in the morning on non-training days. The microcurrent device delivered a current with an intensity between 50 and 400 μA in a ratio of 2:1 (on:off) and a frequency of 1.03 kHz. Measurements of strength (handgrip and 90° isometric leg press), functional capacity (30s chair stand test), and muscle thickness were conducted before and after the intervention. Pre-post changes were analysed to calculate effect sizes.

RESULTS: A significant increase in the post-assessment 90° isometric leg press test was determined in the MCT group (+3.9 kg, p = 0.03, d = -1.85). No other significant, pre-post or between-group differences were observed. Nonetheless, compared to SH, the MCT group showed more favourable effect sizes in 90° isometric leg press (d = -1.20), handgrip strength (d = 0.66), 30s chair stand test (d = -0.99), and vastus lateralis muscle thickness (d = -0.68).

CONCLUSION: Adding a 3-hr post-workout microcurrent treatment appears to favour the positive effects of resistance exercise in middle-aged adults.

IMPROVEMENT IN FUNCTIONAL, CLINICAL SCORE AND QUALITY OF LIFE AFTER A SPECIFICALLY DESIGNED EXERCISE PROGRAM IN PEOPLE WITH TOTAL HIP REPLACEMENT: A PILOT STUDY

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1 UNIVERSITY OF BOLOGNA; 2 IRCCS ISTITUTO ORTOPEDICO RIZZOLI

INTRODUCTION: Hip osteoarthritis (OA) are highly prevalent age-related chronic condition among older people. The end-stage treatment for OA is the total hip replacement (THR). Despite the high impact of physical activity and an active lifestyle on peoples quality of life (QoL) and joint health, the majority of people remain inactive, especially those who suffer from osteoarthritis. The aim of this study was to improve the clinical and functional status of people who have undergone THR as well as their QoL through a specifically designed exercise program

METHODS: A cohort of 10 patients (mean age of 64.1±7.9) was enrolled for participating in the study. The patients were recruited at Rizzoli Orthopedic Institute at the moment of the pre-surgery medical check-up. The participants were randomly assigned to the intervention Group (IG) or control group (CG). The IG followed a 3-month exercise program specifically designed for people with hip arthroplasty. The CG followed the usual care for such patients. Both groups were assessed three times: within 2 weeks pre-surgery (PreSA), 6 months after surgery (PostSA), and after the 3-month exercise (3MA). The outcomes assessed were: Health-related Quality of Life (SF-36 questionnaire), functional (Timed up and go, 30sec chair stand test, single leg stance test) and clinical outcomes (WOMAC and HOOS), strength parameters (handheld dynamometer), and joints mobility. The Student's t-test for unpaired samples was used for parametric quantitative variables and the Chi-square test for qualitative dichotomous ones. A post-hoc analysis with Bonferroni correction was used for the comparison between groups and between the assessment time. The significance level was set at $p < 0.05$

RESULTS: From the initial cohort of participants, 2 of the control group dropped out. Hence, 8 participants completed the assessments (3 in IG and 5 in CG). In the IG group, the "physical function" domain of SF-36 showed statistically significant improvement from PreSA to PostSA ($p<0.01$) and 3MA ($p<0.01$). Concerning the strength assessment, the IG showed a significant improvement in hip extension strength from PreSA to 3MA ($p<0.05$), while the GC showed no significant improvements in strength parameters. Regarding the functional tests, the IG showed a significant improvement in TUG from PreSA to 3MA ($p<0.01$). The other outcomes showed improvement in both groups from PreSA to PostSA and 3MA, however, they were not statistically significant ($p>0.05$).

CONCLUSION: The overall clinical and functional score and QoL parameters improved from the first (PreSA) to the last evaluation (9 months after surgery). However, the IG showed greater improvement in lower limb strength, reduced risk of falls (measured through TUG), and higher self-reported physical function (SF-36) than the CG. Interventions based on exercise programs specifically designed for people with THR have the potential to improve the quality of life of these individuals.

ESTROGEN-TREATED POSTMENOPAUSAL WOMEN HAVE INCREASED MUSCLE MITOCHONDRIAL RESPIRATORY CAPACITY AND THIS IS ENHANCED BY ACUTE EXERCISE

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INSTITUTE OF BIOMEDICAL SCIENCES, COPENHAGEN UNIVERSITY

INTRODUCTION: Estrogen is recognized to exert a protective effect on mitochondrial function, by mediating processes as mitochondrial biogenesis and antioxidant defenses against free radicals. Likewise, loss of estrogen is associated with decreased mitochondrial respiratory capacity (MRC) in rodents [1]. Since menopause causes a rapid decline in circulating estrogen this on-going study investigated if mitochondrial function was affected by estrogen-treatment in postmenopausal women. It was hypothesized that estrogen-treated postmenopausal women showed superior mitochondrial function than non-treated women.

METHODS: Biopsies from vastus lateralis were obtained from 11 hormone-treated (HT) postmenopausal women (55±4 years, BMI: 22±2 kg/m2, VO2max: 36.9±5 ml/kg/min) and 10 non-treated controls (C) (55 ± 6 years, BMI: 23±2 kg/m2,

VO2max: 35.2±6 ml/kg/min) at rest and immediately post exercise on bicycle ergometer (45 min @65%VO2max). MRC and H2O2 emission in permeabilized fibers were measured by high-resolution respirometry and fluorometry (Oxygraph-2 k, Orobros, Austria). HT and C were matched for VO2max and years after last menstrual bleeding. 3-way ANOVA was used to analyze respirometry and fluorometry to compare treatment (HT/C), time (pre/post exercise) and addition of substrates (mitochondrial respiratory states).

RESULTS: A main effect of treatment was found in respiration (p=0.0216), as HT showed higher MRC for both complex I (pre/post HT vs. C (malate, pyruvate, glutamate): 50±13/55±16 vs. 46±8/41±6 pmol/s/mg), complex I+II (+succinate: 84±12/85±15 vs. 70±15/66±25 pmol/s/mg) and uncoupled respiration (+FCCP: 98±18/99±28 vs. 81±14/76±23 pmol/s/mg) than C. No differences were observed in ADP sensitivity measured as Km, though Vmax was significantly increased post exercise in HT compared to post exercise in C (p=0.0444; post HT: 48±18 vs. post C:33±9 pmol/s/mg), with no differences in pre values between groups. ROS production was higher in HT than C (p=0.0318) in all respiratory states (MP, MPS, MPS+ADP) and was not affected by acute exercise.

CONCLUSION: HT exerted higher MRC and uncoupled respiration than C, which could support the idea of estrogen as an important enhancer of mitochondrial function. Simultaneously HT showed increased ROS production, which may serve as intracellular signalling molecule, but may also have a negative impact on the occurrence of metabolic diseases such as type 2 diabetes [2]. The antioxidant properties will therefore be further investigated.

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Conventional Print Poster

CP-SH09 Physical Education

THE RELATIONSHIP OF PROACTIVE PERSONALITY, ATHLETIC IDENTITY AND FUTURE WORK SELF AMONG STUDENT ATHLETES

WU, Y.T.1, WU, Y.F.2

1.SOOCHOW UNIVERSITY 2.MING CHI UNIVERSITY OF TECHNOLOGY

Introduction

Student athletes represent a unique population of universities and colleges. Student athlete's career transition is an important life issue that every athlete must face. However, little attention has focused on student athlete's cognitive representations and their future-oriented possible selves. Thus, to understand student athletes' personality and psychological aspect, this study adopts career construction theory to discover how student athletes' proactive personality relates to athletic identity and how it is reflected in their future work self.

Method

In this study, a quantitative approach was adopted using questionnaire survey, a total of 272 valid questionnaires were collected from student athletes currently studying in a university. Confirmatory factor analysis was used to analyze the current data to reconfirm the validity of the instruments. This study examined the relationship of proactive personality, athletic identity, and future work self among the student athletes with structural equation modeling (SEM).

Results

The result consisted of 137 Male 50.5% and 135 Female 49.6% participants from different student athlete from university in Taiwan, 5-point Likert scale was used in this study with 4 items for proactive personality, 5 items for athletic identity and 5 items for future work self, with a CFA, the Chi square showed 2.5, 5.5, and 2.9. The reliability and validity all met the requirement, according to CR > 0.7 : acceptable (Hair, 1997) with .807; .859; .907 and the AVE > 0.5 : acceptable (Fornell, and Larcker, 1981) .510; .552; .711 and the Cronbachs α >0.6: acceptable (Byrne, 2001) .806, .854, .903.

Discussion

The study results showed that proactive personality, future work self and athletic identity were positively related; while athletic identity was also positively related to future work self. These findings suggest that proactive personality and athletic identity are more likely to develop salient future work self. These results suggested that to develop adaptive abilities, individuals need to continuously gain insights of their own characteristics and the complexity of working environments through various exploring experiences (Savickas, 2013). Future work self is important in student athletes career transitions, counselors and educators can use these personalities to identify challenges that student athlete face throughout their career development.

ENHANCING LEARNING PROCESSES WITH THE FUNCTIONAL ADAVANCED DIDACTIC. A PILOT STUDY BASED ON EMBODIED THEORIES.

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UNIVERSITÀ DEGLI STUDI DI NAPOLI PARTHENOPE

INTRODUCTION: The intensity of technology use in the aftermath of the pandemic and the restrictions imposed by the pandemic have encouraged a reduction in physical activity levels for children and adolescents, causing negative consequences for their health and well-being over time. Hence the need to experiment with innovative teaching protocols that integrate curricular subject study with motor activity. In this sense, in accordance with embodied theories and gamification theory, FAD (Advanced Functional Didactics) is experimented.

METHODS: The following contribution aims to present the results of a research project carried out in Cartagena de Indias (Colombia), in a public school, on a sample of 120 students attending the third year of primary school. This sample was divided into an experimental group (EX) and a control group (CG). The aim of the research was to measure the effectiveness of FAD on learning ability and certain aspects pertaining to the cognitive axis.

For data collection, a battery of tests validated in Colombia was administered to both the EXs and CGs, in phase T1 (pre-intervention) and phase T2 (post-intervention), with the aim of measuring certain aspects related to cognitive functions, such as: graphic and visuo-constructive abilities, immediate verbal memory, deferred verbal memory, deferred visual memory, spatial abilities, planning and organization, and visual attention. Learning, on the other hand, was assessed with tests constructed in collaboration with the teachers as they were ascribable to the acquisition of curricular knowledge also covered by the FAD.

The intervention lasted 3 months with 2 meetings per week, 2 hours each.

RESULTS

With the FAD, significant changes were observed in the experimental group with regard to learning attributable to some curricular subjects (mathematics, geometry, history and English) and some cognitive skills (handwriting and visuo-construction). Specifically for geometry, reference is made only to shape recognition, whereas with regard to English, the change is particularly significant in male subjects. Female subjects report more significant changes in graphical and visuo-constructive skills.

DISCUSSION

The results encourage the experimentation of experimental teaching protocols that, like FAD, integrate motor activity with the study of curricular subjects. Clearly, such experimentation is only feasible through the construction of environments conducive to the performance of such activities, furnished with gymnastic equipment, teaching aids and stationery materials. The results of the following study are an encouraging starting point for refining the proposed activities in order to improve their educational effectiveness to be tested in new experiments.

ENHANCING PARTICIPATION OF BLIND AND VISUALLY IMPAIRED STUDENTS IN PHYSICAL EDUCATION THROUGH DIGITAL TECHNOLOGY – A PARTICIPATORY APPROACH

HÖGER, B., MEIER, S.
UNIVERSITY OF VIENNA

Introduction

For children with blindness and visual impairment (BVI), participation in Physical Education (PE) can serve as an important facilitator of physical and mental health as well as life satisfaction (Labudzki & Tasiemski, 2013; Penedo & Dahn, 2005). Research points towards manifold participation barriers for children with BVI in PE, however, these barriers and possible solutions have so far mainly been investigated from the perspectives of sighted parents, teachers and fellow students (Haegele et al., 2020).

Methods

In the project "Smart Sport Assistance", we adhere to the postulation of the CRPD (2006) "nothing about us without us" and reconstruct participation barriers and possible digital solutions in terms of assistive technology for PE from the perspective of BVI persons using a participatory research approach. Following the Mosaic Approach (Clark, 2005), we collected a variety of data (interviews, school tours, images of significant elements) from 19 BVI students aged 14-21 (7m, 12w) from a school specializing in BVI in Austria to reconstruct the socio-material reality of PE from the perspective of those affected through data analysis with thematic content analysis (Braun & Clarke, 2022).

Results

We identified numerous ways in which spacial, material and interpersonal conditions prohibit BVI students from participation, even in a specialized school. At the same time, students imagined manifold technologies to enhance participation in a digitized future. From these imaginations we derived 15 specific concepts for assistive technologies across several sports disciplines that represent the requirements of BVI students.

Discussion

As an outlook, we present how sighted students from technical schools and their teachers can be involved in participatory research processes to not only develop these technologies but also become more aware of the perspectives of BVI people and their needs.

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THE EFFECTIVE CHARACTERISTICS OF PE-BASED INTERVENTIONS ON SOCIAL BEHAVIOURS

MARIC, S., COTTON, W., CRADDOCK, J., WHITE, R.

UNIVERSITY OF SYDNEY/ MACQUARIE UNIVERSITY

Despite the well-known benefits of participation in physical education (PE), rates of disengagement continue to climb in high school- aged students. It is therefore unsurprising to find that PE-based interventions have become so prevalent in literature. Of the theoretical frameworks that have emerged, Cooperative Learning theories have demonstrated success in this field due to the social benefits explored within studies. The Sport Educational Model (SEM) and Teaching Games for Understanding Model (TGfU) have been embraced by researchers as basis for attempting to establish the positive effects of social theories on students in PE and used as theoretical frameworks within interventions. Within this review, SEM and TGfU, amongst others, have demonstrated positive effects on students' social interactions within PE lessons. Furthermore, studies have shown positive impact on students through improvements in academic performance, student wellbeing, teacher-student relationships, problem solving, and intrinsic motivation. A systematic review of literature was used to identify the effective characteristics in intervention design. A systematic review is required due to its meticulous nature and due to the scope of the research available on Cooperative Learning.

Methods: 16 articles were identified through a review of ERIC, Web of Science, ProQuest and SportsDiscuss. The title and abstract fields were searched for the following terms: 1. School* OR "secondary college" OR "secondary education" OR primary education" OR "elementary education" 2. "physical education" OR "phys ed" OR PE 3. Teach* OR Educat* OR Lead* OR Instruct* 4. Test or RCT or randomi* or control or trial or evaluat* or quasi-exper* or cluster or intervention* Social competenc*" OR Cooperat* OR "Social skill*". The search included articles published between the year 2000 to 2020 and studies were included if they; were published in English, delivered during PE lessons to school aged children, delivered by a specialist PE teacher, focused on evaluating the interventions as opposed to how it affected specific population groups, examined effects of social cohesion, and/or, reported outcomes using independent group difference values.

Results: The current systematic review of literature has found that at present 'effective' characteristics of PE based interventions have found mixed results due to numerous contributing factors. These results indicate that future interventions should include stakeholders, such as parents, teachers as facilitators, and to include interventions in both primary and secondary school settings. The impact of the teacher is important, and results suggest that interventions with a theoretical framework presented more favourable results. The duration of interventions yielded mixed results and in order to demonstrate long term benefits in the future, it was concluded that more research in this area is needed.

STIMULATING ACTIVE STUDENTS THROUGH

ISNANTA, R., FERDINANDUS, M.E., KUSUMA, D.W.Y., SETYAWATI, H.

UNIVERSITAS NEGERI SEMARANG

Introduction

The phenomenon in which a gadget becomes the Z-generations daily need caused 1/5 of children aged 5-12 years, and 1/7 of adolescents aged 13-18 years in Indonesia are overweight and obese. Obesity has known as a non-communicable disease that links to various degenerative diseases such as diabetes mellitus, lipidemia, cardiovascular diseases, etc. On the other hand, physical education (PE) is aimed to improve active behavior by present various forms of games that can stimulate children to be more physically active. This study was conducted to introduce "Move n Fun" (MnF), an android game-based that requires physical movement to play it. This game is an intervention to increase student participation and active time.

Methods

This is a Pretest-Posttest One-Group Study. A total of 150 students in the fifth and sixth grades of 4 elementary schools have participated. Pre and Post intervention assessments measured student subjective attitudes toward PE classes. The Physical Activity Questionnaire for Adolescents (PAQ-A) was used to assess students for personal opinions about their PE class before and after playing MnF. The teacher's comment was also part of the evaluation process.

Results

A paired samples t-test was conducted to evaluate whether students (n = 150) increased their participation in PE class after intervention. The results indicated that the postintervention students (M = 18.55, SD = 1.99) were significantly more active in PE class than before the intervention (M = 16.97, SD = 2.02). Significant findings included an increase in the mean of: (1) How often were you very active for last 7 days; (2) Statement your best for last 7 days; (3) Mark how often you played MnF after school; (4) Which one do you often play category in MnF. Contrary findings were noted for How you feel about PE class significant decrease after intervention.

Conclusion

This study has proved that playing MnF in PE class can increasing student activity as measure to decrease the obesity epidemic. The intervention also suggest that positive behaviors proposed in school can encourage positive behavior at home.

CHANGING ORGANISATIONAL STRUCTURES IN SKATEBOARDING – ETHNOGRAPHY OF A SUBCULTURES LEARNING AND TEACHING ENVIRONMENT

BÜSCHER, B.

TU DORTMUND

Theory

As an ongoing subject in sports pedagogical research Skateboarding is genuinely described as an informal sport with alledgedly open accesses to urban spaces, where sport activites are performed according to the often juvenile actors' capabilites and needs (Beal, 2013). Thereby, particular competences concerning movement, spatial and stylistic practices are acquired and continually discussed concerning its practical relevance in everyday life as well as specific vocational fields (Borden, 2019). However, on the background of its ongoing "sportification" (Kilberth & Schwier, 2019) the contexts of learning and teaching become continually differentiated between competitive and school sports. Of particular pedagogical interest are those settings that originate from the subculture itself, when ex-perienced scene members pass on selected cultural content to beginners at all ages.

Method

In the course of an "organizational ethnography" (Ybema et al., 2009) a total of 45 field visits were carried out in such a setting in order to investigate its internal structures, rules and processes. A participant observation initially consisted of skateboarding with the group as well as the gradual immersion in its organizational and social forms, which finally led to in-depth field interviews as familiarity increased. The data set of 250 pp. observation protocols and 150 pp. interview transcripts was evaluated by means of a "Grounded Theory" (Corbin & Strauss, 2008) and was increasingly put into a praxeological perspective.

Results

The open codings of ritualization, regulation and sanctioning are illustrated by means of essayistically elaborated data-anchors. On the level of an axial category, the field-specific organizational structure can be discussed both in terms of cultural theory with regard to its orgin in skateboarding subculture. In the context of "the changing landscape of urban youth sports" (Atencio et al., 2018), it also needs to be compared to referential institutions of sports.

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Friday, July 7, 2023

08:00 - 09:15

Invited symposia

IS-BM04 Muscle-brain crosstalk and the use of technology for training purposes

COGNITIVE MOTOR INTERFERENCE IN DAILY LIFE SITUATIONS

WOLLESEN, B.

UNIVERSITY OF HAMBURG

Many daily life situations integrate cognitive tasks, such as remembering a phone number, discussing certain topics, or planning cer–tain tactics in team sports. In many cases, however, we have to deal with other cognitive or motor tasks running in parallel, such as remembering a shopping list while navigating through a crowded supermarket. The assumption is that in these multitasking situations that performance is e.g. limited by the capacity of each single process but also depends on how effectively we manage process interactions. Typically, limitations in processing of multiple tasks as compared to processing a single task (ST) are described. These processing limitations become even more obvious when the overall capacity is limited, like in novices or older adults. Getting rid of the limitations or at least pushing the limits to some extent in order to either (a) maintain performance despite disrupting/simultaneous secondary tasks (dual-task scenarios) to optimize performance in specific multitasking settings or (b) to counteract decline in relevant processing capacity has a high functional rele–vance for different target groups (e.g., athletes, older adults, employees) and has therefore been the target of many research studies. This talk will address the conduction of suitable training regimes, integrating particular processing components which actually cause the limitation and try to modify the functionality of these processes through specific interventions.

HOW FAR DOES VIRTUAL REALITY ALTER THE NEUROMUSCULAR SYSTEM?

GROSPRÊTRE, S.

C3S - EA4660

Virtual Reality (VR) is the computer simulation of a three-dimensional environment that a person can interact with in a seemingly real or physical way, using special electronic equipment such as a headset with integrated screens. VR is used in many fields, being used for instance to simulate real-life situations while remaining in a safe context, such as to train future surgeons to perform complex operations. Because it is well known that VR induces a great activation of the autonomic nervous system (ANS), as shown for instance by an increase in heart rate and electrodermal activity, this modality is often used as a way to maximise ANS activation and to improve stress management. However, there is more and more evidence that VR also has benefits for the motor system. For instance, adding the simulation of a virtual environment to a motor task performed in laboratory conditions may increase the impact of the task on the corticospinal excitability, reflecting voluntary motor system efficiency. Adding VR to a fitness training program, by displaying a playful and dynamic background, may increase the gains of the training as compared to a standard fitness program. Regardless of the type of population and type of intervention, a large majority of authors agree that VR increases the benefits of physical practice. However, the effects of VR are highly dependent on both the nature of the simulated environment (considered stressful/stimulating or relaxing), but also on the individuals receptivity to the intervention. The way a person reacts and interacts with the various virtual environments thus depends on a number of technological and psychological characteristics. The degree of immersion is determined by the technological characteristics of VR such as resolution, frame rate, etc. For example, more photorealistic graphics in a virtual environment have a positive effect on immersion. Another factor is the amount of sensory stimulation. The immersion effect is greater in the case of simultaneous stimulation of more sensory systems, congruence of stimulation of different modalities and its intensity. The ability to freely navigate the virtual environment and interact with virtual objects, when their bodies are realistically modelled, contributes greatly to the sense of realism. Therefore, VR needs to be smartly implemented to hope for benefits in sport training or rehabilitation contexts, as its effects might be specific according to the way it is used.

Here, we will discuss the potential benefits of adding VR to physical exercise, on cognitive function as well as on motor performance, based on the very recent literature. Practical recommendations will also be provided, based for example on the current knowledge on dose-response effect, or optimal modalities to induce gains in motor-related performances.

ADAPTATIONS IN MOTOR CONTROL STRATEGIES WEARING A STATE-OF-THE-ART EXOSKELETON OR PROSTHESIS

DE PAUW, K.

VRIJE UNIVERSITEIT BRUSSEL

Even though companies collaborate with ergonomists, prevalence of work-related musculoskeletal injuries exceeds 50% for back, shoulder and neck disorders in the industry (Govaerts et al, 2021). A possible solution to reduce the risk of a musculoskeletal disorder is via the implementation of wearable technologies, such as occupational exoskeletons, exosuits and collaborative robots.

Literature shows that these devices assist the operator during industrial work by reducing muscle activity (e.g. De Bock et al, 2021) and muscle fatigue (De Bock et al, 2022). However, following questions remain 1° What is the impact of using wearable technologies on mental fatigue?; 2° Do wearable technologies impact posture during industrial work?; 3° Is the use of wearable technologies accepted by industrial workers?

In line with abovementioned, individuals with a lower-extremity amputation might improve their quality of life using motorized prosthetics devices. It is known that this population face difficulties during daily activities (less mobility, friction wounds, falling). Nowadays stiff, passive prosthetic devices evolved to flexible motorized prostheses including advanced sensory control systems using machine learning algorithms (mainly reinforcement learning). These novel devices intend to substantially improve daily functioning and comfort, and thus the quality of life of the wearer. Indeed, literature shows that compared to passive ankle-foot prostheses, quasi-passive and active prostheses significantly enhance the quality of life (Lathouwers et al, 2023). However, it still remains to be determined whether the use of advanced technology results in long-term therapeutic benefits. One of the major hurdles in robotics technology is improving human-robot interaction. Customization of robotics technology might be achieved through human-in-the-loop optimization strategies. During this lecture, all abovementioned will be further discussed in detail.

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Invited symposia

IS-PN04 Exogenous Ketone Supplementation: Can we hack metabolism to improve health and performance?

IMPACT OF EXOGENOUS KETONE SUPPLEMENTATION ON EXERCISE PERFORMANCE: A FOCUS ON SKELETAL MUSCLE RECOVERY

STEPHENS, F.

UNIVERSITY OF EXETER

Following the landmark paper published by Cox and colleagues' in Cell Metabolism in 2016, which showed the exogenous ketones could improve endurance exercise performance, research on the performance-enhancing effects of exogenous ketones has been more muted. The majority of publications, highlighted by recent meta-analyses, tend to report no benefit (or detriment) of exogenous ketones on exercise performance. However, there does appear to be some influence of exogenous ketones on adaptation to exercise training with recent studies focusing on how regularly consuming exogenous ketones can impact the exercise training response. Professor Stephens will provide a thorough yet concise overview of the literature on exogenous ketones and exercise performance and then focus his talk on recent studies exploring how exogenous ketosis impacts recovery and adaptation to training with a specific emphasis on skeletal muscle. This will include the theoretical and experimental evidence, including his own published studies, on how the direct anti-inflammatory and anti-catabolic effects of ketones might interact to impact skeletal muscle protein synthesis and recovery from resistance exercise training and/or muscle damage. The lecture will conclude with a discussion of some novel and thought-provoking potential clinical applications of exogenous ketones in trauma and surgery. The target audience includes exercise physiologists, applied and clinical exercise practitioners, skeletal muscle biologists, and clinicians.

EXPLORING THE THERAPEUTIC POTENTIAL OF EXOGENOUS KETONE SUPPLEMENTS

LITTLE, J.
UNIVERSITY OF BRITISH COLUMBIA

Due to their dual function as an alternative metabolic fuel and a hormone-like signalling molecule, ketones have emerged as an intriguing therapeutic tool with potential to improve cardiometabolic and cognitive health. Professor Little will begin by presenting the series of studies conducted in his laboratory, starting in healthy young participants and progressing to individuals with obesity and type 2 diabetes, demonstrating that exogenous ketone supplementation can acutely lower blood glucose and improve glucose tolerance. He will also present a recent meta-analysis he led summarizing the literature on how exogenous ketone supplementation impacts blood glucose regulation. After covering the underlying physiological/metabolic mechanism(s) that may explain how ketones lower blood glucose, he will highlight how the glucose-lowering, anti-lipolytic, and anti-inflammatory effects of ketones could be harnessed using exogenous ketone supplementation as a potential therapy for type 2 diabetes. His talk will finish by exploring some of the other emerging clinical conditions where exogenous ketones are producing encouraging therapeutic findings, including age-related cognitive decline, Alzheimers disease, and heart failure. This talk will be of interest to researchers and practitioners with interests in nutrition, metabolism, diabetes, cardiovascular disease, cognitive/brain health, and immunology/inflammation.

HISTORY, CHALLENGES, AND OPPORTUNITIES IN THE FIELD OF EXOGENOUS KETONE SUPPLEMENTATION

CLARKE, K.
UNIVERSITY OF OXFORD

Professor Kieran Clarke was co-leader of an international team supported by the United States Defense Advanced Research Projects Agency (DARPA) that developed the first, and most potent, exogenous ketone supplement, the ketone monoester (R)-3-hydroxybutyl (R)-3-hydroxybutyrate. Designed as a supplement that would allow soldiers to maintain their physical and mental performance across multiple days in the battlefield, the ketone monoester was the result of over two decades of research on the basic and applied science of ketones. With her international collaborators, Professor Clarke has now published over 40 peer-reviewed research papers describing how exogenous ketones influence metabolism, exercise performance, cognitive function, resilience, and longevity. She will provide a historical perspective to the field of ketosis, teach attendees the basic biochemistry of ketosis and ketolysis, and describe the challenges and opportunities of exogenous ketone supplementation for improving physical and mental health. This talk will provide all attendees, whether new to the field or published experts, with new insights on how the history of ketone research might shape the future application of exogenous ketone supplementation for performance and health.

Oral presentations

OP-PN10 Cardiovascular Physiology I

EFFECTS OF HEAT AND EXERCISE ON CAROTID AND RETINAL HAEMODYNAMICS

CADDY, H.T., CARTER, H.H., CRIDDLE, J.L., DOYLE, B.J., GREEN, D.J.
THE UNIVERSITY OF WESTERN AUSTRALIA

INTRODUCTION: It is unclear if the microvasculature in the brain, such as that leading to the eye, is autoregulated or whether it is responsive to the systemic impacts of heat and/or exercise. We hypothesised that common (CCA), internal (ICA) carotid and central retinal (RA) artery haemodynamics would change significantly in response to passive heating (PH), or heating during exercise (HE), and that responses to these challenges would be associated between arteries.

METHODS: Healthy participants (n=11, 26.1±3.7yrs, body mass index 22.5±2.3) underwent 50 minutes of testing in a climate-controlled chamber (40ºC, 50% relative humidity) under PH (seated upright) and HE (ergometer cycling at 45% VO2max) conditions. Using duplex ultrasound pre and post testing, time averaged blood flow (BF) was calculated in the CCA and ICA from diameter and blood flow velocity (BFv) measurements, with BFv also assessed in the RA using Doppler ultrasound. Differences in haemodynamic responses from baseline were assessed using paired t-tests, and interaction effects between variables were assessed via two-way repeated measures MANOVA and Hotelling T-square analysis. $P < 0.05$ was deemed statistically significant. Data are presented as mean±SD.

RESULTS: In response to PH alone, CCA and ICA BF did not significantly change, while RA BFv significantly decreased (3.92±0.51 vs 3.42±0.53 cm/s, P=0.034). No significant interactions between CCA, ICA and RA data to PH were observed. In response to HE, CCA BF significantly increased (584.15±137.04 vs 750.33±177.49 ml/min, P=0.007), ICA BF remained unchanged, and RA BFv significantly decreased (3.77±0.59 vs 2.89±0.47 cm/s, P<0.001). A significant interaction was present between ICA and CCA BF ($F(1,10)=8.06$, P=0.018), and between RA BFv and CCA BF ($F(1,10)=11.37$, P=0.007) in response to HE. No interaction was observed between the RA and ICA data.

CONCLUSION: Under challenging environmental conditions blood flow distribution is altered to favour systemic thermoregulation. Whilst gross brain blood flow is not compromised in absolute terms, we found evidence of diminished flows in the RA which may reflect microvascular flows in the brain.

FUNDING:

This work was supported by a WA Government FHRI Research Excellence Award, Forrest Research Foundation Scholarship and the United States Office of Naval Research, Science and Technology, in collaboration with the Australian Defence Science and Technology (DST) HPRnet program.

THE MIDDLE CEREBRAL ARTERY BLOOD VELOCITY RESPONSE TO MODERATE INTENSITY CYCLING IN CHILDREN, ADOLESCENTS AND ADULTS

WESTON, M.E., BARKER, A.R., COOMBES, J.S., BAILEY, T.G., BOND, B.

UNIVERSITY OF EXETER

INTRODUCTION: Age-related differences in the cerebral blood flow response to incremental exercise have previously been observed in children, adolescents and adults, but this has yet to be investigated during constant work-rate exercise. The purpose of this study was to investigate the middle cerebral artery blood velocity (MCAv) response to constant work-rate moderate intensity cycling exercise in 21 children (aged 9.3±0.8 years, 10 males), 17 adolescents (12.3±0.4 years, 10 males) and 20 young adults (23.6±2.4 years, 10 males).

METHODS: Participants completed an incremental ramp test to exhaustion on a cycle ergometer, to determine maximal oxygen uptake and gas exchange threshold (GET), before completing three 6-minute transitions at a moderate-intensity (90% GET), on separate visits. Bilateral MCAv was measured by transcranial Doppler ultrasonography on each visit, and ensemble-averaged for each participant into 1-s data. Data were analysed using a mono-exponential model with a time delay, except for in 3 children, who did not display an exponential rise in MCAv during exercise. Differences in kinetic parameters between age groups were analysed using one-way ANOVAs.

RESULTS: Baseline MCAv was significantly higher in children (99.3±12.2 cm/s) compared to adolescents (87.2±10.0 cm/s, P<0.01), and both were significantly higher than adults (68.4±9.3 cm/s, P<0.01). The time constant of the exponential rise of MCAv was significantly slower in adults (27±9 s) compared to both children (14±9 s) and adolescents (14±8 s, P<0.01), but no differences were observed in the time delay (P=0.09). The absolute amplitude of the exponential increase in MCAv was significantly greater in adolescents (17.8±5.0 cm/s) compared to adults (13.1±4.4 cm/s, P=0.01), but not children (14.5±6.6 cm/s, P=0.08). However, when expressed as a relative change from baseline (Δ%), the increase in MCAv during moderate intensity exercise was significantly smaller in children (14.6±6.4%) compared to both adolescents (20.5±5.6%) and adults (19.7±7.6%, P<0.05). One striking feature of the MCAv response was an absence of a steady-state across all age groups following the initial exponential rise. The fall in MCAv occurred earlier in children (140±53 s) and adolescents (165 ± 77 s), compared to adults (242 ± 92 s, P<0.01), and MCAv fell by a greater magnitude in children (6.4±3.6 cm/s) and adolescents (7.3±4.4 cm/s), compared to adults (3.3±3.7 cm/s, P<0.05).

CONCLUSION: These novel findings are the first to identify smaller relative increases in MCAv during moderate intensity exercise in children, compared to adolescents and adults. Furthermore, this study is the first to find a slower adjustment of MCAv during moderate intensity exercise in adults, compared to children and adolescents. These amplitude and time-based differences in the cerebral blood velocity response to exercise may suggest differences in the mechanisms of regulation of cerebral blood flow during exercise throughout the transition from childhood to adulthood.

BLOOD OXYGEN IN THE NON-EXERCISING HUMAN FOREARM DURING DYNAMIC EXERCISE IN THE HEAT: IMPLICATIONS FOR SKIN BLOOD FLOW CONTROL

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INTRODUCTION: Based on classical estimations (1), it is widely considered that incremental exercise through to volitional exhaustion invokes a substantial vasoconstriction in the skin vasculature, attenuating skin blood flow. This process appears to occur in parallel to the exponential rise in sympathetic nerve activity and circulating catecholamines (2–5). There is, however, no direct empirical evidence to support the assumption that skin perfusion declines at near-maximal aerobic exercise in the heat. We measured non-exercising forearm blood O2 contents, a surrogate for skin blood flow, during incremental exercise in the heat.

METHODS: Nine endurance-trained males (29±5 yrs, 184±5 cm, 79±9 kg, and VO2peak: 59±7 ml·kg-1·min-1) performed three incremental exercise tests (INC1, INC2 & INC3; 20, 40, 60, 80 & 100% of Wmax) with INC2 being preceded by 2 h of submaximal exercise and 5 min of rest (5). Exercise was performed in the semi-recumbent position in the heat (35°C, rH 50%). Regular fluid ingestion afforded maintenance of euhydration status. Regular blood samples were obtained from the median cubital vein with the arm maintained inactive throughout exercise. Blood samples were drawn into pre-heparinized syringes and rapidly analysed for haemoglobin (Hb), oxygen saturation (SO2%), oxygen tension (PO2) and other blood metabolites. Arterial (estimated from (5)) and venous O2 contents, and a-vO2 diff were calculated. Data are expressed as mean+SD.

RESULTS: During INC1, all blood variables remained unchanged from rest to 40% Wmax. Between 60-100% Wmax, however, venous Hb (peak vs. rest; ~154±11 vs. ~141±10 g/L), SvO2% (88±8 vs. 67±9%, P<0.001), PvO2 (66±19 vs. 42±15 mmHg, P<0.001) and forearm venous O2 content (183±32 vs. 135±18 mL/L, P<0.001) increased and then stabilized, whilst arterial O2 content stayed essentially unchanged (198±13 mL/L). Forearm a-vO2 diff decreased from 56±27 mL/L at baseline rest, to a nadir of ~25±27 mL/L at 80% Wmax (P<0.05), remaining stable thereafter. The pattern of response and end exercise values were similar among the three incremental tests, despite the higher baseline forearm venous O2 content values in INC2 (~181±21 mL/L). Similar responses were seen during prolonged, submaximal exercise in the heat.

CONCLUSION: We observed a marked elevation in inactive-forearm venous blood O2 content during prolonged submaximal and incremental exercise, leading to a substantial decline in inactive-forearm a-vO2 diff. These findings suggest that skin perfusion and oxygen delivery remain elevated during incremental cycling exercise to volitional exhaustion in the heat in the face of profound increases in sympathoadrenal activity.

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SEX DIFFERENCES IN THE IMPACT OF EXERCISE ON VASCULAR FUNCTION: A WITHIN-SUBJECT RANDOMISED CROSS-OVER TRIAL OF TWINS

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THE UNIVERSITY OF WESTERN AUSTRALIA

INTRODUCTION: Physical activity reduces cardiovascular risk, in part via direct effects of exercise on arterial wall function. Response to exercise can be idiosyncratic, however, and may depend upon the type of exercise performed, sex differences, or the genetic predisposition to vascular adaptation. The current study utilised a classical twin paradigm, in a randomised cross-over design of distinct exercise modalities (endurance [END] vs resistance [RES]). We hypothesised that 1) vascular function responses would be modality-specific; 2) most individuals would not respond similarly to both training modalities; 3) vascular responses to exercise would be sex dependent; and 4) vascular responses to each training mode would express a high degree of heritability.

METHODS: This study recruited 90 same-sex twins (31MZ and 14DZ pairs; 25.8±6.0yrs) to complete, as pairs, 3 months of RES and END training, separated by a 3-month washout. Vascular function was assessed with high-resolution ultrasound in the brachial artery via endothelium-dependent vasodilation (flow-mediated dilation (FMD)) and endothelium-independent vasodilation (glyceryl-trinitrate induced dilation (GTN)).

RESULTS: FMD% and GTN% increased following END (1.46%, P<0.001 and 1.76%, P=0.004, respectively) and RES (1.73%, P<0.001 and 1.68%, P=0.045). Females showed significant increases in both FMD% and GTN% in response to both modes of training (RES: FMD% 2.19%, P<0.001; GTN% 2.25%, P=0.043, END: FMD% 1.91%, P<0.001; GTN% 2.38%, P=0.003), whereas male responses yielded smaller average increases (RES: FMD% 0.97%, P=0.146; GTN% 0.73%, P=0.555, END: FMD% 0.82%, P=0.073; GTN% 0.91%, P=0.328). Around 1/3 of participants did not respond to one of the two modes and only 10% and 17% did not respond to both forms of training for FMD% and GTN%, respectively. For FMD%, a larger proportion of females than males responded positively to RES (78% and 56%, respectively) and END (78% and 70%). For GTN%, this sex difference was less apparent (RES 63% and 52%; END 72% and 65%). Twin analysis revealed that following RES training both FMD% and GTN% were highly correlated for MZ pairs (rMZ=0.58, P=0.003 and rMZ=0.61, P=0.001, respectively), and GTN% was also highly correlated in MZ pairs following END (rMZ=0.75, P<0.001), indicating that both modalities were dependent on factors shared only by MZ twins and that a large contribution from genetic effects is unlikely.

CONCLUSION: Our findings indicate that different forms of exercise training (END and RES) can enhance vascular function in young healthy subjects and that responses in females are more marked. Most individuals respond to one or other form of training, with few unresponsive to both; this finding has implications for optimising exercise-based approaches to vascular health for individualised benefit. Focusing on characteristics of exercise prescription may be more important than the impact of distinct candidate genes when considering exercise as a form of vascular medicine.

POST-EXERCISE BLOOD PRESSURE AFTER AEROBIC CONTINUOUS AND INTERVAL EXERCISE IN YOUNG HEALTHY SUBJECTS

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UNIVERSITY OF OULU

INTRODUCTION: Post-exercise hypotension (PEH) revels appropriate vascular responsiveness to exercise. However, a large interindividual differences has been observed in PEH after acute aerobic exercise. The minimal detectable difference, counting typical and random errors in interpretation of PEH, have been published recently for systolic blood pressure (sBP), defined as PEH1 (post-exercise sBP–pre-exercise sBP). This allows the identification of responders (PEH1<-7.0 mmHg) and non-responders (PEH1≥-7.0 mmHg) after aerobic exercise. We hypothesized that aerobic training mode modifies PEH in healthy young subjects

METHODS: Twenty subjects (female n=8, 28±5 years; male n=12, 26±6 years) performed an incremental maximal exercise test by bicycle ergometer until exhaustion, starting from 40 W and increasing load at every 2 min 15 W for female and 20 W for male. Furthermore, subjects performed 3 exercise sessions, 30 min each and all in separate days, by bicycle ergometer with BP measurements at sitting position before and 1 h after exercise. First exercise was treated as a familiarization session. Thereafter, continuous and interval aerobic exercises were performed in a random order. The intensity of continuous exercise was 60% of maximal Watts. Interval training was 8x1 min high intensity exercise (80-90% of maximal Watts) with 2 min recovery between intervals (50% of maximal Watts). The average Watts over 30 min exercise was 60% of maximal Watts for both. Rating of Perceived Exertion (RPE from 0 to 20) and BP were measured at every 5 min during

continuous exercise and during high intensity and recovery phases during interval exercise. Heart rate was recorded continuously during exercises.

RESULTS: Maximal oxygen uptake was 43±6 (range 35-50) and 47±7 (range 36-60) ml/kg/min for female and male, respectively. Baseline BP was 124±12/72±6 and 123±12/72±6 mmHg (p=ns) before continuous and interval exercise, respectively. The average values for sBP were 166±22 and 172±23 mmHg (p=ns), heart rate 74±6 and 76±5 % of maximal heart rate (p=ns) and, RPE 12±1 and 13±1 (p<0.01) during continuous and interval exercises, respectively. PEH1 was -9±10 (range -30-+8) and -9±5 (range -17-+5) mmHg (p=ns), after continuous and interval exercises, respectively. PEH1 did not correlate with maximal oxygen uptake, sBP or RPE during exercise in either condition. Ten subjects after continuous (50%) and fourteen subjects (70%) after interval exercise were categorized as responders according to PEH1 analysis. Most importantly, 6 subjects (30 %) were responders regarding PEH1 only after interval exercise according to minimal detectable difference analysis.

CONCLUSION: Aerobic exercise training mode such as continuous vs. interval modifies PEH in healthy young subjects. This was obvious even performing the exercise at the same average workload, heart rate and sBP. Thirty percent of young subjects results in measurable PEH only after interval exercise favoring activation of fast skeletal muscle fibers during exercise.

Oral presentations

OP-AP26 Football: Analytics

PHYSIOLOGICAL PROFILES AND ACTIVITY PATTERNS OF AMPUTEE SOCCER PLAYERS DURING AMPUTEE SOCCER MATCH PLAY

ESATBEYOGLU, F., HAZIR, T., KIN-ISLER, A.

BOZOK UNIVERSITY

INTRODUCTION: There is a wealth of research investigating on the match characteristics of regular soccer whereas match demands of amputee soccer game is scarce. Therefore, the objective of this study was to analyse the match demands of amputee soccer game.

METHODS: Ratings of perceived exertion, heart rate (HR) and blood lactate were analyzed as physiological responses and peak speed, total distance covered (TD), TD at five speed categories (SC), percentages of TD at five SC and time spent in four maximal heart rate (HRmax) zones were analyzed as activity patterns during amputee soccer matches (n=22). The Kolmogorov-Smirnov test was used to analyze the normality of the variables. The deviation from the normal distribution is insignificant for all variables (p>0.05) and they are presented as means and standard deviations unless otherwise stated. A paired sample t-test was conducted to determine the differences in activity patterns and physiological parameters between the halves. Cohen's d effect size (ES) (trivial=< .19; small= .20–.59; medium= .60–1.19; large=1.20–1.99 and very large=> 2.0) was used to measure the paired effects.12,13 Differences between the halves in TD at five SC and percentages of TD at five SC were determined with 2 x 5 (half x SC) two-way ANOVA with repeated measures. Differences between the halves in time spent at HRmax% was determined with 2 x 4 (half x HRmax) two-way ANOVA with repeated measures. In case of significant difference, Bonferroni's post-hoc tests were used. Data were analyzed using SPSS (v. 22.0) with the level of significance at p≤ .05.

RESULTS: The mean HR in the first half was higher than the second half (p=.049) whereas other physiological responses were not statistically different between the halves (p>0.05). TD in the first half was higher than the second half (p=.000) and players covered more distance at lower SC in both halves and during matches. TD at very low SC accounted for ~73 % whereas low, moderate, high and very high efforts accounted for ~27 % of the TD. Amputee soccer players spent ~46 min at moderate and high intensity HRmax zones whereas these accounted only about ~4 min at very low and low intensity HRmax zones during 50 min matches.

CONCLUSION: The results of the current study showed that physiological responses during amputee soccer game were not differed between the halves except HRmean response. Results of the activity profiles revealed similar Speedmax attained in the halves whereasTD, percentage of the mean TD at various SC and time spent at HRpeak% during amputee soccer game were differed according to the halves. These results confirm that exercise intensity in amputee soccer is high and amputee soccer players are under high physiological loads and they play amputee soccer at higher percentages of individual HRmax.

ENERGY INTAKE, TRAINING AND MATCH LOAD OF ADOLESCENT FEMALE SOCCER PLAYERS OF INTERNATIONAL STANDARD

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LIVERPOOL JOHN MOORES UNIVERSITY

INTRODUCTION: Elite female adult soccer players of international (1) and club level standard (2) under-consume carbohydrate in relation to nutritional guidelines. In addition, we also qualitatively explored a culture of "under-fuelling" that was

related to a fear of consuming carbohydrates in the belief that it would lead to gains in fat mass (3). In contrast to adult players, however, the habitual nutritional practices of elite adolescent players have not yet been objectively assessed. Therefore, the aim of the present study was to quantify the energy intake (EI) of elite adolescent female soccer players during a training and game schedule of international standard.

METHODS: Elite adolescent players from the English national team (n=23, age: 16.6 +/- 0.6y, body mass: 61.6 +/ 6.1 kg) took part in a 10-day international training camp comprising two match days, five training days and three rest days. All players self-reported their EI via the remote food photography method and pitch-based training and match load were measured using GPS technology. Comparisons in EI and physical loading indices between days were assessed using mixed linear models. Data are reported in proximity to the match with a minus symbol (-) indicative of the days before the match day (MD).

RESULTS: Total distance covered was greater (all $p<0.001$) on MD-4 (6121 ± 1400 m) and both MDs (6582 ± 4133 m; 6753 ± 3352 m) when compared with all other training days: MD-5 (3004 ± 280 m), MD-2 (2963 ± 604 m) and both MD-1s (2822 ± 953 m; 3491 ± 413 m). Total daily EI was greater (all $p<0.05$) on both MD-1s (2413 ± 486 kcal-1; 2004 ± 521 kcal-1) and both MDs (2314 ± 484 kcal-1; 2165 ± 479 kcal-1) when compared with both MD+1s (1776 ± 471 kcal-1; 1697 ± 394 kcal-1), MD-5 (2164 ± 440 kcal-1), MD-4 (2059 ± 425 kcal-1) and MD-2 (2057 ± 313 kcal-1). Similarly, relative CHO intake was greater (all $p<0.05$) on both MD-1s (4.1 ± 0.8 g.kg-1; 4.3 ± 1.1 g.kg-1) and both MDs (4.8 ± 1.2 g.kg-1; 4.8 ± 1.4 g.kg-1) in comparison to both MD+1s (3.6 ± 1.1 g.kg-1; 3.1 ± 0.8 g.kg-1) , MD-5 (3.7 ± 0.8 g.kg-1), MD-4 (4.1 ± 1.1 g.kg-1), MD-3 (3.6 ± 0.8g.kg-1) and MD-2 (4.0 ± 1.0 g.kg-1). Furthermore, only 15% of players consumed greater than 6g/kg of CHO on MD-1, 17% on MD and 2% on MD+1.

CONCLUSION: In summary, we report for the first time that adolescent female soccer players competing at international standard do not adjust daily CHO intake to levels (i.e. >6 g/kg body mass) that are recommended to prepare for and recover from soccer match play (4). In addition, players also under-fuel on training days, thus presenting a culture of "under-fuelling" that is comparable to adult female players. From a practical perspective, these data highlight the requirement for relevant education and behaviour change strategies that aim to promote increased CHO intake before, during and after exercise.

CHANGE OF DIRECTION DEMANDS IN GERMAN HIGH-PERFORMANCE SOCCER

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INTRODUCTION: This study aimed to compare the change of direction (COD) demands of German Bundesliga soccer match play relative to playing position using an optical-tracking-system. COD data were collected from German Bundesliga soccer teams (2017–2018 season; 17 matches). The findings of this study would give further insights into soccer match play demands and could therefore influence load management, physical training and rehabilitation process of soccer practitioners.

METHODS: An event in which a player completed a deceleration (≤-2 m·s-2), an angular change in the direction of motion (≥20°), and a subsequent acceleration (≥2 m·s-2) within a duration of 1 second was defined as a COD. These thresholds have typically been used to classify accelerations and decelerations above a moderate intensity level during a team sports match (Delves et al., 2021; Newans et al., 2019). Directional changes were subdivided by entry velocity (<3.0 m·s-1 (COD3), 3.0-5.5 m·s-1 (COD3_5.5), 5.5-7.0 m·s-1 (COD5.5_7) and >7.0 m·s-1 (COD7)) and rotation angle (Low: 20-59° (COD60); Medium: 60-119° (COD120); and High: 120-180° (COD180)). The frequency of total COD, the subcategories of entry velocity and rotation angle for each playing position (Goalkeeper (GK), Centre Back (CB), Full Back (FB), Central Midfield (CM), Winger (WI) and Striker (ST)) and the average, standard deviation, maximum and minimum values were calculated.

RESULTS: ANOVA revealed significant group effects for COD60 ($p<0.001$; $\eta2 = 0.08$), COD120 ($p<0.001$; $\eta2 = 0.63$), COD180, ($p<0.001$; $\eta2 = 0.05$) between positions. Post hoc tests revealed significant differences between positions for all angles. Further, ANOVA revealed significant group effects for COD3 ($p<0.001$; $\eta2 = 0.07$), COD3_5.5 ($p<0.001$; $\eta2 = 0.20$), COD5.5_7 ($p<0.001$; $\eta2 = 0.14$) and COD7 ($p=0.034$; $\eta2 = 0.02$). Post hoc test revealed significant differences for all entry velocities, except COD7. Approximately, 90% of COD during matches were performed with entry speeds <5.5 m·s-1 and about 70% were low (~40%) and moderate (~30%) angled turns.

CONCLUSION: This study provides insights into the COD demands of German Bundesliga soccer matches, which can be used to guide position-specific physical preparation strategies, to monitor player load, to develop performance tests and to give recommendations for rehab and return to play standards.

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PHYSICAL DEMANDS COMPARISON OF AN ELITE SOCCER TEAM IN BRAZIL AT DIFFERENT COMPETITION LEVELS: STATE, NATIONAL AND INTERNATIONAL.

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CLUB ATHLETICO PARANAENSE

INTRODUCTION: The difficulties of the Brazilian professional soccer schedule are known worldwide. The teams often compete during the year for state, nationals and internationals championships, being able to lead 75 games a year. Thus, the objective of the present study was to follow the 2022 season of an elite Brazilian soccer professional team and observe whether the different levels of competition - state, national and international - also present different levels of physical demands: for the whole team such as for the player positions.

METHODS: The study included 37 athletes (24.3±3.9 years; 180.2±4.9cm; 76.0±6.9kg; 15.8±2.3%BF) from the main team, divided into fullbacks (n=6; 22,3±2,7years; 179,0±3,9cm; 72,8±5,2kg; 15,1±2.1%BF), defenders (n=7; 24,4±4,3years; 185,6±1,8cm; 85,9±9,9kg; 17,6±1,7%BF), midfielders (n=13; 25,5±4,9years; 177,6±4,3cm; 74,0±5,3kg; 15,9±2,3%BF) and forwards (n=11; 23,5±4,9years; 180,5±4,3cm; 75,4±5,3kg; 15,3±2,3%BF). The athletes played 5 state games, 44 national games and 15 international games during the season. Players were monitored in all games by a global positioning device at 10 Hz and with inertial motion sensors at 100 Hz (S7 Catapult System). The total distance (TD), the distance covered in high intensity (HSR), the distance covered in sprint (SD), the density (DEN) of the team and of the positions in the field at different competitions were evaluated. After collecting the information, the normality of the data was verified and they proved to be non-parametric, thus, the Kruskal-Wallis test was performed and later the Dunns multiple comparison test was used ($p<0.05$).

RESULTS: The most relevant results founded in the present study were detected in DEN and SD. In the DEN we found a statistical difference between the state championship (105.0±11.6 m/min) and the international championships (100.3±10.8 m/min), as well, we founded a difference in this variable for the midfielders between the state (113.2±7.7 m/min) and international (107.2±8.5 m/min) championships. Regarding the SD, a difference was found for forwards between the state (195.5±77.4 m) and national (242.5±130.1 m) championships.

CONCLUSION: From the data found, we can infer that international championship games have a higher number of fouls and interruptions in the game and this causes a decrease in the DEN of the game, especially when we observe this same variable in the state championship, in which the team is technically superior and can have a higher ball possession, making the distance covered per minute greater. When we observe the SD variable, we find significantly higher values in national championships. Sometimes the team plays more compactly in these competitions, favoring the counterattack and having space to develop this variable when compared to the state championship.

Oral presentations

OP-BM10 Strength training

ESTIMATION OF NEUROMODULATORY AND INHIBITORY INPUTS TO MOTONEURONS IN CHRONICALLY STRENGTH TRAINED INDIVIDUALS

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INTRODUCTION: Strength training (ST) is accompanied by neural adaptations that augment muscle force production (1). All motor commands are transformed into muscle fibre twitches via motor units (MUs) as a result of excitatory and inhibitory ionotropic inputs, which are modified by neuromodulatory inputs. The way in which these commands are altered as a result of ST is not well-studied, but chronically ST individuals exhibit lower antagonist muscle coactivation at various force levels (2), which suggests that chronic ST might lead to adaptations in the motor commands that transform neural inputs to superior mechanical outputs. Here, we compared estimates of neuromodulatory inputs and patterns of inhibitory inputs to motoneurons from MU discharge patterns in chronically ST and untrained (UT) individuals.

METHODS: Chronically ST (8±3 years of ST experience) and UT individuals (n=15 in each group, 4 females per group) performed isometric dorsiflexion forces of a triangular shape up to 30, 50, and 70% of maximal voluntary force (MVF) whilst high-density surface EMG signals were recorded from tibialis anterior. EMG signals were decomposed into individual MU discharges (3) that were subsequently smoothed using support vector regression (4). Delta F (onset-offset hysteresis of pairs of discharging MUs) was calculated to estimate the persistent inward current magnitudes. A quasi-geometric approach (5) was used to garner further insights into the neuromodulatory inputs (brace height) and the inhibition pattern (MU discharge acceleration, and post-acceleration [attenuation] slopes). Linear mixed models were used to assess whether outcome variables were predicted by group, contraction level, and their interaction.

RESULTS: ST were 50% stronger than UT (413±117 vs. 275±88 N, $p=0.0011$), and exhibited greater peak MU discharge rates during 70% (34±1 vs. 29±1 Hz, $p = 0.0157$), but not 30% and 50% MVF ($p\geq0.0869$). Delta F and MU acceleration slope increased with contraction level ($p<0.0001$) but were similar between groups ($p=0.8370$). Brace height was modulated differently between groups across contraction intensities ($p<0.0001$), with it being lower for ST compared to UT at 50%

(p=0.0235) and 70% MVF (p=0.0090). The post-acceleration slope of the MU discharge attenuation phase was greater in ST compared to UT (p=0.0104).

CONCLUSION: Our results suggest that the neural networks responsible for generating the motor commands that govern MU discharge patterns are modulated with chronic ST. In particular, chronically ST individuals exhibit modifications in the pattern of inhibition, one that is more reciprocal in nature, which is likely associated with greater MU discharge rates and superior muscle force production.

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THE USE OF BLOOD FLOW RESTRICTION DOES NOT ENHANCE ADAPTATIONS OF CORTICOSPINAL EXCITABILITY OR INTRACORTICAL INHIBITION AFTER ACUTE RESISTANCE TRAINING

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INTRODUCTION: Resistance exercise with blood flow restriction (BFR) is considered a safe and powerful training tool. Low-load (LL) resistance training with BFR results in comparable hypertrophy compared to conventional heavy-load (HL) resistance training (Centner et al. 2019). Additionally, LL training with BFR (LL-BFR) induces comparable (Grønfeldt et al. 2020) or slightly lower (Centner et al. 2019) effects on muscle strength than HL training. It is generally accepted that increases in maximum strength are mediated by muscular hypertrophy and/or neural adaptations. However, the effect of BFR on neural adaptations is scarcely investigated. The aim of this study was therefore to investigate the effects of BFR on acute neural adaptations following a single bout of resistance training.

METHODS: Fifteen male participants (21-35 years) volunteered to participate in this study. On three separate days, participants performed a strength training session of the right elbow flexors with either LL, LL-BFR or HL. Neuromuscular adaptations were investigated before and after each resistance training session by means of transcranial magnetic stimulation (single- and paired-pulse TMS) and peripheral nerve stimulation (Mmax). Data were acquired during submaximal sustained isometric contractions. During LL-BFR, the cuff was inflated to 50% of the individual arterial occlusion pressure to restrict venous outflow in the working musculature during exercise.

RESULTS: The preliminary data analysis with mixed linear models revealed that, compared to baseline values, normalized MEPs (% of Mmax) from the trained biceps brachii were enhanced for HL (Cohen's d = 0.51) but not LL-BFR (Cohen's d = 0.03) when compared to LL. Changes in short-interval intracortical inhibition (SICI) and intracortical facilitation (ICF) were very inconsistent and did not differ between training session.

CONCLUSION: This is the first study that investigated neural adaptations after a single bout of resistance training with and without BFR. We observed augmented MEP amplitudes after HL when compared to LL what is in line with previous evidence (Colomer-Poveda et al. 2020). Adding BFR to LL training did not alter corticospinal responses. The data therefore indicate that training with BFR less likely affects cortical neural adaptations.

Literature

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COMPARISON OF MOTOR UNIT FIRING RATE DURING HIGH-LOAD VS. LOW–LOAD BLOOD-FLOW RESTRICTION RESISTANCE TRAINING

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INTRODUCTION: Chronic low-load resistance training with the addition of blood-flow restriction (BFR) leads to greater adaptation compared to comparable load exercise without BFR. Indeed low-load BFR resistance training leads to increases in muscle mass, and possibly in strength, that are similar to those observed with high-load resistance training [1, 2]. The aim of this research was to assess early adaptations in strength, muscle mass, and muscle contractile properties to resistance training using low loads with BFR compared to high loads, and to explore potential neural mechanisms underlying these adaptations by examining motor unit firing rate during each training condition.

METHODS: Seven healthy-active, but previously non-resistance trained individuals completed seven training sessions involving unilateral leg press and leg extension. One leg was trained using low-load (40% of 1-RM) with BFR, the other was trained using high-load (80% of 1-RM). Pre- and post-training: 1-RM leg press and leg extension, and MVC knee extension were measured to assess strength; and thigh circumference and volume were measured to estimate quadriceps mass. Tensiomyography was used to measure muscle stiffness and contraction velocity of vastus lateralis pre-, mid-, and post-

training. Electromyogram (EMG) was captured from vastus lateralis throughout all training sessions using a 4-channel surface array. EMG was decomposed into individual motor unit action potential trains [3].

RESULTS: Mean motor unit firing rate was greater during high-load training than during low-load BFR training (P = 0.016). Leg extension 1-RM (P = 0.001), knee extension MVC (P = 0.019), and thigh circumference (P = 0.001) and volume (P = 0.001) increased following both resistance training conditions. Leg press 1-RM (P = 0.103), and vastus lateralis stiffness (P = 0.483) and contraction velocity (P = 0.585) did not change with training.

CONCLUSION: Despite greater motor unit firing rates during high-load training, seven resistance training sessions increased strength and markers of muscle mass to a similar extent in both training conditions. Greater relative demand of leg extension exercise may explain the improved 1-RM and knee extension MVC observed, while leg press 1-RM remained unchanged. Precise mechanisms underlying the early adaptations to resistance exercise with BFR remain to be elucidated.

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COMPARISON OF PERSISTENT INWARD CURRENTS IN LOWER LIMB MUSCLES OF RESISTANCE TRAINED, ENDURANCE TRAINED, AND INACTIVE YOUNG INDIVIDUALS

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INTRODUCTION: Physical training is known to induce neural adaptations in the motor pathways, resulting in changes to the output of α-motoneurons. Persistent inward currents (PICs) have a substantial influence on α-motoneuron output and have been found to increase with resistance training in older adults. However, the adaptations of PICs related to physical training in young adults remain unknown. Additionally, since monoaminergic drive is believed to be diffuse within α-motoneurons of an individual, it is possible that physical training promotes PICs in all muscles. The aim of this study is to compare the PICs of individuals with different physical training experiences by assessing several muscles in the lower limb.

METHODS: Twelve resistance-trained (RES), twelve endurance-trained (END), and thirteen inactive (INA) individuals participated in one experimental session. Surface electromyographic signals were collected using 64-channel electrodes placed over the soleus (SOL), gastrocnemius medialis (GM), tibialis anterior (TA), vastus medialis (VM), and vastus lateralis (VL). Motor unit discharge rates of each muscle was extracted from these signals. Paired-motor unit analysis was used to calculate delta frequency (ΔF) as an estimate of PICs amplitudes during triangular-shaped contractions to 20% of maximum torque capacity. A linear mixed-effect model was used to compare ΔF values, with physical training and muscles as fixed factors and random intercepts and slopes for participants. Pearson correlations were performed between each pair of muscles.

RESULTS: Regardless of the muscle, there was no significant difference in ΔF between the physical training groups (RES: 3.5 pulses per second (pps), END: 3.7 pps, INA: 3.4 pps, $p = 0.35$). There was no significant interaction between the physical training group and muscle ($p = 0.45$). ΔF differed significantly between muscles (SOL: 3.1 pps, GM: 3.4 pps, TA: 4.8 pps, VM: 2.2 pps, VL: 2.0, $p < 0.001$). There were only significant correlations between VL and VM ($r = 0.60$, $p < 0.001$), SOL and GM ($r = 0.35$, $p = 0.041$), and TA and GM ($r = 0.49$, $p = 0.03$).

CONCLUSION: Contrary to our hypothesis, the results suggest that there is no difference in PICs between physical training groups, despite substantial differences in physical training experiences. As the ΔF values obtained in this study are derived from lower threshold motor units recruited at a low force level, it cannot be ruled out that PICs adaptation occurs but is constrained to higher threshold motor units. The correlations observed in ΔF between certain pairs of muscles are noteworthy, as they suggest the existence of individual profiles in the amplitude of PICs.

Oral presentations

OP-BM27 Swimming

TORSO MOVEMENT AT SPRINT FRONT CRAWL AND BACKSTROKE SWIMMING SHARE SIMILAR PATTERNS BUT ALSO HAVE DISTINCT DIFFERENCES.

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INTRODUCTION: Front crawl and backstroke, due to the alternating movements of the limbs facilitate a distinct roll of the torso along the longitudinal axis of the body. The torso also rotates around its sagittal axis (yaw rotation). These rotations are usually analyzed by breaking the torso in two segments (upper and lower trunk). Due to the fact that these two swimming techniques share similar characteristics (e.g. almost horizontal body position, extending – bending – extending the elbow, flutter kick, etc.), in practice of teaching coaches and swimmers often intuitively transfer tips and parts of teaching from one style to the other. Yet, this may have a scientific base only if the parts of technique that facilitate a positive transfer of learning are identified and discriminated. This study investigated coordination of the pelvis and the upper trunk area, 7th cervical vertebrae (C7), regarding the participants' yaw and roll rotation, at sprint front crawl and backstroke.

METHODS: Thirty-four swimmers performed a 25m sprint at each stroke. Segmental rotations of pelvis and upper trunk (C7) were assessed, using gyroscopes (Kapa-Swim sensor, K-Invent, © 2014). From the whole trial the following parameters were calculated: angular amplitudes of each segment, their mean autocorrelation values, the max cross correlation coefficient between the two segments, its phase lag and percent of total power at the main frequency. Normal distribution was verified using the Shapiro–Wilk test. Repeated measures ANOVAs were applied with three within subjects' factors (style: backstroke vs. front crawl, segment: pelvis vs. C7, direction: yaw vs. roll) for angle amplitude, auto-correlation and relative power, for cross-correlation the segment factor was omitted.

RESULTS: Pelvis yaw and roll as well as C7 roll amplitudes were greater in backstroke, while C7 yaw was greater in front crawl. In backstroke, C7 had greater values than pelvis in both directions, while in front crawl C7 had greater values than pelvis only in yaw. Mean peak values of the autocorrelogram were high except the one of pelvis at front crawl in yaw. Cross correlation between pelvis and C7 rotations yielded higher values in roll compared to yaw. Front crawl had higher values than backstroke only in yaw. The power spectral density analysis showed that relative power amplitude of angular displacement at the main frequency was larger in backstroke compared to front crawl.

CONCLUSION: Both strokes share similar characteristics in roll but the coupling of the two segments in yaw is different between them. These findings imply that proper focus should be given from instructors to enhance only a positive transfer of learning between the two strokes. More comparative research is needed for yaw rotation in conjunction with stroke kinematics and propulsive forces to understand the role of the torso in these bilateral swimming techniques and embody the findings in the teaching process.

STROKE REGULATION TIMING ACCORDING TO FINAL PERFORMANCE DURING INTERNATIONAL OPEN-WATER RACES : A RACE ANALYSIS USING EMBEDDED SENSORS

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INTRODUCTION: Race analysis of open-water swimming is of crucial interest to provide valuable feedbacks on performance that drive construction of further training plans or race strategies. Thus, some studies look at pacing during these events but were restricted to split time and rank [1, 2, 3, 4] or intermediate stroke rate (SR) [5]. Then, there is a need for continuous monitoring of biomechanical aspects during open-water swimming associated with performance, especially because timing of kinematical regulation along the race remain unclear. The aim of this study was to analyze cycle-to-cycle SR and jerk cost (JC) profiles and identify the dependency of biomechanical regulations timing on final performance during international open water races.

METHODS: 12 elite swimmers were analyzed during 18 races of two legs of LEN European open water cup including both a 10km, and a 5km race for one leg, with an Inertial Measurement Unit (Xsens DOT, The Netherlands) on the sacrum. Data were divided into 4 segments of 25% (S1 to S4) and swimmers were pooled on 3 balanced group according to final rank (G1 to G3). Cycle-to-cycle SR and JC were computed [6] and fitted using 3rd order polynomials to defined kinematical profiles. A two-way mixed ANOVA was used to compare SR and JC values using segments as within and group as between-subjects factor and Bonferroni post-hoc procedures for significant effects. Significance was set at $p<0.05$.

RESULTS: Kinematical profiles displayed specific regulations as J-shape, U-shape and reverse L-shape for G1, G2 and G3 with significant effect of segment on SR and JC for G1 ($p<0.001$, $\eta^2=0.24$ and $p<0.05$, $\eta^2=0.15$) and G2 ($p<0.001$, $\eta^2=0.46$ and $p<0.01$, $\eta^2=0.02$). We highlighted two tipping-points (TP1 and TP2) at respectively 30% and 75% of the race related to final performance because they were greater in G1: ΔG1: -0.04 ; ΔG2: +0.10 g²/s²x10^3 for TP1 and ΔG1: +2.25 ; ΔG2: +0.87 cycles/min and ΔG1: +1.06 ; ΔG2: +0.13 g²/s²x10^3 for TP2.

CONCLUSION: This work provided the first cycle-to-cycle monitoring of stroke parameters coming from in-situ data collection during full international open water events. We showed the importance of SR and JC control to support effective pac-

ing leading to open water performance through two tipping-points. Such points led to a typical J-shape profile of best performers driven by milestones in stroke regulation. Then, TP1 reflected the end of a stroke economy period (0-30%) and TP2 the end of a progressive increase in kinematics (30-75%) towards end-spurt (75-100%). Results indicated that open water races followed high-grading dynamics requiring specific timing of biomechanical regulation. Best swimmers displayed a stroke rate reserve and a specific management of stroke smoothness to follow the both tipping-points respectively related to preserving energy and launching decisive end-spurt.

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RESISTED SWIMMING: COMPARISON BETWEEN THRUST FORCE EXERTED BY THE HAND AND APPLIED TO THE TETHERED DEVICE

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INTRODUCTION: The thrust force (FT) is only a fraction of the overall force exerted by the swimmer to move his body (1). The capability to maximize FT is a key factor to improve swimming performance. In the last decades, the hand pressure measurement technique has been implemented to support the understanding of FT mechanism (2). However, because the direct assessment during free swimming remains difficult to quantify, the FT measurement during tethered swimming was proposed as an alternative tool. To our knowledge, the relationship between FT exerted by the hand and FT applied to the tethered device has never been tested, and an agreement between these techniques is needed (3). Thus, the aim of this study was to compare FT assessed during fully-resisted swimming by two approaches: the differential pressure and the dynamometrical one.

METHODS: Ten young swimmers (7 F, 15.3 ± 0.5 years, 75.5 ± 7.1 % of WR) performed one full tethered test only-arms wearing a wireless pressure sensor (SEAL, Platysens) on the palmar and dorsal side of each hand. FT applied to the load cell (FTtet; Globus Ergometer, Globus) was assessed during the tethered trial as the average value of 10-s maximal effort in front-crawl. Based on pressure sensors data, the resultant force exerted by each hand to move the water (Fhand) was calculated as the product of differential hand pressure (palmar minus dorsal, PRdiff) and the hand surface (A). Assuming that the hand kinematics was circle-shaped, the instantaneous FT exerted by the hand to propel the body (FThand) was the horizontal component of the force at the hand and was estimated as Fhand • sin(α), where α was the angle in the underwater phase between the trunk and the upper arm considered as a single rigid segment.

RESULTS: PRdiff was 4.099 ± 0.381 Kpa, A was 0.0155 ± 0.0005 m2, and stroke frequency was 1.12 ± 0.09 Hz. Positive associations were observed between FTtet and FThand ($r = 0.641$, $p = 0.023$), FTtet and Fhand ($r = 0.613$, $p = 0.030$) and FThand and Fhand ($r = 0.977$, $p < 0.001$). FThand (43.4 ± 4.4 N) and Fhand (63.5 ± 6.2 N) were significantly lower than FTtet (74.2 ± 9.6 N; $p < 0.001$, Holm's post-hoc test).

CONCLUSION: The swimmer's thrust force assessed by the differential pressure approach during fully-resisted swimming is lower than the force collected by the dynamometrical approach (- 41%). This finding is supported by a previous review comparing different studies using these approaches singularly (3). Because the differential pressure approach can only measure the thrust force exerted by the last segment of the upper limb, and because the hand contribution to the propulsion decreased when the stroke frequency was ≥ 1.1 Hz (4), this difference could be partly imputable to the contribution of the forearm that was not considered.

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WEARABLE PRESSURE SENSORS FOR SWIMMING THRUST ANALYSIS: A VALIDATION STUDY

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INTRODUCTION: The swimmer can increase his velocity by decreasing hydrodynamic resistance and/or increasing thrust force (1). To assess thrust force, indirect techniques (video-based analysis or computational fluid dynamic) are more time-consuming than direct ones (tethered swimming with load cell or pressure sensors system). According to Takagi et al. (2), the pressor sensor systems calculate the forces exerted through the hands surface (A) as F = A • Pdiff where Pdiff is the hydrodynamic pressure (PD) difference between the palmar and dorsal side excluding the hydrostatic pressure influence (PS). Due to the greater ecological features of modern wearables technologies, this study aims to validate the first wireless pressure sensor system in terms of PS and PD accuracies compared with theoric static pressure (tPS) and theoric dynamic pressure (tPD).

METHODS: The validation was conducted as: i) PS vs. tPS (calculated as $P = Patm + \rho \bullet g \bullet h$) through the static immersion of the wearable pressure sensor (SEAL, Platysense) down to a depth of 34 cm with a constant step of 1cm; ii) PD vs. tPD (calculated as $P = 0.5 \bullet \rho \bullet v2$) by towing 4 SEALs using an electromechanical towing system at constant velocities of 0.5,

1.0, 1.6, 1.9 ms-1 and constant depth of 10 cm. Bidimensional video analysis was used to confirm the correct depth. Within-trials (3 trials), between-sensor (10 sensors), and day-by-day reliability (2 days for 6 sensors) were analyzed in terms of ICC, CV%, TE, SEM, and MDC. Bias, standard error of estimate (SEE) and T-test/ANOVA were calculated to test the accuracy for PS and PD considering the theoric gold standard. The sensitivity of the pressure sensor was 0.1 KPa.

RESULTS: PS showed excellent agreement for within-sensor, between-sensor, and day-by-day reliability regarding ICC (0.99, 0.99, >0.96), CV% (0.1, 0.1, 0.2), TE (0.1, 0.1, 0.1 KPa), SEM (0.1, 0.1, 0.1 KPa), and MDC (0.1, 0.1, 0.4 KPa). No differences ($p < 0.05$) were found between PS and tPS and between PD and tPD. Small bias and small SEE were found for PS vs. tPS (0.2 KPa and 0.1 KPa, respectively), which increase with depth according to the equation PS = 0.968 • tPS + 3.182. Furthermore, PD vs. tPD comparisons revealed a small bias at each different velocity (0.3, 0.1, 0.3, 0.4 KPa).

CONCLUSION: The present results suggest that hydrostatic and hydrodynamic pressures acquired by wearable wireless devices demonstrate a small amount of error compared to theoric pressures, despite its increases as a function of depth (always lower than 0.4 %). The proposed instrument seems suitable for future studies in swimming propulsion analysis due to its ecologic features and lower impact on swimming technique.

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PERFORMANCE DESCRIPTORS IN ARTISTIC SWIMMING TECHNIQUE: THE RELATIONSHIP BETWEEN PROPULSION, SYMMETRY, STABILITY, AND HEIGHT IN DIFFERENT STATIC FIGURES

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INTRODUCTION: Biomechanical parameters allow the quantitative description of the performance in artistic swimming technique. Few studies investigated the kinematics and the dynamics of different sculling using underwater cameras, load cell, and/or wired sensor pressure (1,2). Thanks to the advances in wearable technology, it is now possible to evaluate propulsion and stability ecologically during daily training sessions. The present study aimed to investigate the relationship between force exerted by the hands during sculling motion, the symmetry of this force between the hands, the stability of the leg and pelvis, and the body level height with respect to water surface during the flamingo (FLA), gru (GRU), and vertical (VER) static figures.

METHODS: Sixteen female synchronized swimmers (19.1±3.0years, 163.7±4.3cm height, 56.3±6.0kg mass) were analyzed. FLA, GRU and VER figures were randomly executed 3 times during a single trial (each figure held for 5s, followed by 10s paused). Using the differential approach (3), the force exerted by the hands was estimated by means of 2 wireless pressure sensors (SEAL, Platysens). Mean value (Fmean) and symmetry index (Fsym) were estimated for the 5/trial central sculling. The stability of the pelvis (STABpel) and of the vertical leg (STABleg) were estimated considering all 3 axes using 2 inertial sensors (Wavetrack, Cometa) (4). The height (HGT) corresponded to the level of the water surface with respect to 3 thigh zones (proximal, central and distal part) using a camera.

RESULTS: Variables between figures showed strong associations: Fmean, Fsym, STABleg, STABpel and HGT obtained during GRU were significantly correlated ($p < 0.05$) with the corresponding variables during FLA ($r = 0.748$, $r = 0.955$, $r = 0.630$, $r = 0.968$, $r = 0.615$) and VER ($r = 0.916$, $r = 0.666$, $r = 0.650$, $r = 0.747$, $r = 0.632$). Significant correlations ($p < 0.05$) for Fmean, Fsym, STABleg, STABpel and HGT between FLA and VER were also found ($r = 0.721$, $r = 0.571$, $r = 0.724$, $r = 0.804$, $r = 0.783$). No correlation was observed between any variables within the figures.

CONCLUSION: The results supported the technical coherence in terms of propulsion, stability, symmetry and height among the artistic swimming figures of flamingo, gru, and vertical. However, these descriptors were not correlated within the single figure, probably due to the low variability of the quantities among the athletes.

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Oral presentations

OP-AP28 Talent Identification

NON-INVASIVE ESTIMATION OF HUMAN MUSCLE FIBER TYPE COMPOSITION; A MULTIDIMENSIONAL APPROACH

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INTRODUCTION: Muscle fiber type composition (MFTC) is a sport performance determinant with potential for talent orientation and training individualization. However, its use in sports practice remains limited, because the current gold standard to measure MFTC requires a muscle biopsy. There is no consensus regarding the optimal non-invasive method to estimate MFTC, since most studies are limited to relating one test to a single biopsy-based MFTC in a small male-only sample. Therefore, our aim was to determine the best (combination of) non-invasive method(s) by addressing these limitations.

METHODS: Forty young, recreationally active participants (20 men, 20 women) were subjected to two muscle biopsies in vastus lateralis, two in gastrocnemius medialis and multiple non-invasive tests. Test selection was based on 1) how well measurements were related to MFTC in literature (overview of 80 studies), 2) how often they were used in the field (survey on 446 coaches) and 3) capturing different MFTC dimensions: metabolism, power, fatigue and contractility. Subjects performed 30 m sprints, squat jumps, a Wingate test, isokinetic and isometric knee extensions, electrostimulation of the n. femoralis, a maximal incremental cycling exercise test and a proton magnetic resonance spectroscopy scan to measure muscle carnosine. Muscle cross-sections were stained for myosin heavy chain type I, IIa and IIx and analyzed in ImageJ. Average relative type I area of four biopsies across two muscles was our MFTC criterion variable. Pearson correlations (all subjects) examined the relationship between tests and MFTC and the largest significant correlation for each test is shown. The predictive value of test combinations was assessed by multiple linear regression.

RESULTS: The multi-biopsy typology, as relative type I area, ranged from 39.1 to 79.6 % and was based on the analysis of 3590 ± 1059 fibers per individual. For metabolic parameters, blood lactate 3 min after the Wingate ($r=-0.67;p<0.001$) and average carnosine concentration in the vastus lateralis and gastrocnemius ($r=-0.48;p=0.002$) showed criterion validity. For power, we found best correlations for maximal torque during 300°/s knee extensions ($r=-0.47;p=0.002$), 15m sprint time ($r=0.42;p=0.007$) and squat jump height ($r=-0.36;p=0.022$). The fatigue index during a Wingate also showed significant correlation ($r=-0.48;p=0.002$). For contractility, rate of torque relaxation after electrical stimulation of the knee extensors was correlated with MFTC ($r=0.39;p=0.013$). When combining methods, MFTC could be estimated for 45% (adj. R^2; $p<0.001$) in all subjects and for respectively 52% and 66% (adj. $R^2;p<0.001$) in men and women separately.

CONCLUSION: Several non-invasive estimators, covering different MFTC dimensions, were each related to MFTC, but a multivariate approach led to superior estimations at the individual level. Therefore, to bring more accurate MFTC assessments to sports science research and practice, we should move to a multidimensional combination of tests.

ORIENTING ADOLESCENTS AND INCREASING TALENT POOLS IN TRACK AND FIELD, VOLLEYBALL AND CYCLING.

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INTRODUCTION: Keeping children active during adolescence is proving to be a challenge. This has implications for sports participation and the pathway to elite sport. A better connection between schools and sports clubs can prevent sports dropouts and increase talent pools. For this purpose, a new project was set-up in which schools, sports clubs and municipalities work together to support talent detection/orientation among adolescents in three sports: athletics, volleyball and cycling. However, previous studies show that talent detection can be distorted by (temporary) differences in maturity status. The research question is whether those with the greatest potential are more likely to be detected.

METHODS: In total 420 adolescents (13.62y ± .45y) were assessed by means of the "(SportKompas I Like" survey that mapped which activity they liked and an adapted "SportKompas I Do" test battery that charted participants performance profiles. The maturity status was measured with the Khamis-Roche method. Assessing the results was done in three ways: First, seven sports were presented to each participant based on personal exercise preferences. Second, a generic test battery was assessed in both age and maturity groups and ranked into a list of better movers. Third, the organisers wanted to improve inflow in 3 sports where the infrastructure in the area offers opportunities, namely athletics (running), volleyball and cycling (track).

RESULTS: Out of 196 girls, 81 were late mature, 71 on-time and 44 early mature. Among the 214 boys, 29 were late mature, 108 on-time and 77 early mature. Both discriminant analyses with 2 grouping variables i.e., early and late mature girls/boys were significant (girls: rcan = .827 and Wilks' Λ = .316 and $P < .001$; boys: rcan = .883 and Wilks' Λ = .220 and $P < .001$). The cross validated analysis classified 89.6% of the girls and 97.2% of the boys correctly. Early mature girls ($F=103,142$ and $P<.001$) and boys ($F=205,152$ and $P<.001$) were significantly taller than their late mature peers. Early mature girls also outperformed late mature peers for standing broad jump ($F=5,297$ and $P<.023$), sprint 30m ($F=4,118$ and $P<.045$), knee push-ups ($F=5,635$ and $P<.019$), curl-ups ($F=4,807$ and $P<.030$), endurance shuttle run ($F=12,117$ and $P=.001$)

and KTK balance beams (F=5,758 and P<.018), while early mature boys scored better for shuttle run (F=6,342 and P=.013), KTK balance beams (F=7,460 and P=.007) and KTK jumping sideways (F=5,026 and P=.027).

CONCLUSION: Sport professionals from schools and municipalities try to give a quality impetus to the talent pool in clubs. All adolescents received sports promotion recommendations. However, detecting potential at the age of 13 is biased by maturity status. Using only the ranking of performance on tests to estimate potential is not sufficient because false positives are detected while false negatives are forgotten. When evaluating the data for selection towards the sports in the region, it is important to consider differences in maturity status.

PHYSICAL FITNESS AND MOTOR COMPETENCE TESTS AS PREDICTORS OF TALENT IN SOCCER? THE CORRELATION OF JUVENILE TEST RESULTS AND LATER SUCCESS VIEWED STEPWISE OVER 12 YEARS – A LONGITUDINAL STUDY

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INTRODUCTION: There are already several studies on talent identification in youth soccer. However, only a minority of these studies have a longitudinal design or observe the complete performance trajectory of young athletes all the way to adulthood. The few studies that investigated associations between youth performance and later success in senior competitive sports showed that the validity of talent predictions steadily decreased with increasing time periods. However, the data available to date is very limited. Therefore, the aim of this study was to analyze the correlations of early test performance (physical fitness and motor competence tests) of young soccer players with their later successes stepwise over 12 years until adulthood.

METHODS: Over the past 12 years, about 100 male soccer players aged 8 years (U9) were tested annually (N = 1,266) in various physical fitness and motor competence tests. The test tasks included a 20m sprint, push-ups, sit-ups, standing long jump, standing bend forward, balancing backward, 6min endurance run, change of direction agility, hand grip, sideward jumping, soccer dribbling, agility run, and ball throw. For each participant, a 20-point performance scale was used to determine and assess the playing and competition success achieved in the following years in the respective age groups (up to U21). Using correlation analysis, it was examined whether juvenile test scores were significantly related to playing performance achieved later on.

RESULTS: The findings show significant correlations with later achieved performance for almost all juvenile test tasks. Nevertheless, in early adolescence (U11–U15), mostly no or only weak correlations ($|r|<0.17$) of playing success with the test results can be demonstrated. However, it is noticeable that all correlation values become higher with an increasing prediction period. Thus, the highest correlation values are reached between U9 test performance and U21 playing success. However, the effects are predominantly moderate ($|r|<0.35$). The soccer-specific test items showed the largest correlations.

CONCLUSION: Contrary to the results of other studies, the findings show that the correlations become stronger over a longer period. This is surprising since it can be assumed that performance parameters such as strength or endurance do not remain stable over such a long period of time (12 years) or can first become apparent later, e.g. during puberty. However, the reason that the correlations increase over time could be due to the fact that the league structure in soccer is not yet fully developed at a young age. Only at the adult level exists a distinctive league system that facilitates the differentiation between better and weaker soccer players, which facilitates the assessment of performance success. As expected, the two high-fidelity tests soccer dribbling and agility run performed best. Both tests have been practiced by the German Football Association (DFB) for many years.

Oral presentations

OP-MH19 Ageing and exercise interventions

APPLICABILITY OF A CONTROLLED SUPRAMAXIMAL HIT PROGRAM AMONG NON-EXERCISING OLDER ADULTS

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INTRODUCTION: Supramaximal High-Intensity Interval Training (HIT) is effective and time-efficient for older adults. Still, concerns about the safety and applicability warrant development and evaluation of adapted exercise programs. This study aims to evaluate the applicability of the supramaximal HIT program (Hedlund et al., 2019) applied in the randomized controlled Umeå HIT Study (NCT03765385).

METHODS: Sixty-eight non-exercising older adults (66 to 79 years old, 44% males) were randomised to 25 sessions of controlled supramaximal HIT (10x6-seconds) or moderate-intensity training (MIT) (3x8-minutes). The training was supervised and performed on stationary bicycles at a local gym in groups of 8-10 participants. The exercise intensity was individualized and watt-controlled. Standardized escalation criteria were used to allow gradual and individual escalation of the target intensity. Applicability outcomes were attendance, target intensity compliance and escalation, and positive and negative events related to the training sessions.

RESULTS: Participants in HIT attended 748 of 850 sessions with a participant mean (SD) attendance rate of 88% (12). Corresponding numbers in MIT were 749 of 850 sessions and 88% (17), respectively. The most common causes of non-attendance were pre-announced absence (56% in HIT, and 54% in MIT) or being ill (28% in HIT, and 24% in MIT). The mean stipulated interval intensity increased from 235 to 428 watts in HIT, and from 54 to 84 watts in MIT. The most common criteria for not increasing the intensity in HIT was the participant not feeling ready to escalate, while in MIT it was that the participant's heart rate exceeded 70% of heart rate reserve. Participants' mean compliance to the stipulated intensity across sessions was 81% (11) in HIT, and 98% (4) in MIT. In total, 112 positive and 52 negative events were expressed in HIT, with a participant median (range) of 2 (0-12) positive and 1 (0-10) negative events across sessions. Corresponding numbers in MIT were 74 positive and 94 negative events, with a participant median of 1 (0-9) positive and 2 (0-14) negative events. The most common type of positive event was general vitality ("more energetic/happier") in HIT, and musculoskeletal ("muscle soreness/stronger muscles") in MIT. In both groups, the most common type of negative event was musculoskeletal ("muscle soreness/pain"). No negative event was considered a serious adverse event.

CONCLUSION: This exercise program of watt-controlled supramaximal HIT seems applicable and enjoyable in non-exercising older adults. Attendance was high, with fewer negative events and more positive events in HIT. The participants in HIT could comply to the stipulated intensity and its progression over time. Consideration of the participant's own readiness to increase intensity seems important.

Clinical Trial Registration: NCT03765385

Hedlund et al. 2019; doi: 10.3389/fphys.2019.00590

HOW DOES OLDER ADULTS' FITNESS LEVEL IMPACT THE ASSOCIATIONS BETWEEN BORGS RPE SCALE AND PHYSIOLOGICAL MEASURES OF EXERCISE INTENSITY?

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INTRODUCTION: A vast amount of research indicates strong validity for Borgs (6-20) Rating of Perceived Exertion (RPE) scale using physiological measures (e.g., heart rate, blood lactate concentration, and respiratory exchange ratio (RER)) as criterion measures.1 However, a recent study by Kossi et al.2 showed that older adults reported higher RPE than younger individuals at the same training intensity. In light of these findings, it is of interest to investigate if older adults' fitness level could impact the associations between Borgs RPE scale and physiological measures of exercise intensity.

We hypothesized that peak oxygen consumption (VO2peak) would be negatively associated with RPE and physiological intensity measures at the lactate threshold, and positively associated with physiological intensity measures at exhaustion.

METHODS: 138 older adults (68.5±5.7 yrs) completed an incremental maximal treadmill test to exhaustion, using a modified Balke protocol, combining measures of lactate threshold and VO2peak.3 General linear regression analyses, taking into account age and sex/gender, were performed to examine associations between Borgs RPE scale and physiological measures of exercise intensity at lactate threshold and exhaustion.

RESULTS: VO2peak was positively associated with RPE (β=0.79 [0.33, 1.25], and negatively associated with % of VO2peak (β =-32.72 [-46.43; -19.01] at the lactate threshold, but not with % of peak heart rate (p>0.05). At exhaustion, VO2peak was positively associated with both RPE and RER (β =0.91 [0.16, 1,66], β =22.99 [7.63, 38.34]), respectively, but not with peak blood lactate concentration (p>0.05).

CONCLUSION: The present studys findings contradict our hypothesis, as the participants with the lowest fitness level did not report a higher RPE at the lactate threshold but instead reported lower RPE than their fitter counterparts. Moreover, a higher RER was observed for participants with higher fitness levels, in addition to reporting a higher RPE at exhaustion. Thus, fitness level may impact the associations between Borgs RPE scale and physiological measures of exercise intensity in older adults, although further research is needed to explore these associations.

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A LONGITUDINAL STUDY ON CARDIOPULMONARY FUNCTION OF OLDER ADULT CYCLISTS

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INTRODUCTION: The relationship between ageing, exercise and disease is obscure. This longitudinal study of older amateur road cyclists, who were extensively physiologically characterised nine years ago(1), provides an opportunity for new

insights into this relationship. Thus, the aim of the study was to investigate the effects of 9 years of active ageing on cardiopulmonary function in relation to any change in health status.

METHODS: Eighty older road cyclists were re-tested after nine years and categorised according to i) no declared health issues (Group 1, 21=M (males), 10=F (females)), ii) exhibiting new but well-controlled health condition(s) unlikely to affect exercise (Group 2, 17=M, 12=F) or iii) having any poorly controlled underlying condition(s) that may compromise exercise tolerance (Group 3, 13=M, 7=F). Blood pressure and heart rate (RHR) were measured at rest along with pulmonary function (Forced Vital Capacity, FVC; Forced Expiratory volume, FEV1). An incremental exercise test was performed on a cycle ergometer to determine maximal aerobic power (VO2peak), maximum heart rate (MHR), and ventilatory threshold (VT). O2 kinetics (TAU) was also determined. Statistical analysis: i) one-way ANOVA assessed for differences at baseline, ii) paired T-test assessed for change over time, and iii) multiple regression analysed between-group differences over time.

RESULTS: Results are mean group changes±SD (*denotes significant change over time, $p<0.05$,) for groups 1, 2 and 3 respectively. The age of participants after nine years were 71±5, 73±6, and 72±6 (yrs). With the exception of FVC, there were no between-group differences at baseline for any indices. Cycling volume declined in two groups (km month−1; -242±276*, -242±339*, -125±296),. SBP increased in group 2 only (mmHg; -0.4±15.3, 7.0±15.7*, 7.3±27.5), whereas DBP increased in all groups (mmHg; 6.7±11.0*, 10.7±10.2*, 12.4±14.8*). Groups 2 and 3 saw an increase in RHR (bpm; 1.5±5.0, 3.4±6.1*, 5.1±8.6*), whilst lung function declined in all groups (FEV1: L; -0.7±0.4*, -0.5±0.6*, -0.8±0.4*; FVC: L; -1.6±0.9*, -1.4±0.7*, -1.9±0.9*). MHR (bpm; -8.8±8.0*, -11.6±8.3*, -13.4±10.1*), VO2peak (ml kg−1 min−1; -7.8±4.6*, -8.5±4.8*, -11.0±5.5*), and VT (ml kg−1 min−1; -3.6±4.0*, -5.4±5.1*, -5.6±4.3*) have declined in all groups. TAU increased in group 2 (s; 1.8±7.9, 7.4±12.3*, 6.6±15.1). The data show a significant interaction between groups over time across all indices ($p<0.01$), except for TAU, with Group 3 showing the greatest change in function.

CONCLUSION: The development of disease over nine-years of active ageing appears to impact global cardiopulmonary function. Despite this, the cyclists maintain high levels of physiological function. Thus, whilst ageing increases susceptibility to some diseases, their impact on function may be ameliorated by exercise.

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MUSCLE STRENGTH AND METABOLIC HEALTH IN MASTER ENDURANCE RUNNER: DO THEY DIFFER FROM YOUNG RUNNERS AND SEDENTARY ELDERLY?

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INTRODUCTION: Lower levels of physical activity in old age contribute to the natural decline in an individual´s muscle strength and metabolic health. However, master athletes, who maintain high levels of regular physical activity, may affect the extent to which these physical functions decline, as they are ageing. Yet, there are still some differences in physical functioning between master and young athletes. The study aims to examine the effect of ageing and lifelong endurance running in master athletes on metabolic health and muscle strength, compared to their elderly sedentary counterparts and young endurance runners.

METHODS: The cross-sectional study involved totally 42 healthy males split into 4 groups: 1) young endurance runners (YR: n=11, age: 28.2±2.05 yrs); 2) young sedentary (YS: n=11, age: 28.2±2.34 yrs), 3) master endurance runners (MR: n=10, age: 69±3.09 yrs); 4) elderly sedentary (ES: n=10, age: 71.1±3.64 yrs).YR and MR involved only the active marathon runners, according to the following inclusion criteria: 1) above 300 mins per week of endurance running, 2) regular participation of YR (at least 3 years) and MR (at least 25 years) in running competitions (in 10 km, half, and full marathon), 3) to have their personal best time on 10 km run in last season under 35 mins in YR and under 55 mins in MR.

To compare the differences in metabolic health and muscle strength among the abovementioned groups, the venous blood was collected (blood glucose, insulin, TAG, LDL, HDL and total cholesterol), the body composition (body weight, skeletal muscle mass and body fat) by bioimpedance was measured, and the muscle strength of lower limbs was tested via maximal voluntary contraction of both isometric extension and flexion on the knee dynamometer.

RESULTS: Blood glucose was significantly higher in ES and YS (4.11±0.22 mmol/l; P=.003). Insulin was significantly higher in ES (9.32±3.77 IU) compared to MR (5.16±2.32 IU; P=.005) and YS (10.01±6.52 IU) vs. YA (3.39±1.02 IU; P=.001). HDL cholesterol was significantly higher in both YR (1.51±0.20 mmol/l) compared to YS (1.22±0.25 mmol/l; P=.007) and MR (1.61±0.30 mmol/l) compared to ES (1.04±0.19 mmol/l; P=.001). LDL cholesterol was significantly in YR (2.09±0.60 mmol/l) compared to MR (3.33±0.60 mmol/l; P=.001) and in YS (2.50±0.73 mmol/l) vs. ES 3.20±0.99 mmol/l; P=.037). No significant differences were observed in triacylglycerol. Similarly there were observed differences between YR and YS and MR and ES.

CONCLUSION: The results proved, there are some differences in the parameters of metabolic health according to age as well as the effect of regular exercise. Lifelong endurance running may positively affect the process of ageing due to maintaining higher levels of muscle strength and slowing down metabolic alterations.

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EFFECTS OF OLD AND VERY OLD AGE ON NEUROMUSCULAR FATIGUE DURING ISOMETRIC, CONCENTRIC AND CYCLING FATIGUING TASKS IN MEN AND WOMEN

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INTRODUCTION: The effects of aging on performance fatigability (decrease in maximal force) has been extensively studied during local (i.e. single-joint) isometric and dynamic fatiguing tasks. However, the experimental setup are usually far from ecologically valid conditions, with workloads set in percentage of maximal capacities and fatigability evaluated at exhaustion. The aim of the present study was to investigate performance fatigability during isometric, dynamic and cycling incremental fatiguing tasks across age with absolute workloads.

METHODS: Twenty-six young (13 women), 27 old (14 women) and 23 very old (11 women) adults randomly performed an isometric (ISO) and a dynamic (DYN) quadriceps intermittent fatigue tests on an isokinetic dynamometer and a similar test on a validated cycle ergometer (BIKE). This test consisted of incremental stages of 75 contractions (0.8-s on/0.8-s off; ISO and DYN) or 120-s cycling at 37.5 rpm (BIKE) with increments relative to the participants body weight. Maximal voluntary force, voluntary activation (VA) and amplitude of the resting twitch (Tw) were assessed using the interpolated twitch technique with percutaneous electrical nerve stimulation before, after each stage and at exhaustion.

RESULTS: Performance (number of stages) decreased with age for men and women in the three conditions. For men, maximal force decreased earlier in old and very old adults compared to young adults during BIKE but not during ISO and CON. However, the decrease in maximal force at exhaustion was greater for young than very old adults after ISO ($P<0.001$), but similar across age in CON and BIKE. For women, maximal force decreased earlier for very old adults compared to young adults during CON but not during ISO and BIKE. At exhaustion, the decrease in maximal force was similar across age and fatiguing tasks. For both men and women, impairments in VA and Tw amplitude were similar across age and fatiguing task, except a larger decrease in Tw amplitude for young men after BIKE compared to older groups ($P<0.05$).

CONCLUSION: These results showed that young men and women were more performant than old and very old adults independent of the task when the load was set relative to individual body weight. Fatigability (decrease in force) occurred earlier in old and very old men during cycling, and earlier in very old women during the concentric task. At exhaustion, no age-related difference were observed for men and women independent of task, except for the isometric task in which young men had greater fatigability than very old men. Fatigability was mainly driven by impairments in contractile function. These results suggest that fatigability should not only be evaluated at exhaustion but also at sub-maximal levels that are closer to the intensity of activities of daily living.

Oral presentations

OP-AP29 Body Composition

NEW BIOELECTRICAL IMPEDANCE VECTOR REFERENCES AND PHASE ANGLE CENTILE CURVES IN 4,367 HEALTHY MALE AND FEMALE CAUCASIAN ADULTS: THE NEED FOR AN URGENT UPDATE AFTER 30 YEARS

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INTRODUCTION: The bioelectrical impedance vector analysis (BIVA) represents a qualitative analysis of body composition. Starting from the bioelectrical characteristics, the vector can be evaluated compared to 50%,75%, and 95% tolerance ellipses representative of reference populations. The tolerance ellipses for healthy adults have been provided in 1995 and were developed by mixing underage, adult, and elderly subjects.

METHODS: The current study aimed to provide new tolerance ellipses for healthy adults and as a secondary aim to present centile curves for the bioelectrical phase angle. Bioelectrical resistance (R), reactance (Xc), and phase angle were measured in 2,137 and 2,230 Caucasian males and females using phase-sensitive foot-to-hand analyzers at 50 kHz. A minimum of 35 subjects were included for each age category from 18 to 65 years.

RESULTS: The new mean vectors showed a shift to the left on the R–Xc graph with respect to the former reference values (males: $F=75.3$; $p<0.001$; females: $F=36.6$, $p<0.001$). The results provided new 5th, 10th, 25th, 50th, 75th, 90th, and 95th percentile curves for phase angle, identifying time point phases of decrement (males: -0.03° per year at 33.0-51.0 years and -0.05° per year after 51 years; females: -0.03° per year from 37.2 to 57.9 years).

CONCLUSION: Compared to the references provided along with the BIVA invention, the present study showed that the tolerance ellipses of the adult population are shifted to the left within the R-Xc graph, also suggesting a higher phase angle. After 30 years, the current study presents new BIVA and phase angle reference values for the healthy Caucasian adult population.

SOMATOTYPE AFFECTS LEAN BODY MASS ESTIMATION WITH BIOELECTRICAL IMPEDANCE ANALYSIS

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INTRODUCTION: Body composition measurements, particularly using bioelectrical impedance are quite common among athletes. However, when evaluating the results, we need to know the limitations of this method, furthermore potential influencing factors. The aim of the study was to examine the effects of the individual somatotype on body composition estimated by bioelectrical impedance analysis, especially on lean body mass and to investigate how body proportions affect the variability of estimates.

METHODS: 719 male athletes were measured aged between 10 and 20 years (mean age: 15.6±1.9 years). The athletes were all players from sport clubs or academies in Hungary. Body composition was estimated by bioelectrical impedance analysis (InBody 720) and by dual-energy X-ray absorptiometry (Lunar Prodigy). Somatotype was determined with regression equations using the Heath&Carter method (1967). Groups based on the trunk to limb ratio were calculated by the ratio of sitting height to hip height. The effect of somatotype components and body ratio on lean body mass estimation was examined by multivariate linear regression. The differences between groups were analyzed by one-way analysis of variance (ANOVA).

RESULTS: On average, BIA underestimated body fat percent by 7.6% compared to DXA. Further, the average difference in lean mass between BIA and DXA was -3.9 kg. The smallest difference between the two methods was found in the mesomorphic dominant group, for both lean body mass (-3.3 kg) and fat percentage (6.4%). The mean difference in fat percentage estimation was the largest in the ectomorphic dominant group (8.6%), while the mean difference in lean body mass estimation was the largest in the endomorphic dominant group (-5.4 kg). Regarding segmental lean body mass analyses, we found significantly larger difference in the lean body mass estimation of the lower limbs in the ectomorphic dominant group. Based on the trunk-to-limb length groups, fat percentage was underestimated, while lean body mass was overestimated for athletes with proportionally longer limbs. The difference between BIA and DXA decreased with increasing trunk-to-limb ratio. Multivariate linear regression revealed that individual somatotype and trunk-to-limb ratio together explained 27% of the differences in lean body mass estimation.

CONCLUSION: As both the BIA and DXA provide estimates of body composition, it is important to understand any factors that may affect the results of the measurements. Our findings suggest that body composition measurements and somatotype are related. Therefore, it can be assumed that lean body mass estimates are influenced by the dominant component that determines somatotype and this should be considered when using BIA analysis. Overall, body proportions affect BIA measurements, with a lower trunk to limb ratio being associated with an overestimation of lean body mass.

RELATIONSHIP BETWEEN MAXIMUM FAT OXIDATION DURING A GRADED CYCLING TEST AND SUBCUTANEOUS ADIPOSE TISSUE MEASURED USING ULTRASOUND IN ELITE TRIATHLETES

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INTRODUCTION: In endurance sports, such as triathlon, body mass and fat are of great importance. On the one hand, carrying low body mass and fat as well might be an advantage, on the other hand providing sufficient energy for high amount of training hours and multiple competitions is essential. Consequences of insufficient energy availability may have adverse effects on performance and long-term health of athletes. Therefore, an accurate (1) and reliable (2) measurement method for measuring subcutaneous adipose tissue (SAT) may provide relevant data to enhance athletes` performance. The aim of this study is to analyse a potential relation between SAT and parameters of fat oxidation in elite triathletes.

METHODS: A sample of 12 male national team triathletes (age 22.3±2.9y, body height 1.85±0.06m, body mass 73.7±4.9kg, BMI 21.7±1.1kgm-2, VO2peak 4922.1±313mL) performed a graded exercise test with measurement of respiratory gases. The last 90 s of oxygen uptake and carbon dioxide production for each stage were averaged and fat oxidation was calculated using stoichiometric equations (3). Using this data, maximal fat oxidation (MFO) and FATmax (expressed as % of VO2peak) was calculated for each participant. SAT thickness was measured at eight defined body sites using ultrasound according to a published protocol (1). SAT thickness sums of all sites (in terms of DI; I fibrous structures incl.) were used: upper-and lower abdomen, front-and lateral thigh, medial calf, erector spinae, distal triceps, and brachioradialis. Further, SAT thickness sums of the lower limbs (DI,LL; front-and lateral thigh, and medial calf) were used. Ultrasound images were calculated using a semi-automatic image evaluation software (NISOS-BCA Fat Analysis Tool, v.4.2, nisos.at). To assess strength of the relation between parameters Pearson moment correlations have been used (GraphPad Prism version 9.0.0).

RESULTS: Results showed non-significant correlations between DI (14.83±7.67 mm) and MFO (0.57±0.13 g/min; r=-0.347, p=0.269) and for DI and FATmax (2.4±0.2 W/kg; r= 0.08, p=0.808). Moreover, non-significant correlations were found between DI,LL (6.34±3.80 mm) and MFO (r=-0.484, p=0.111) and FATmax, (r=0.553, p=0.062). Five of 12 males had 'extremely low' and four had 'very low' DI values according to a preliminary assessment schedule (4).

CONCLUSION: The main findings indicate that thickness of adipose tissue does not predict the athlete's capability to maximise fat oxidation. Also, SAT of lower limbs, which might be more specific in the type of physical load, did not show a relationship to parameters related to fat oxidation during exercise. A transfer of SAT values on interpretation of training zones and training recommendations in concern of fat oxidation might not be justified. However, the influence of SAT values on performance in competition should be observed and SAT changes should be noted for each athlete individually.

(1) Müller et al., 2016 (2) Störchle et al., 2017 (3) Brouwer, 1957 (4) Ackland & Müller, 2022

DOES THE ULTRASOUND THICKNESS REPRESENT AN ACCURATE METHOD TO PREDICT LEAN MASS IN RESISTANCE TRAINED MEN?

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INTRODUCTION: Increasing muscle mass is the main objective of individuals engaged in resistance training(RT) programs. Ultrasound (US) can play an important role in monitoring such musculoskeletal adaptations because it provides objective measures of muscle mass and muscle quality. Furthermore, US is a non-ionizing imaging technique, as well as being portable and highly accessible, contrary to dual-energy X-ray absorptiometry(DXA), traditionally used in this research context. However, the literature does not provide an adequate US-based model to estimate total and appendicular lean mass (LM) in RT adult men. Thus, the main purpose of the present study was to develop a model to estimate the whole body (WB) and thigh LM based on ultrasound measurements of the vastus lateralis (VL) and rectus femoris (RF) thickness in resistance-trained men.

METHODS: Men (N = 79,31 ± 7.0 years, 76.3 ± 10.2 kg and, 174.3 ± 6.0 cm), previously engaged in RT for at least 1 year and at least 3 times per week, participated in this study. Each participant performed body composition assessments by DXA to calculate WB and regional (thigh) LML. Muscle thickness of VL and RF of the dominant leg were assessed at rest using B-mode US imaging. Longitudinal and transversal scans were taken from the muscles mid-belly corresponding to 39%(VL) and 56%(RF) of the distance from the proximal edge of the patella to the anterior superior iliac spine.

Mathematical models, based on anthropometric and US measurements, were developed using stepwise multiple regression analyses, and new developed models were cross-validated using the PRESS approach.

RESULTS: The muscle thickness of RF and VL showed a positive correlation with weight, WB and thigh LM assessed by DXA. Regression analysis showed that RF alone explain 18.9% and 19% of the WB and thigh LM, respectively, while VL by itself explain 26.5% and 20.1% of the WB and the thigh LM, respectively. Four models were developed (two for WB and two for thigh, each one including a measure of ultrasound thickness (RF or VL). After validation, the best equation to predict lean mass in WB is: Lean mass (kg) = -1.657 + 0.719* Weight (kg) + 0.416* VL (mm), where R2=0.882 and a standard error of estimate (SEE)= 2.99kg. If considering only the thigh, the best approach for LM estimation based on ultrasound thickness is: Lean mass (kg) = -0.354 + 0.146* Weight (kg) + 0.047* VL (mm) where R2=0.849 and SEE=0.667 kg.

CONCLUSION: The present study provides a valid and useful mathematical model based in US measurements, more specifically based on vastus lateralis thickness, that can be used as a practical and ecological approach to assess lean mass at a whole-body level as well as for thigh only, in RT men. These mathematical models represent an important tool to assess body composition, monitor RT adaptations and identify possible asymmetries between thighs.

Oral presentations

OP-MH18 Physical activity promotion

BECOMING A CYCLIST TO BE ACTIVE: A SYSTEMATIC REVIEW OF THE EFFECT OF CYCLING EDUCATION AND BUILT ENVIRONMENT ON PHYSICAL ACTIVITY

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Introduction

According to the high level of sedentary behaviour, physical activity (PA) is a public health issue (Guthold et al., 2020). Cycling, as an active transport, makes it possible to maintain sustainable daily activity (Khan et al., 2020). However, many children stopped their PA when they became adults, and it seems interesting to understand how cycling can overcome this.

Following the ecological framework of human development (Bauman et al., 2012), the aim of this systematic review is to evaluate the effectiveness of school-based interventions (interpersonal determinant) or built environment (environmental determinant) to promote sustainable engagement in PA by cycling. The research question is: 'among school-aged children, ages 6 to 18 years (P), what are the characteristics of cycle educational and environmental interventions (I) that promote engagement in PA (O), compared with children and adolescents of the same age who do not receive these interventions (C)?'

Methods

The PICO method was used to define the research question, and PRISMA checklist searched for articles in 11 databases (WOS, Embase, Psychinfo, Cochrane, Pubmed, ScienceDirect, Proquest, ERIC, Lilacs, Sportdiscus, and Scopus). Eligibility criteria were (1) English language, (2) population of school-based aged, (3) intervention study design on education and on

built environment, and (4) results related to PA engagement. The risk of bias was assessed. Inverse variance meta-analyses using random effects models are in progress.

Results

Results showed relatively poor number of studies included which try to promote PA through cycling (n=8). Despite various measurement tools: questionnaire (n=1), accelerometers (n=4) and GPS (n=3), all studies were unanimous about the benefits of built environments (n=6) or school-based interventions (n=2) on PA levels.

Discussion

This systematic review provides a consensus on the positive effects of (a) school-based interventions which are open to environmental factors, and (b) build environment facilities, on the amount of PA practiced by children and adolescents. However, no studies considered the interaction of these interpersonal and environmental variables. In the future, we encourage interventional studies with would be systemic with the interaction of the ecological variables to promote PA practices across the life course.

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THE BENEFICIAL EFFECT OF 12 WEEKS OF RESISTANCE TRAINING ON MEMORY AND EXECUTIVE COGNITIVE FUNCTION OF MILD COGNITIVELY IMPAIRED OLDER ADULTS

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INTRODUCTION: Promotion of healthy ageing is one of the major challenges for health care systems in current times. Mild Cognitive Impairment (MCI) prevalence increases with age with a risk to turn into dementia. Older adults with MCI are at a higher risk of developing impaired balance behavior because of impaired executive function integrity. Exercise training is likely to improve cognitive measures and balance [Wu J. et al, 2021]. Nevertheless, studies on the effects of physical exercise in older adults with MCI are still insufficient and vary in efficacy, exercise protocols, compliance, and interpretation of the results. This study we investigated the effects of therapeutic structured lower limb resistance training (RT) intended to improve memory, executive function, and posture in adults with MCI.

METHODS: We assessed the effect of 12 weeks resistance training to cognitive function in older adults (age: 60–80 years (completed the intervention n=53))) with intact memory (n=35) and MCI (n=18). Participants either underwent two times weekly RT program which consisted of 4 lower limbs resistant exercises performed for 3 sets of 6–10 repetitions at 70–85% of 1 repetition maximum or served as the passive control group. Posturography, Purdue Pegboard Test (PPT), ANAM test battery and Montreal Cognitive Assessment (MoCA) were collected before and after the intervention.

RESULTS: At Week 12, the MCI subjects in RT intervention group achieved significantly improved MoCA scores executive functions (before 3.96 ± 1.04 after 4.36 ± 0.95), and delayed recall (before 3.46 ± 1.37 after 4.25 ± 1.01) ($p \leq .005$). Participants in the control group also showed an increase in total MoCA score, but improvement was observed only in delayed recall ($p < .005$). Moreover, MCI subjects in the experimental group exhibited significant increases in the balance task (Sway velocity (mm\s) before 23.34 ± 8.95 versus after 19.97 ± 8.21), indicating that limb exercise training positively influenced their balance ($p < 0.05$). Performance on the ANAM test battery and PTT were not statistically different before and after the RT training intervention.

CONCLUSION: The results conclude that twelve weeks of twice-weekly lower limb resistance training intervention can effectively improve executive function and memory in elderly with MCI. Since effective balance control requires attention, we propose that improved executive function may lead to better balance control in MCI.

Tailored interventions might target physical performance to maintain cognitive state and to prevent dementia. Larger studies are required to examine the effects of exercise and the possible moderators.

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PREVENTING PHYSICAL PERFORMANCES DURING ISOLATION PERIODS IN COMMUNITY-DWELLING OLDER ADULTS: ONLY ONE ONLINE REMOTE PHYSICAL ACTIVITY INTERVENTION MODE AS SOLUTION?

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INTRODUCTION: Periods of involuntary isolation (such as lockdown; heat or cold waves) increase the risk of physical inactivity, which can contribute to physical decline among older adults. Online technology could be an innovative solution to promote physical activity habits in this context. However, the effects of these adapted remote web-based interventions (live or video or combined) remain unclear in older adults. Thus, we aimed: 1) to examine the acceptability, feasibility and

potential benefits of 2 modalities of web-based PA interventions (study-1); 2) to explore which recorded-live sessions ratio leads to the best implementation and benefits (study-2).

METHODS: Non-physically active community-dwelling older adults (>60yrs) were recruited during the 2 first covid-19 lock-downs and randomized by block period to a 12-week web-based PA intervention [study-1: Live Group (LG; n=38) vs. Recorded Group (RG; n=45) /study-2: Live-Recorded-Live group (LRL; n=22) vs. Recorded-Live-Recorded group (RLR; n=24)]. Acceptability, feasibility as well as physical performance [muscle endurance (30sec STS); muscle power (10 STS); SPPB] quality of life (EQ-5D) and PA level/motivation were assessed pre- and post-intervention.

RESULTS: 1st study: Fewer dropouts in LG than RG (LG:16% vs. RG:46%) were found. Adherence rate (LG:89%; RG:81%), level of satisfaction (LG:77%; RG:64%) and enjoyment (LG:68%; RG:62%) were similar across groups. Physical performance and quality of life improved significantly in both groups. Only LG showed significant improvements in perceived health and PA levels. Finally, LG showed greater physical performance and quality of life improvements than RG.

2d study: Dropout rate (LRL:14% vs. RLR: 29%) and adherence (>85%) were similar between groups. Both groups reported similar levels of satisfaction (>70%), enjoyment (>75%) and perceived exertion (>60%). Both groups increased physical performances with greater improvements in muscle power (p=0.010) and endurance (p<0.001) in the LRL group.

CONCLUSION: Web-based PA interventions using a decisional tree to prescribed adapted levels are safe, feasible, acceptable and beneficial for improving physical performance during isolation periods. However, PA programs which included full or more interactive web and live sessions (LLL or LRL) appear to be more effective for maintaining or improving physical health. Further research is needed as well as longitudinal follow-up (in process).

"HEALTHY ACTIVE LEARNING": 1-YEAR FOLLOW-UP EVALUATION TO INFORM LOCAL CO-DESIGN OF A NATIONAL CROSS-GOVERNMENT PHYSICAL ACTIVITY INITIATIVE

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INTRODUCTION: Healthy Active Learning (HAL) is part of the New Zealand governments Wellbeing Budget, with $47m (€28m) provided to Sport NZ, Ministry of Health and Ministry of Education to undertake a 5-year initiative in 800 schools (children aged 5-13 years) in NZ to improve the wellbeing of students through healthy eating and drinking and quality physical activity. Prior to implementing HAL, little was known about existing opportunities and teacher capability to deliver physical education (HPE) in these schools. There was also limited understanding of how physical activity was valued and prioritised by schools and teachers.

METHODS: We analysed the 1-year follow-up results from a longitudinal quasi-experimental evaluation. This included a school leader/teacher survey about physical activity opportunities and the delivery of HPE. Pre-post descriptive data were calculated for 'intervention' schools (n=528 teachers) in addition to a comparative analysis with 'control' schools (n=502 teachers).

RESULTS: Experienced teachers demonstrated better teaching practices than inexperienced teachers across all schools. At follow-up, 88% of respondents from intervention schools agreed that physical activity is a key part of student wellbeing. There was a higher proportion of intervention schools with visibility of physical activity in their school charters/plans (55% vs. 39%) and that rated HPE as a high priority (21% vs. 10%). Teachers in intervention schools were more likely to run their own HPE lessons (35% vs. 28%), plan HPE lessons to meet student needs (47% vs. 38%) and assess student progress in HPE (46% vs. 39%). Intervention schools also reported improved physical activity opportunities, with 78% of teachers agreeing their school provides physical activity experiences that meet the needs of all students. The changes from baseline in all of the outcomes listed above was statistically significant in the intervention schools (p<0.05).

CONCLUSION: These results highlight the short-term difference the HAL approach can have on the school environment and teaching practices. System-wide change takes time and embedding these early changes within the whole-school is key to improving the physical activity experience and participation levels of students. There is also a clear indication of the value of improved teacher training in HPE planning and delivery.

Oral presentations

OP-MH28 Health and fitness (mixed)

HIGH INTENSITY INTERVAL TRAINING ENHANCES CARDIOPULMONARY FITNESS IN PREGNANT WOMEN WITHOUT ADVERSE EFFECTS ON THE LEVELS OF PLACENTAL GROWTH FACTOR (PLGF)

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INTRODUCTION: High intensity interval training (HIIT) has become one of the most popular fitness trends, improving health and fitness outcomes in general, special or clinical populations. However there is limited data on the effects of HIIT im-

plemented during pregnancy (1). There are still unjustified opinions that intense maternal physical effort can negatively affect the development of the foetus.

First, we aimed at answering how HIIT programme will affect cardiopulmonary parameters in pregnant women; secondly, will the levels of placental growth factor (PlGF), which has key pro-angiogenic impact on the foeto-placental circulation (2), remain normal after HIIT intervention?

METHODS: It was an experimental trial (3) in 39 Caucasian women in uncomplicated, singleton pregnancy (age 32 ± 4 years, week of gestation 24 ± 3, mean ± SD). 21 women attended an 8-week supervised, online high intensity interval training programme (HIIT group). There were 18 pregnant women in the comparative (EDU) group who completed an educational programme. We encouraged them to perform moderate to vigorous physical activity by their own. Before and after the interventions we measured maternal cardiopulmonary parameters during a progressive maximal exercise test on a cycloergometer with respiratory gas analyser. On the days of the exercise tests we assessed the levels of PlGF from the blood samples in fasting conditions. Both groups presented similar values of analysed parameters at baseline.

RESULTS: In the HIIT group compared to the EDU group we observed substantially higher post-intervention values of maximal oxygen consumption (VO2max; 25.14 ± 4.48 vs. 19.67 ± 3.36 mL/kg/min; $p < 0.001$), maximal minute ventilation (VEmax; 66.48 ± 9.96 vs. 54.33 ± 13.87 L/min; $p < 0.001$) and maximal heart rate (HRmax; 167 ± 9 vs 155 ± 16 beats/min; $p = 0.005$). In both groups, the levels of PlGF significantly increased, achieving normal ranges for particular stage of gestation (HIIT: pre intervention 296.87 ± 157.27 and post intervention 585.29 ± 391.11 pg/mL, $p = 0.002$; EDU: pre 348.88 ± 208.29, post 473.12 ± 299.07 pg/mL; $p = 0.02$); insignificant difference between groups: $F = 2.98$; $p = 0.09$). We have not observed any adverse obstetric and neonatal outcomes in either group.

CONCLUSION: Both supervised HIIT and self-performed moderate to vigorous physical activity can be recommended during pregnancy to prevent disorders in the production of PlGF. However, to improve maternal cardiopulmonary fitness pregnant individuals should perform high intensity exercise.

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ACUTE EFFECT OF PSYCH UP ON MUSCULAR PERFORMANCE

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INTRODUCTION: Muscular performance depends on components of fitness such as maximal force, muscular power, rate of force development, and muscular endurance [1]. These fitness components rely on several biological and psychological attributes, such as the muscle fiber type composition and self-efficacy. In addition, several psychological techniques have been recently promoted for acute improvement of sport performance, with psyching up being one of the most popular, yet the physiological mechanism for performance improvement remains unknown [2]. Aim of this study was to examine the acute psyching-up influence on maximum force production, rate of force development, jumping performance and muscular endurance. It was hypothesized that individuals with higher percentage of type II fibers in their quadriceps muscles would be benefited more in explosive movements from psyching up, while individuals with higher percentage of type I fibers in their quadriceps muscles would be benefited more from psyching up in tests demanding muscular endurance.

METHODS: Twelve young moderately trained men (height 177±5cm, body mass 74±9kg), with no strength training and mental preparation experience, underwent a non-psych up and a psych-up trials, with a week interval between them. Tests included: maximal isometric leg press for measurement of the rate of force development (RFD) and maximal isometric force (MIF), counter movement jump for jump height (CMJh) and power (CMJp), and 45o incline leg press to evaluate the maximum number of repetitions with a load 50% of the MIF (LPRM). Self-talk, goal setting and self-efficacy techniques, were applied in the psych-up trial, 30 minutes before the second session of performance tests. Muscle fiber type composition and fiber cross sectional area (fCSA) of vastus lateralis estimated through muscle biopsies.

RESULTS: MIF ($p<0.025$), CMJh ($p<0.001$), CMJp ($p<0.001$), LPRM ($p<0.003$) and exercise volume (LPv, load x repetitions) ($p<0.001$) after psyching up were significantly higher by 9.73%, 9.25%, 4.30%, 54.35% and 66.65%, respectively, than baseline. RFD did not change after the psych up intervention. A significant positive correlation appeared between the percentage of type I muscle fibers and the percentage change in LPRM ($r=0.62$, $p<0.05$) and LPv ($r=0.69$, $p<0.05$). Low and non-significant correlations were found between the percentage of type II muscle fibers and the percentage change in all performance indices.

CONCLUSION: Self-talk, goal-setting and self-efficacy techniques, can acutely improve maximal strength, muscle power and muscular endurance. Individuals with higher type I muscle fibers in their protagonist muscles may be benefited more by these techniques during muscular endurance demanding tasks. The acute performance improvement in explosive tasks by these psych up techniques is not influenced by the fiber type composition, in moderately trained men.

1.Suchomel et al. (2018) 2. Tod et al. (2015)

CLOSING THE GAP: IDENTIFYING SEX-SPECIFIC MITOCHONDRIAL RESPONSES TO HIGH-INTENSITY INTERVAL TRAINING (HIIT) IN HUMAN SKELETAL MUSCLE

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INTRODUCTION: Mitochondria are energy generating "powerhouses" that help regulate various cellular processes. Impairments in mitochondrial function are heavily associated with type 2 diabetes (T2D), a disease characterised by impaired energy metabolism that affects nearly 500 million people worldwide. Although men are more likely to receive a diagnosis of T2D, the varying pathological presentation and societal pressures has led to worse clinical outcomes for women with T2D (1). Exercise has arisen as a powerful non-pharmacological treatment for T2D through its ability to improve mitochondrial function in skeletal muscle. However, providing an adequate training prescription for women remains a challenge due to most exercise studies recruiting only men. To address this gap, the aim of our study was to identify sex-specific changes to mitochondrial function in response to exercise.

METHODS: High-resolution mitochondrial respirometry was performed on skeletal muscle biopsies taken from 18 healthy untrained young men (26.9 ± 6.3 y; 179.9 ± 10.4 cm; 82.3 ± 12.4 kg) and 13 healthy untrained women (28.0 ± 5.8 y; 167.5 ± 7.4 cm; 68.7 ± 11.0 kg) prior to and following 8-weeks of HIIT (values indicated as mean ± SD). The HIIT consisted of four sessions per a week of 4 x 4 min with 2 min of rest between each interval. The intensity of each interval was set at WLT + x (Wpeak – WLT), with x increasing from 45% in week one (x=0.45) to 75% in week eight (x=0.75), with WLT representing power at the lactate threshold and Wpeak representing peak power.

RESULTS: Skeletal muscle mitochondrial ADP sensitivity was unchanged after HIIT in both men and women, however, when both sexes were examined as a single cohort a decrease in ADP sensitivity, and therefore increase in substrate utilisation, was detected ($p=0.008$). All measures of mitochondrial respiration (Complex I peak, Complex I+II peak, and Complex I+II capacity) were increased after 8-weeks of HIIT in both men and women ($p<0.05$), but no difference ($p>0.05$) was observed between sexes. This contrasted to VO2max values, with men improving significantly more ($p=0.013$) compared to women with an average increase of 22.4% and 16.6% respectively after 8-weeks of HIIT.

CONCLUSION: Our sample size was likely inadequate to detect differences in mitochondria ADP sentivity following 8-weeks of HIIT within and between men and women. In spite of this, our study does indicate ADP kinetics in healthy populations may be improved by exercise. Due to no differences observed between the sexes, our results indicate HIIT is equally as effective at improving mitochondrial respiratory function in healthy men and women. The further validation of these findings in T2D populations will enhance clinical exercise prescription and improve outcomes for patients with mitochondrial dysfunction.

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SPORT-SPECIFIC TRAINING DOES NOT ENHANCE IMPROVEMENT IN NEUROMUSCULAR PERFORMANCE IN RELATION TO GROWTH

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INTRODUCTION: Periods of natural improvement in neuromuscular performance have been reported around the age at peak height velocity (APHV) in young athletes. However, there is a lack of evidence that specific training stimuli may further enhance improvement rates. In this study we examined the developmental pattern of neuromuscular performance in relation to maturity status in three sports. We tested the hypothesis that training effects may increase the adaptation in neuromuscular performance beyond the degree, which is attributed to growth and maturity.

METHODS: Data from 716 athletes were analysed (from 11 to 16 years) from three sports (soccer, handball, basketball). The athletes performed countermovement jump on a force platform (HUR labs), including in the analysis also the mechanical properties of the jump (force, power) and the modified reactive strength index. Maturity was estimated by calculating APHV. According to the years from PHV we divided the athletes to groups of one year interval. Descriptive statistics and two-way ANOVA (maturity status x sport) was used for inter-group comparisons.

RESULTS: From the least (-2 years from PHV) to the more mature group (+2 years from PHV) in the entire sample, vertical jump performance increased from 26.9±3.4 to 36.4±3.9 cm (+35.3%). The largest increase (>60%) occurred ±1 year around APHV. Further, maximal relative power increased by 22% (from 39.2±4.7 to 47.9±4.5 w/kg) with the two-third of this increase taken place again around (1 year) APHV. Regarding sport group comparisons, significant differences were found, with basketball players exhibiting lower values, particularly one and two years after APHV. Similarly, after APHV the initial differences in relative power diminished and there was not any difference between the three groups.

CONCLUSION: Findings support the hypothesis that a period of accelerated adaptation in neuromuscular performance exists ±1 year from APHV. We expected that basketball players will demonstrate larger improvement compared to soccer and handball players as a result of their training, particularly in the period within and after APHV. However, the results did not confirm our assumption since we could not provide evidence that specific training may enhance improvement rates in

neuromuscular performance beyond to the improvement attributed to growth. The results are limited by the nature of the examined sports, which show several similarities in their everyday training. Data from more different sports and from non-athletes could give a better understanding of this phenomenon.

RELATIONSHIP BETWEEN MODERATE-TO-VIGOROUS, LIGHT INTENSITY PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOR IN A PROSPECTIVE COHORT OF OLDER FRENCH ADULTS: A 18-YEAR FOLLOW-UP OF MORTALITY AND CARDIOVASCULAR

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INTRODUCTION: It is well documented that moderate-to-vigorous intensity physical activity (MVPA) is effective in the prevention of major chronic diseases. Even though the current international physical activity (PA) guidelines still mainly focus on MVPA, the topic of the most recent epidemiological studies has shifted from MVPA to light intensity physical activity (LPA), owing to the necessity of promoting all activities vs. sedentary behavior (SB). However, the evidence remains currently limited. Thus, the clarification of the effects of LPA and the close relationship with SB is crucial to promote public health.

Aim: To investigate the associations of assessed MVPA, LPA and SB with all-cause mortality, mortality from cardiovascular disease (CVD) and cardiovascular (CV) events in an elderly French population-based cohort with 18 years of follow-up.

METHODS: PA and SB were assessed by a validated self-administered questionnaire (POPAQ) investigating 5 different types of PA during the 7 previous days. PA was measured in metabolic equivalent of task (MET)-h, which refers to the amount of energy (calories) expended per hour of PA. SB was measured in hour/day. Medical histories and examinations were taken during each clinical visit to determine clinical events. All-cause mortality was established using the same procedure and by checking local death registries.

The relationships between the intensity of PA (light, moderate to vigorous) and mortality and between the periods of SB and mortality or CV events were analyzed by splines and COX models, adjusted for sex and year of birth.

RESULTS: From the 1011 65-year-old subjects initially included in 2001 (60% women), the last 18-year follow-up has been currently completed since 2019. A total of 197 deaths (19.2%, including 77 CV deaths) and 195 CV events (19.3%) were reported. Averages (standard deviation) of MVPA, LPA and SB were respectively 1.2 h/d (0.3), 5.8 h/d (1.1) and 6.6 h/d (2.3). For all-cause deaths, as well as CV deaths, the splines were significant for LPA ($p=0.04$ and $p=0.01$), and MVPA ($p<0.001$ and $p<0.001$), but not for SB ($p=0.24$ and $p=0.90$). There was a significant reduction in CV events when SB was decreasing from 10.9 to 3.3 h/d.

CONCLUSION: The PROOF cohort study shows a clear dose-response between the dose of LPA, MVPA, SB and risk of mortality. These findings provide additional evidence to support the inclusion of LPA in future PA guidelines.

Oral presentations

OP-MH29 Sports medicine and orthopedics

CREATINE KINASE LEVELS IN PLASMA CAN PREDICT MUSCLE TISSUE DAMAGE FOLLOWING ELECTRICAL MUSCLE STIMULATION

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INTRODUCTION: The musculoskeletal system can withstand large loads, however excessive sudden loading and lengthening of the muscle often results in muscle strain injury, the most common muscle injury type (Baker BA, J Sport Rehabil, 2017). Following a muscle injury there will be period of loss of strength and an increase in plasma creatine kinase (CK) (Paulsen et al., Exerc Immunol Rev, 2012), both of which are often used as indirect markers of damage. To directly assess damage, a tissue sample is needed, where post injury muscle biopsies reveal direct markers of damage and the following regeneration. However, it is currently unclear whether there is a correlation between the indirect markers and the direct markers of muscle damage, therefor also if indirect markers of muscle injury can predict the degree of injury.

In this study we examined if the direct and indirect markers of muscle damage are correlated, which would potentially ease the accessibility of evaluating the presence and degree of muscle damage.

METHODS: 40 males aged 18-50 were included in this 8-day study, where repeated electrical stimulated eccentric contractions (EMS) were used to induce a muscle injury in the vastus lateralis muscle. Participants were randomized to EMS in either the dominant or non-dominant leg. Isometric muscle strength and plasma CK were measured prior to EMS as well 2, 4 and 8 days following the injury. Muscle biopsies were taken prior to EMS in the non-stimulated leg and after injury in the stimulated leg as well as 4 and 8 days after injury. The biopsies were analysed for myogenin positive cells and dystrophin negative fibres.

A Spearman Rank's Correlation analyses were done between indirect markers (strength and plasma CK) measured 4 days post EMS and direct markers of muscle damage (dystrophin) and muscle regeneration (myogenin) measured 8 days post EMS.

RESULTS: Following one single bout of EMS the highest drop in strength was a 14 (± 3) % drop in strength seen at day 4. Similarly, the CK peaked 4 days after EMS, with a 122 (± 21 SEM) fold increase in plasma CK and a mean value of 17475 (± 2697 SEM) U/l, ranging from 1070 U/l - 72300 U/l. The direct markers of muscle damage and regeneration peaked 8 days after EMS with 17 (± 3 SEM) % dystrophin negative fibres and 0.18 (± 0.04 SEM) myogenin positive cells/fibre. We found no correlation between loss of strength and neither dystrophin negative fibres nor myogenin positive cells. However, plasma CK at day 4 correlated with both dystrophin negative fibres (P=0.0004) and myogenin positive cells/fibre at day 8 (P=0.0006).

CONCLUSION: To our surprise, plasma CK level measured 4 days after an injury can in this setting predict presence and degree of muscle tissue damage as assessed in a muscle biopsy. This might be due to the high mean level as well as high range of plasma CK found using this EMS protocol.

CHANGES IN TREADMILL AND OVERGROUND RUNNING BIOMECHANICS WHILE LISTENING TO IN-EAR MUSIC: A PILOT, GENDER-BASED STUDY

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INTRODUCTION: Listening to music while running has been proven to have several physiological benefits, including increased endurance and lactate clearance, but also a negative effect, i.e., increased impact forces while running with moderate-to-loud in-ear music, which represent a potential risk factor for injury.

Aim of this study was to test if music listening at moderate-to-high volume may alter running biomechanics.

METHODS: Thirty-six fit, normal hearing volunteers (F:M=18:18; 23±2 years old) performed 400-meter running stints over 2 conditions (no-music; 85-dB music), at 2 velocities (8 and 10 km/h) and 2 settings (indoor, treadmill; outdoor, athletics track).

A wearable system including two magneto-inertial units attached on the feet and connected to 16-elements pressure insoles was employed to estimate the main spatial-temporal parameters of running.

RESULTS: Regarding the trials on the treadmill, compared to no-music, listening to 85-dB music resulted for both sexes in decreased stride duration at 8 km/h (-3.8%, p<0.0001) and 10 km/h (-3.2%; p<0.0001), decreased stance duration at 8 km/h (-9.4%, p<0.0001) and 10 km/h (-9.1%, p<0.0001), and increased stride rate at 8 km/h (+3.7%; p=0.001). Vertical displacement of the center of mass increased only in women at 10 km/h (+8.6%, p=0.041).

Regarding outdoor trials, compared to no-music, music listening resulted, only for women, in increased vertical displacement of the center of mass at 8 km/h (+7.4%, p=0.005). No significant changes were detected in the other spatial-temporal parameters.

CONCLUSION: Listening to moderate-to-loud in-ear music led to significant biomechanical variations in both sexes when running on the treadmill, with shorter and less frequent strides. Conversely, overground running biomechanics was only marginally influenced, and only in women.

Further analyses are needed to unveil the major determinants of the observed biomechanical pattern alteration when running on a treadmill. In particular, looking into the timing of the subcomponents of the stance phase (initial contact, loading response, mid-stance, push) and the related ground reaction forces would allow to infer on differences in running biomechanics related to the setting as well as to gender.

IMPLEMENTING THE CONCUSSION AWARENESS TRAINING TOOL FOR HIGH PERFORMANCE ATHLETES

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INTRODUCTION: Education is an essential component of sport-concussion protocols to improve management and avoid negative consequences associated with participants continuing to play through concussion symptoms. Tailored messaging is an effective way to help change the beliefs of those involved in concussion management. Partnering within government and provincial and national stakeholders, the Concussion Awareness Training Tool (https://cattonline.com/) was developed, which contain a series of evidence-based online educational modules and resources for various audiences including sport, health care, violence, and workplace related concussions. In 2019, partnering with U SPORTS (Canadian university sports-governing body), a new concussion education module with tailored messaging specific to high performance athletes (CATT-A) was created. The aim of this study was to evaluate the implementation of CATT-A among U SPORTS universities in Canada.

METHODS: University administrators and athletic therapists/physiotherapists at all 56 U SPORTS affiliated institutions were provided a link to the CATT-A to share with their athletes including a post-course assessment. A convenience sample of athletes assessed the course on 6 domains using a 5-point Likert scale (i.e. overall assessment, learned something new,

usefulness, engagement, recommendation for other athletes, and likelihood of returning). Certificate completions and requests for mandatory tracking throughout the evaluation period was observed.

RESULTS: A total of 24/56 (42.9%) universities contacted, participated, mandated or shared the tool during the 2020-2021 season. Approximately 1292/5555 athletes who were provided the link to the module, completed the course. In total, 347 athletes completed all the questions in the post course assessment (39.2% male, 59.7% females, 1.2% undisclosed; median (range) age: 19 (17-33)). The majority of athletes rated the course as good or excellent (296/347, 85.30%). In total, 283/347 (81.56%) athletes felt they learned something new, 305/347 (87.90%) felt the course was useful, 226/347 (65.13%) agreed the course was engaging, 258/347 (74.35%) agreed they would recommend the course to other varsity athletes, and 211/347 (60.81%) planned on returning to access content if needed. To date, 21 Canadian U SPORTS universities have implemented the institution email certificate tracking system and there have been over 10,562 certificate completions from 47/56 (84%; median (range): 153 (1-898)) universities.

CONCLUSION: Implementation of the CATT-A in Canadian university high performance athletes was very successful, despite the challenges associated with COVID-19. The CATT-A provides freely accessible, engaging and informative concussion information customized for high performance athletes, with the functionality to track certificate completions as part of a concussion protocol. The tool will be promoted nationally and internationally.

THE POWERLIFTING COMMUNITY'S KNOWLEDGE AND UNDERSTANDING OF THE TRIAD

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INTRODUCTION: The Female Athlete Triad (Triad) is characterized by three interrelated components: low energy availability (LEA), menstrual cycle (MC) dysfunction, and low bone mineral density (BMD). Clinical manifestations include eating disorders, amenorrhea (loss of MC), and osteopenia. In the literature, the underrepresentation of female athletes has become a concerning issue along with the limited focus on ethnicity, diversity, and inclusion in sport science research (Langan-Evans et al. 2021). Female athletes in weight-restricted sports, i.e., Powerlifting, are underrepresented and recent research suggests that many coaches of female athletes have little awareness of the Triad, specifically because of misconceptions surrounding symptoms (Mukherjee et al. 2016). Therefore, the large project research goals were to identify these literature gaps while focusing on the community of female powerlifters and their coaches.

METHODS: This studys purpose was to determine knowledge of the Triad in the powerlifting coach community through a Qualtrics survey accessible on desktop and or mobile devices through a bar code or URL code found on a poster. Posters were available at major competitions in Canada, Europe and South Africa. The Female-Athlete Triad prep participation evaluation survey (Panteo 2006) was employed in this cross-sectional design and eligible individuals had coached a least one female powerlifter between the age of 18-39 years.

RESULTS: A total of 48 coaches accessed the survey, 37 consented, and 19 (50%) complete all 31 questions. Most (90%) survey respondents were male (65%), under 32 (90%) years of age, had coached for a minimum of 2 years (range 1 to 5 plus years), and the majority coached female athletes 51%-75% of the time. Forty-three percent (17/22) stated they had heard of the triad and 85% (18/20) were able to correctly name all components. Most coaches had noticed disordered eating (14/20) , 57% (11/19) stated that they used prevention strategies for the triad, and yet coaches were unsure of the suggested intake of calcium for females. Confusion over terms associated with bone mineral density and menstrual dysfunction may have resulted in a number of no responses and may have contributed to some coaches misperceptions related to low body fat, leanness, menstrual irregularity, and bone health in female athletes.

CONCLUSION: In summary, there were no significant differences between gender and the ability of the coach to correctly name the 3 triad components, or correlation between coach gender, age, number of years of coaching, and coach knowledge of the triad components, respectively. Surprisingly these results agree with the 2016 study by Mukherjee and 2006 by Panteo and therefore misperceptions and knowledge gaps still persist in the coaching community, specifically powerlifting. More communication with the powerlifting coaches on nutrition, menstrual history, and bone health is warranted through coaching associations or organizations accessed by coaches.

INVESTIGATING THE EFFECTS OF REPETITIVE SOCCER HEADING ON COGNITIVE AND SENSORIMOTOR PERFORMANCES IN FEMALE SOCCER PLAYERS – A PROSPECTIVE APPROACH

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INTRODUCTION: Soccer is unique in that players deliberately expose themselves to repetitive head impacts by heading the ball. Although females have been identified as being particularly vulnerable towards these types of head impacts [1], previous studies have mainly focused on male populations and, moreover, employed retrospective research designs. Therefore, our aim was to prospectively investigate the potentially adverse effects of heading on cognitive and sensorimotor performance in female soccer players.

METHODS: A total of 27 female soccer players (22.2 ± 4.2 years) and 15 female athletes participating in non-contact sports (23.2 ± 3.0) took part in the study. We used an extensive test battery to assess subjects' cognitive and sensorimotor skills at baseline as well as one and a half soccer seasons (39 matches) after the beginning of the study. Moreover, soccer players took part in an additional assessment after the end of the first soccer season. Throughout the whole period, soccer matches were video-recorded and footage analyzed to obtain players' individual number of headers, which was used

to divide them into high and low exposure groups. ANOVAs were used to assess differences in test performances between groups over time. Further, a potential association between heading exposure and cognitive or sensorimotor performance changes was assessed by means of correlation and multiple linear regression analyses.

RESULTS: While conducted ANOVAs showed no unequivocal evidence for negative consequences of soccer heading, we found statistically significant interaction and main effects pointing towards adverse effects of heading on some aspects of fine motor control ($p < 0.01$), which were, in part, confirmed by correlation and multiple linear regression results. The latter revealed that greater heading exposure was linked to negative changes in fine motor performance as assessed by writing tasks ($p = 0.02$ and $p < 0.01$) as well as negative alterations in postural control ($p < 0.01$). However, most performance changes were not related to the number of performed headers.

CONCLUSION: While our findings must be confirmed in larger-scale studies, they, in contrast to previous reports [2], suggest that a greater number of headers might be associated with sensorimotor performance changes. Moreover, the present results are the first to point towards a cumulative effect of soccer heading on both postural and fine motor control in female soccer players.

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Oral presentations

OP-SH11 Mindfulness

A SYSTEMATIC REVIEW OF SELF-COMPASSION CORRELATES IN COMPETITIVE SPORTS

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Background: Compassion refers to the sensitivity to suffering in self and others with a commitment to try to alleviate and prevent it. It is linked to one's emotions, motives and competencies to be supportive, kind, helpful and understanding. To date, researchers have considered various benefits in athletes by adopting a self-compassionate mind, such as adaptive psychophysiological responses to stress, greater mental well-being, and superior coping under challenging performance scenarios. However, barriers exist when incorporating compassion in competitive sport (e.g. fear of losing personal standards), and there is a lack of synthesis of what influences athletes' self-compassion (SC) and what SC can facilitate athletes in competitive sport. Therefore, we systematically gathered quantitative evidence about correlates of SC for an up-to-date review of SC in competitive sport.

Method: We identified 108 research articles via a systematic search of databases (Web of Science, n = 31; Scopus, n = 38; SPORTDiscus, n = 14; Psychinfo, n = 25). 24 duplicates were removed, whilst a further 39 studies were excluded based on abstract and title screening. The 48 remainings with full-text articles were further assessed for eligibility, of which 30 papers were removed based on the set exclusion criteria (i.e., qualitative research, n = 7; irrelevant population, n = 9; irrelevant context, n = 11, not passing the quality assessment, n = 3). We retained 18 published research for the final review, which involves 14 cross-sectional survey studies, 2 laboratory-based studies, and 3 longitudinal survey studies.

Results: Greater self-esteem (strong correlations), mindfulness (moderate to strong correlations), lower-level sense of inadequate self (strong correlations), fewer concerns over mistakes (moderate to strong correlations), and lower self-criticism (moderate to strong correlations) were key predictors of SC in competitive athletes. Reduced sport-specific stress and internalised shame, mitigated fear of failure, and enhanced self-regulation (all strong correlations) were key outcomes associated with SC in competitive sport. Furthermore, SC manifested indirect effects on decreased grit, enhanced self-regulation, superior goal progress, and more positive affect under various sport situations. It also underpinned the mindfulness-burnout and the mental toughness-menatal health relationships, as well as moderating (mitigating) negative effects of threat appraisal, masculinity, and sport-specific daily stress on various outcomes facilitative to competitive athletes.

Conclusion: SC is associated with a variety of facilitative psycho-behavioural factors in athletes and plays a vital role in competitive sport. Researchers and practitioners would do well to disseminate the benefits of SC to competitive athletes and deliver interventions to promote the use of compassion and overcome its related fears. Future research should establish more evidence on the performance effect.

EVALUATION OF SPORTS-SPECIFIC MINDFUL PROGRAM (SSMP) FOR ELITE ARCHERS

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Introduction

Mindfulness is trainable with a structured program and regular practice for better self-awareness, attentional control, and emotional regulation to improve athletic coping skills under stressful sports competitions [1]. The application of Mindfulness-Based Intervention (MBI) to elite sports performance has recently become very popular in precision sports and has a positive effect on shooting and dart throwing but no consistent findings in archery. This study aimed to evaluate the effectiveness of a newly developed Sports-Specific Mindful Program (SSMP) with eleven mindfulness-based intervention sessions and one sports-specific simulated competition session to enhance archers shooting performance, mindfulness levels, and flow states with decreasing anxiety levels.

Method

A wait-list control design was used in the study. The participants first waited for 12 weeks and received the 12 weeks of the Sports-Specific Mindful Program (SSMP). Informed consent and demographic information were gathered at baseline. Twelve participants from the Hong Kong Elite Archery Team completed shooting performance competitions [2], the computerized Five Facet Mindfulness Questionnaire (FFMQ) [3], the computerized Competition State Anxiety Inventory-2 Questionnaire (CSAI-2) [4], Short Dispositional Flow State (SDFS) [5] at baseline, pre-intervention (12th weeks), and post-intervention (24th weeks). Participants views of the SSMP programs acceptability were measured post-intervention. ANOVAs with repeated measures were used to compare the intervention effects across the time points (baseline, pre-intervention, and post-intervention). Bonferroni test as a post hoc test was used if significant differences were found between the time points.

Result

The repeated measure analysis showed that SSMP had a positive effect on shooting performance ($p<0.001$). Furthermore, there was a significant increase in mindfulness level in the total score of FFMQ ($p=0.016$), and flow state ($p=0.014$). On a ten-point Likert scale, the mean enjoyment of the Sports Specific Mindful Program (SSMP) was 7.9, and the mean mindfulness practice frequency was 3.1 times/week. The athletes' favorite SSMP sessions were the sports-specific simulate competitions, with the highest the average enjoyment of 8.3 in the session.

Conclusion

The positive evaluations suggest that Sports-Specific Mindful Program (SSMP), with the sports-specific simulated competition session, is an acceptable and feasible intervention to enhance shooting performance, mindfulness levels and flow states of archers. Future study is suggested to include more subjects and explore their experience on how they apply mindfulness to enhance their experience in sports performance.

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THE PSYCHOLOGICAL STATE AND MENTAL HEALTH OF ELITE ADOLESCENT ATHLETES: THE MEDIATION EFFECT OF RESILIENCE

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The mental health of adolescent athletes is important for their performance and career growth as they experience both physical and psychological development. Research has shown that stable psychological state helps athletes maintain mental health during stressful situations. The Peace of Mind (PoM) Index is a measure of psychological well-being in Asian cultures. It encompasses a state of low arousal, happiness, harmony, and an overall feeling of peacefulness within oneself. High PoM individuals are characterized by a stable emotional state, which allows them to quickly readjust their psychological condition without experiencing significant fluctuations. Hence, psychological resilience, the ability to maintain psychological stability and return to normal during adverse situations, is believed to play a significant role in the relationship between psychological state and mental health. To clarify the role of the resilience, we hypothesize that PoM will affect the mental health of adolescent elite athletes via resilience. In this study, 31 male adolescent soccer players (mean age: 16.61 ± 0.84 years) were recruited. The psychological state, resilence, and mental health were measured with POM, Resilience Scale for Adults (RSA), and Becks Depression Inventory scale (BDI-II), respectively. Using the bootstrapping method (with 5000 times) of Process 4.2 SPSS macro by Hayes (2022), the findings of the simple mediation analysis indicated that the indirect effect of PoM on BDI-II through RSA was statistically significant and in a negative direction. The bootstrapping result also confirmed the Sobel test, showing that the indirect effect was significant with the 95% confidence interval not including zero [-5.11 - -0.07]. The results emphasize the vital role of resilience in maintaining a stable psycho-

logical state and low levels of depression among elite adolescent athletes. Specifically, elite adolescent athletes with high resilience are found to possess a more stable psychological state and exhibit lower levels of depression. Future research can explore intervention for enhancing psychological resilience, thus improving the mental well-being of adolescent athletes.

EFFECTS OF AN 8-WEEK OF BRIEF MINDFULNESS MEDITATION COMBINED WITH A RUNNING PROGRAM ON MINDFULNESS SKILLS AND WELL-BEING OF TRAINED RUNNERS

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INTRODUCTION

The influences of Mindfulness Meditations (MM) on mindfulness skills in athletes are recent.1,2 Moreover, these studies1,2 proposed long time of MM at a low physical activity intensity level.3 We proposed here to approach new perspectives of reflections on this subject by evaluating the influences of Brief Mindfulness Meditation (BMM) combined with a running program with high intensity on mindfulness skills and well-being in runners.

METHODS

Fifty-five trained athletes were randomized in a control group or a BMM group following the same running training program. The Mindfulness Inventory for Sport (MIS) was assessed at 3 different times: baseline (T0), 4 (T4) and 8 weeks (T8). It includes 3 subscales: (a) awareness; (b) acceptance and (c) refocusing. The Diagnofeel® measured the manifestations and regulations of well-being at T0 and T8. There was 10 subscales: manifestations (4): leisure activities, joy, social relations (SR) ; regulations (6) (AP, isolation, pleasures, taking distance, SR and problem solving). A 2-way repeated measures Analysis of Variance (ANOVA) was conducted for each subscale. A Bonferroni post-hoc test was realized when significant differences were noted.

RESULTS

No time*group interaction is observed on awareness and acceptance. However, according to refocusing, an increase is discerned only for BMM between T0 andT4 ($p = 0.036$), T4 andT8 ($p = 0.027$) and T0 and T8 ($p = 0.002$). Moreover, intergroup comparisons suggest that BMM group had a (better level of refocusing compared to control group only at T8 ($p = 0.016$).

For the well-being, an increase of SR (manifestation) is noted between T0 and T8 for the BMM group only ($p = 0.045$). Pleasure also increased for BMM group between T0 and T8 ($p = 0.042$) which had also a greater level of pleasure compared to control group at T8 ($p = 0.01$).

DISCUSSION

The most powerful results of this new program are on refocusing. When athletes faced with the intensity of physical effort, they were able to refocus their attention on the present moment and stay engage in the intensity of the effort. From the well-being, the increase of SR and pleasure for the BMM group could also be associated with the ability to refocus in the present moment and to restore their well-being. The implementation of a BMM program seems having an impact on the athlete's ability to refocus. These benefits also seem to extend beyond a sporting context.More studies with larger sample sizes could be conducted to confirm these results.

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EFFECTIVENESS OF AN ONLINE ACCEPTANCE AND COMMITMENT THERAPY-BASED PROGRAMME IN REDUCING PERFECTIONISM IN FEMALE SOCCER PLAYERS

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UNIVERSITY OF BOLTON

Introduction

Perfectionism contributes to a range of psychological and emotional difficulties in athletes (e.g., burnout and depressive symptoms). However, there are few studies that have examined approaches to reduce perfectionism and help athletes deal with these negative effects. In the current study, we did so by evaluating the effectiveness of a novel online Acceptance and Commitment Therapy (ACT)-based intervention in adult female soccer players.

Methods

Using a randomized control trial (RCT), eighty-one female soccer players (M age = 24.28 years, SD = 6.77) were randomly allocated to either an intervention group (n = 41) or a waitlist control group (n = 40). The intervention group had access to set of online ACT-based modules for 8-weeks. Participants completed measures of trait perfectionism, perfectionistic cognitions, and pre-competition emotions pre-intervention and post-intervention.

Results

A 2 (group) x 2 (time) ANOVA revealed significant interaction effects for trait perfectionism, perfectionistic cognitions, and pre-competition emotions. Following the intervention, the two groups displayed significant mean differences for trait perfectionism (perfectionistic strivings, personal standards, striving for perfection, self-orientated perfectionism, perfectionistic concerns, concerns over mistakes, negative reactions to imperfections, and socially-prescribed perfectionism), perfectionistic cognitions, and all pre-competition emotions (anxiety, dejection, anger, happiness, and excitement). Largest effects were for negative reactions to imperfections and perfectionistic cognitions. Furthermore, the number of hours spent on the modules and number of modules completed were significantly correlated with observed improvements.

Discussion

The findings suggest that online ACT-based interventions may be an effective and viable way to reduce perfectionism in female soccer players. Therefore, this approach should be considered by sport psychologists, coaches, and organisations to support perfectionistic athletes.

Oral presentations

OP-MH21 Exercise therapy

DOES HEART RATE VARIABILITY MEDIATE THE ASSOCIATION BETWEEN CHRONIC STRESS, CARDIORESPIRATORY FITNESS, AND WORKING MEMORY MAINTENANCE?

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UNIVERSITY OF BASEL

INTRODUCTION: Young adulthood is a demanding developmental stage during which individuals encounter numerous physical and psychosocial stressors (Malter Cohen, Tottenham, & Casey, 2013). High degrees of chronic stress elicit detrimental effects on various physical and mental health outcomes (Malter Cohen et al., 2013). For working memory in particular, the sensitivity to acute stress is well-known, whereas insights into the consequences of prolonged stress exposure are lacking. Empirical evidence supports the assumption that cardiorespiratory fitness has the potential to buffer potential harmful effects of chronic stress on working memory performance (Loprinzi & Frith, 2019). According to the Neurovisceral Integration Theory, shared neurophysiological areas are involved in cardiac autonomic control as well as the modulation of attentional and emotional regulatory processing (Forte, Favieri, & Casagrande, 2019). Therefore, heart rate-variability (HRV) might be a physiological correlate mediating the association between chronic stress, cardiorespiratory fitness, and working memory maintenance.

METHODS: The present study investigates the mediating role of resting heart rate-variability on the association between chronic stress, cardiorespiratory fitness, and working memory maintenance in young healthy adults. Working memory maintenance was assessed in N= 115 healthy adults (48% female) aged 18 to 35 years (M = 24.1, SD = 3.8) using a modified version of the Sternberg task with low (3 items) and high cognitive load (6 items). Additionally, maximal oxygen consumption (VO2max) was estimated using the Åstrand test. Resting HRV was recorded using electrocardiography and the LF/HF ratio was extracted for mediation analyses.

RESULTS: Path analysis revealed a significant association between cardiorespiratory fitness and accuracy on high cognitive load trials, but not on trials with low cognitive load. Levels of perceived chronic stress showed a trend for a positive association with working memory maintenance, independently of cognitive load. The pattern of results remained unchanged after introduction of HRV as a mediator.

CONCLUSION: Results indicate that cardiorespiratory fitness influences working memory maintenance during young adulthood. However, this association cannot be explained by vagal influences on memory processing driven by the autonomic nervous system.

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EFFECT OF A THREE-MONTH PHYSICAL ACTIVITY INTERVENTION ON BALANCE, EXERCISE CAPACITY AND MAXIMAL LOWER LIMB STRENGTH IN PATIENTS WITH LOWER EXTREMITY ARTERY DISEASE – PRELIMINARY RESULTS.

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INTRODUCTION: Lower limb artery disease (LEAD) is characterized by lower limbs arteries atherosclerosis. This can lead to walking pain and exercise intolerance called intermittent claudication (IC). Cardiovascular diseases progression and gravity are associated to lower limb strength and balance impairment. However, these aspects were poorly observed in studies on LEAD with patients presenting IC. Additionally, we showed that the anatomical level of ischemia in lower limbs affects gait parameters (Guilleron et al., 2021). When supervised exercise therapy (SET) is implemented for these patients (most recommended treatment for IC), exercises are non-specific to the level of ischemia. Therefore, this study seeks to compare these parameters in patients presenting IC following either a global or a focalized SET.

METHODS: Pain onset (POWD) and maximal walking distance (MWD; using strandness treadmill testing), unipedal balance (time), one minute sit to stand test (OneSTST) and maximal isometric strength of tibialis anterior (TA), rectus femoralis, triceps surae and gluteus maximus were recorded in 18 patients (67+/- 6 years) presenting IC during initial, intermediate and final evaluations of a three-month SET (three times a week walking and muscular trainings). Patients were randomized into two groups according to muscular training: global or specific to the pain localization (calf, thigh or buttock).

RESULTS: Significant differences were found between initial and final evaluations for POWD (+107%, p=0,002), MWD (+49%, p=0,012), unipedal balance time (+59%, p=0,002), OneSTST (+13%, p=0,023) and force of TA in both groups (+19%, p=0,05). MWD (+64%, p=0,07), OneSTST (+10%, p=0.07) trend to be more improved in groups with localized muscular training.

CONCLUSION: Our results on POWD and MWD are consistent to previous study implemented SET for patients presenting IC (Schieber et al., 2020). We do not find significant effect on lower limb strength except for TA.

Our study reveals the effect of SET for patients presenting IC on balance and OneSTST. We observed improvements for unipedal balance and OneSTST, a marker for overall exercise capacity (Bohannon & Crouch, 2019). These improvements seem to be greater in patients performing localized muscular training.

A three-month SET allows patients to walk longer and longer without pain, combined to better balance and exercise capacity. This should improve their quality of life and reduce risk of falls. In addition, localized muscular training appears to be more efficient than global training, however, we need to include more patients to confirm this trend.

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IMPACT OF TWO TYPES OF PHYSICAL EXERCISE PROGRAMS AND NUTRITIONAL COUNSELLING ON CARDIOVASCULAR RISK IN TYPE 2 DIABETES MELLITUS

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INTRODUCTION: The prevalence of type 2 diabetes mellitus (T2DM) and obesity are increasing rapidly worldwide and increasing the risk of cardiovascular diseases (1). Nutritional education and exercise programs are used to improve cardiovascular health (2). The aim is to study the effect of the type of exercise training and nutritional counselling on cardiovascular risk and the management of T2DM.

METHODS: The study is a controlled clinical trial of 12 weeks of intervention. This is the first batch of 62 adults with T2DM and obesity (37 men; 55.90±7.28 years old) randomized into 6 groups according to the nutritional counselling (Diet vs. NoDiet groups) and the physical exercise program which consisted of high-intensity interval training (HIIT) or moderate-intensity continuous training (MICT) or maintaining their inactive levels (INACT) as controls. Thus, participants were allocated into Diet+HIIT, Diet+MICT, Diet+INACT, NoDiet+HIIT, NoDiet+MICT, and NoDiet+INACT. Weight, body mass index, fat percentage, visceral fat, waist circumference (Wc), blood pressure, glycosylated haemoglobin (GhA1c), cholesterol and triglycerides were measured. Delta was calculated as differences between post and pre intervention. ANOVA test and DMS were applied with statistical significance set at $p<0.05$.

RESULTS: The cardiovascular risk significantly differed after the intervention program in the fat percentage (p=0.008), visceral fat (p=0.002), Wc (p=0.009) and GhA1c (p=0.049). There was a difference in the fat percentage between Diet+MICT and NoDiet+INACT (-2.153±0.779;p=0.008), Diet+MICT and MICT (-1.744±0.779;p=0.029), HIIT and Diet+INACT (2.167±0.934;p=0.024), Diet+INACT and INACT (-2.562±0.779;p=0.002).

Visceral fat was statistical significant in Diet+MICT and NoDiet+INACT (-0.992±0.447;p=0.031), HIIT and Diet+INACT (1.417±0.536;p=0.011), MICT and CONTROL+EDU (1.644±0.447;p=0.001), Diet+INACT and NoDiet+INACT (-1,826±0.448;p=0.000). The Wc difference between Diet+HIIT and NoDiet+INACT (-4.768±2.156;p=0.031), Diet+MICT and

NoDiet+INACT (-4.369±2.059; p=0.038), MICT and Diet+INACT (6,388±2.059;p=0.003), HIIT and NoDiet+INACT (-5.32±2.503; p=0.038). Data showed differences in the GhA1c between Diet+HIIT and MICT (-0.838±0.336;p=0.016), Diet+HIIT and NoDiet+INACT (-0.787±0.319;p=0.017), MICT and Diet+INACT (0.778±0.328;p=0.022), Diet+INACT and NoDiet+INACT (-0.727±0.311;p=0.024).

CONCLUSION: Both interventions of physical exercise and nutritional counselling improve cardiovascular markers of adiposity and GhA1c independent of each group. The nutritional intervention was more effective in the fat percentage and visceral fat decreases, even in the inactive groups. However, it is important that the GhA1c improves in the Diet+HIIT group with respect to other groups.

APETEX (PID2020-120034RA-I00).

CURRENT IMPLEMENTATION AND BARRIERS TO USING BLOOD FLOW RESTRICTION TRAINING: INSIGHTS FROM A SURVEY OF ALLIED HEALTH PRACTITIONERS

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INTRODUCTION: Blood flow restriction (BFR) exercise improves muscular and cardiovascular fitness without high mechanical loads. As BFR training is most useful for individuals who cannot tolerate the mechanical demands of vigorous activity [1], research is needed to determine how this technique is implemented by allied health professionals working with such populations. Therefore, this survey-based study investigated how practitioners use BFR exercise for clinical or older populations, and the barriers preventing the prescription of BFR.

METHODS: An online survey was disseminated globally to allied health practitioners, with data from 397 responders included in analyses. Responders who had prescribed BFR exercise (n=308) completed questions about how they implement this technique. Those who had not prescribed BFR exercise (n=89) provided information on barriers to this technique, and a subset of these responders (n=22) completed a follow-up survey to investigate how these barriers could be alleviated.

RESULTS: Most practitioners prescribe BFR exercise for musculoskeletal rehabilitation (91.6%), with cuff pressure relative to arterial occlusion pressure (81.1%) and implemented with low-intensity resistance (96.8%) or aerobic exercise (42.9%). Most practitioners screen for contraindications (68.2%), though minor side-effects including muscle soreness (65.8%) are common. The main barriers to using BFR are lack of equipment (60.2%), insufficient education (55.7%) and safety concerns (31.8%). These could be partly alleviated by affordable and convenient training on safe applications and benefits of BFR (n=20).

CONCLUSION: Prescription of BFR for clinical and older cohorts mainly conforms with current guidelines [1], which is important considering the potentially increased risk for adverse events in these populations. Despite this, minor side-effects to BFR were reported with greater frequency than in previous surveys [2], likely because of the specific client demographic targeted in this research. To reduce the likelihood of BFR side-effects, practitioners should gradually implement BFR exercise by increasing cuff pressures and exercise volumes over time. Barriers prevent broader utility of BFR training, though some may be alleviated through well-developed BFR educational offerings to train practitioners. Accessible education is needed to train practitioners on safe applications of BFR.

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Oral presentations

OP-PN29 Caffeine

DO CAFFEINE AND MENSTRUAL CYCLE PHASE AFFECT PHYSICAL PERFORMANCE IN A 5-KM CYCLE TIME TRIAL IN WOMEN? PRELIMINARY DATA FROM A PARALLEL, DOUBLE-BLIND, PLACEBO-CONTROLLED CLINICAL TRIAL.

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INTRODUCTION: Studies involving women are scarce, mostly due to the influence of the different menstrual cycle phases on several physical and physiological parameters. Caffeine (CAF) is one of the most studied ergogenic supplements and its effects on exercise performance in different menstrual cycle phases are limited to endurance exercises. The aim of this study is to verify the effect of CAF supplementation on exercise performance of women in different menstrual cycle phases.

METHODS: Inclusion criteria: physically active healthy women aged 18-35 years; normal menstrual cycle for at least 4 months; IMC 18.5-24.99 kg/m2. Exclusion criteria: diabetes mellitus (HbA1 ≥ 6,5%) or other diseases which affect men-

struation; women taking supplements; women using hormonal contraceptive methods; smokers; and women consuming > 30.0g of alcohol/day. Subjects were randomly (randomizer.org) assigned to one of the 2 groups: CAF supplementation (GCAF) or Placebo (GPLA) (allocation ratio 1:1). Laboratory visit 1: health and sociodemographic questionnaire, resting energy expenditure (REE) assessment (indirect calorimetry; K5, COSMED®), body composition assessment (bioelectrical impedance analysis; model 450®, Biodynamics), and cycle ergometer familiarization. Visit 2 (follicular or luteal phase): planned meal + 30-minute interval + CAF or PLA supplementation + 1-hour interval + 5-km cycling time trial. Visit 3: identical to visit 2 for a different menstrual cycle phase (follicular or luteal phase). Data were analyzed using Jamovi® 2.3. version. Repeated measures ANOVA with post-hoc Tukey test were performed. Data are described as mean and SD.

RESULTS: Subject characteristics (n = 12): BMI (kg/m2): GCAF 22.38 (3.53), GPLA 21.99 (1.46); body fat (%): GCAF 29.68 (4.71), GPLA: 25.1 (2.53). The test duration (min) in the follicular phase was 9.97 (1.46) for GPLA and 10.52 (0.85) for GCAF, with no difference between groups (p = 0.184; d = 0.44). Likewise, test duration (min) in the luteal phase was 8.66 (0.48) for GPLA and 9.73 (0.39) GCAF, with no difference between groups (p = 0.201; d = 2.46). Test duration did not differ between menstrual cycle phases in GPLA (p = 0.964) and GCAF (p = 0.635). Exercise-induced energy expenditure (ExEE) did not differ between groups: follicular phase, GCAF 98.13 (4.41) kcal; GPLA 104.7 (10.44) kcal (p = 0.241; d = 0.78); luteal phase, GCAF 102.5 (2.67) kcal; PLA 114.3 (3.32) kcal (p = 0.159; d = 4.06). ExEE did not differ between menstrual cycle phases in GPLA (p = 0.981) or GCAF (p = 0.406). Mean respiratory quotient (RQ) did not differ between groups in the follicular phase: GCAF 1.03 (0.06); GPLA 0.94 (0.03) (p = 0.593; d = 1.8) and in the luteal phase: GCAF 1.01 (0.03); GPLA: 0.92 (0.02) (p = 0.137; d = 2.93). There were no differences in RQ between the cycle phases in GPLA (p = 0.936) and GCAF (p = 0.939).

CONCLUSION: Our preliminary data suggest that caffeine may not be ergogenic in a 5-km cycling time trial, and that the menstrual cycle does not affect physical performance.

EFFECTS OF CAFFEINE ON SALIVA IMMUNOGLOBULIN A IN RESPONSE TO PROLONGED INTERMITTENT EXERCISE IN FEMALE TEAM-SPORT ATHLETES

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INTRODUCTION: Female team-sport athletes, like their male counterparts are often required to train and compete in the evening. Consuming caffeine for potential training and competition advantage later in the day has been shown to impact female athletes' subsequent sleep quality (1). Caffeine has also been shown to modulate a number of immune functions and transiently increase saliva immunoglobulin (Ig) A in male athletes following prolonged exercise (2). Yet to date, little to no work has been conducted on female athletes. As such, the aim of this study was to investigate the effect of caffeine on saliva IgA in response to prolonged intermittent exercise in female team-sport athletes

METHODS: In a double-blind repeated-measures crossover design, ten healthy eumenorrheic female team-sport athletes [mean (SD): 24 (4) years; body mass 59.7 (3.5) kg; VO2peak 50.0 (5.3) mL/kg/min], currently taking a monophasic oral contraceptive (OC) (30 ug Ethinyloestradiol and 150 ug Levonorgestrel) completed two experimental trials during days 5-8 and 18-22 of their OC cycle. Participants reported to the lab at 18:00 h, at which time an unstimulated pre-supplement saliva sample was taken. Participants then ingested 0 (placebo, PLA) or 6 mg/kg BM of caffeine (CAF) taken in the form of gelatin capsules and rested in the lab for 1 h before providing a pre-exercise saliva sample. Participants then began 90 min intermittent running on the treadmill, which consisted of six x 15 min blocks designed to simulate the activity patterns of a football match. Further saliva samples were obtained immediately after and 30 min after exercise cessation. Saliva IgA, alpha-amylase and cortisol were analysed using commercially available kits. Data were examined using a two-way ANOVA with repeated measures design. Any significant data were assessed post-hoc using paired samples t-tests, with Holm-Bonferroni adjustments. Statistical significance was accepted at $P < 0.05$.

RESULTS: There was a significant trial x time interaction ($p<0.05$) for saliva IgA concentration. Caffeine significantly reduced the concentration of saliva IgA compared to placebo 30min post-exercise [CAF: 40.8 (19.5) v PLA: 91.5 (66.6) mg/L, $p<0.05$). Saliva alpha-amylase concentration was elevated above pre-supplement values at 30min post-exercise [time effect $p<0.05$; pre-supplement: 898 (354) v 30min post-ex 1217 (589) U/mL]. Saliva cortisol concentration did not appear to be influenced by caffeine or exercise ($p>0.05$).

CONCLUSION: These findings suggest that caffeine ingestion prior to prolonged intermittent exercise in female team-sport athletes (taking monophasic oral contraceptives) decreases the concentration of saliva IgA 30 min into recovery. Given the drop in one of our front-line defence mechanisms and the published negative impact evening caffeine consumption can have on subsequent sleep quality, more research in this area is needed to better determine the possible illness risk this practice could pose.

1. Ali et al. (2015)

2. Senchina et al. (2014)

PRE-EXERCISE SUPPLEMENTATION OF 5 MG/KG CAFFEINE INCREASES HEAT PRODUCTION AND CORE TEMPERATURE WITHOUT CHANGING EXERCISE TOLERANCE IN THE HEAT: A DOUBLE-BLIND, PLACEBO-CONTROLLED TRIAL

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INTRODUCTION: Endurance exercise in the heat increases thermoregulatory and cardiometabolic strain compared to temperate conditions, thereby reducing exercise tolerance. Whilst caffeine supplementation is often reported to enhance endurance performance, its ergogenic properties are questionable during exercise in the heat, where caffeine may even exacerbate thermal strain. However, the results of studies on this topic are inconclusive and the reasons for potential adverse effects are unclear. It is possible that the control of exercise intensity is partly responsible for this. Therefore, we aimed to evaluate the effects of pre-exercise caffeine (5 mg/kg) on time to exhaustion (TTE) and thermo-physiological responses at an intensity equivalent to the gas exchange threshold (GET) in a hot environment.

METHODS: Following ethical approval, 12 recreationally active males consented to participate in the study. Participants performed fixed-intensity cycling at the GET in a controlled thermal chamber (35°C & 40% relative humidity) until exhaustion, 1-h after supplementing with caffeine (5 mg/kg) or a placebo. Supplements were double-blinded and trials were separated by 72-h. Exercising thermo-physiological measures included: pulmonary gas exchange, core and skin temperatures, whole body sweat rate, heart rate, perceived exertion and thermal sensation. Heat production and evaporative heat transfer were determined using partitional calorimetry. Post-ingestion venous blood was analysed for plasma caffeine concentrations. Two-way analyses of variance were used to determine the effect of condition (caffeine vs. placebo) and time (10% to 100% epochs) on all thermo-physiological responses, while paired t-tests were used to assess condition effects on TTE. Data are reported as mean±SD.

RESULTS: There was no difference in TTE between the conditions ($p = 0.251$; caffeine 28.5 ± 8.3-min vs. placebo 29.9 ± 8.8-min). The caffeine condition had a higher concentration of plasma caffeine relative to placebo ($p < 0.001$). Compared to placebo, there was an increased oxygen uptake ($p = 0.003$; 2,883 ± 219 mL/min vs. 2,678 ± 190 mL/min), heat production ($p = 0.004$; 396 ± 37 W vs. 366 ± 32 W), evaporative heat transfer ($p = 0.006$; 341 ± 73 W vs. 289 ± 42 W), yet lower estimated skin blood flow ($p < 0.001$; 4.5 ± 0.8 L/min vs. 5.1 ± 0.9 L/min), after caffeine ingestion. This resulted in a higher mean core temperature in the caffeine condition ($p = 0.013$; 38.09 ± 0.37°C vs. 37.87 ± 0.34°C).

CONCLUSION: There was no ergogenic effect of caffeine ingestion prior to endurance exercise in the heat, with caffeine increasing heat production and core temperature. Whilst caffeine increased the capacity for evaporative heat transfer, estimated skin blood flow was reduced. These combined results demonstrate that ingestion of caffeine negatively influenced thermoregulation in the heat when exercise was controlled at the GET. These findings question the use of caffeine supplementation for those performing endurance exercise in the heat.

CAFFEINE IMPROVES 30-MIN TIME TRIAL RUNNING PERFORMANCE AFTER ONE NIGHT OF SLEEP DEPRIVATION

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INTRODUCTION: Caffeine is one of the most popular substances used by athletes from a wide variety of sporting disciplines due to its ergogenic effects [1]. The use of caffeine to increase wakefulness has been studied extensively [2]. The purpose of the study was to investigate the effects of caffeine on endurance performance after one night of sleep deprivation.

METHODS: Ten subjects visited our laboratory on three separate occasions: a preliminary visit to determine maximal oxygen consumption (VO2 max) and to familiarise with the protocol, equipment and scales used; and two experimental visits, in a randomised order, a pill containing 6 mg/kg of caffeine or placebo were given to the participants after a night of sleep deprivation. The Alpha Attenuation Test (AAT), the Psychomotor Vigilance Test (PVT), and the Stroop Test (ST) were administered to assess sleepiness, vigilance, and inhibitory control, respectively. Participants run for 30 minutes at a constant workload of 60% VO2 max (CWL) followed by a 30-minute time trial (TT). During the running bouts, cardiopulmonary responses, blood lactate (BLa), ratings of perceived exertion (RPE), and ratings of feelings (FS) were measured.

RESULTS: Compared to placebo, subjective sleepiness was lower in caffeine ($p = 0.011$). No differences were found in AAT ($p = 0.784$). Caffeine enhanced PVT performance (reaction time, $p = 0.001$; number of lapses, $p = 0.008$), and ST performance (incongruent stimuli: reaction time, $p = 0.008$; accuracy, $p = 0.022$). During CWL, RPE was lower in caffeine condition ($p = 0.034$). Caffeine increased minute ventilation (VE, $p = 0.009$) and tidal volume (VT, $p < 0.001$). Caffeine improved TT performance ($p = 0.008$) by 319 m (5.54%). Consequently, running speed was higher in caffeine ($p = 0.008$). At minute 10, RPE was lower in caffeine than in placebo ($p = 0.018$). Physiological parameters were greater in caffeine (heart rate, $p = 0.013$; BLa, $p = 0.005$; VO2, $p = 0.005$; VCO2, $p = 0.012$; VE, $p = 0.002$; VT, $p = 0.002$). No differences were found in FS neither during CWL ($p = 0.073$) nor during TT ($p = 0.112$).

CONCLUSION: Our results are in line with current findings [3] and provide further evidence that, after one night of sleep deprivation, caffeine can improve running performance. An enhancement in cognitive functions, such as vigilance and inhibitory control, followed by a reduction in RPE during exercise, might have allowed participants to sustain a higher speed during TT. As a result of that, increases in physiological parameters, such as heart rate, VO2, VCO2, VT, and BLa were observed. Caffeine supplementation could be an effective measure to counteract the negative effects associated with prolonged periods of wakefulness in both cognitive and running performance.

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THE EFFECT OF CAFFEINE ON GUT CELL DAMAGE FOLLOWING EXERCISE IS INFLUENCED BY ADORA2A GENOTYPE BUT NOT CYP1A2 GENOTYPE.

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INTRODUCTION: Endurance exercise may be associated with acute damage to intestinal epithelial cells (gut cells). The effect of caffeine supplementation, and whether this is influenced by common genetic polymorphisms, is not currently known. Therefore, the aim of this study was to determine the effects of acute caffeine ingestion on a marker of gut cell damage and whether this is influenced by two commonly occurring genetic (single nucleotide) polymorphisms (SNPs).

METHODS: Eighteen recreationally active adults volunteered in this double-blind, randomised crossover study. After an overnight fast, they ingested a capsule containing 3 mg/kg body mass caffeine or placebo 45 min prior to 20 min cycling at 70% maximal oxygen uptake. They rested for 5 min then completed a 15-min cycling performance time-trial. Cognitive function tests (psychomotor vigilance test, PVT) were performed at baseline (before capsule), during the first cycling bout, and 10 min after the time-trial. Venous blood samples were collected at baseline (after the PVT, before capsule), before the 20 min cycle and after the final PVT (~30 min post-time-trial). Results for physiological responses, time-trial performance and PVT performance have been published previously (Carswell et al., 2020, Eur J Appl Physiol, 120(7):1495-1508). Plasma intestinal fatty acid binding protein (iFABP), as a marker of 'gut cell' damage, was determined by ELISA (Bio-Techne, USA). Genomic DNA was extracted from whole blood samples and SNPs in ADORA2A (rs5751876) and CYP1A2 (rs762551) genes determined with rhAmp assays (Integrated DNA Tech, USA). Participants were categorised by ADORA2A gene as high sensitivity (TT homozygous) or low sensitivity (C allele carriers: CT heterozygous or CC homozygous); and by CYP1A2 gene as fast metabolisers (AA homozygous) or slow metabolisers (C allele carriers: AC or CC).

RESULTS: For iFABP, three-way mixed ANOVAs (repeated for treatment [i.e. caffeine vs placebo] and time, between for genotype) revealed significant main effects of treatment, time, and treatment × time interaction ($P < 0.05$), showing an influence of caffeine. Post hoc paired t-tests (Bonferroni corrected) revealed a significant mean increase (~85%, $P = 0.009$) following the time-trial. There was a trial x ADORA2A genotype interaction ($P = 0.021$), showing that the overall effect of trial was influenced by this genotype. However, there were no other significant main effects, 2-way or 3-way interactions (all $P > 0.05$) for either genotype. Further post hoc analysis revealed a significant post-time-trial increase in the ADORA2A TT group only (~109% increase $P = 0.020$, vs ~48% increase $P > 0.05$ in CT/CC) suggesting the mean increase seen with caffeine vs placebo was largely driven by 'high sensitivity' participants.

CONCLUSION: Acute damage to gut cells caused by endurance exercise may be exacerbated by caffeine, especially in sensitive individuals. The potential implications of this to gut/gastrointestinal responses to exercise requires further examination.

Oral presentations

OP-SH21 Motivation

STUDENTS' NEEDS FRUSTRATION IN PHYSICAL EDUCATION CLASS AS PREDICTOR OF THEIR INTENTION TO BE PHYSICALLY ACTIVE

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UNIVERSIDAD PONTIFICIA COMILLAS

Introduction

Physical education (PE) setting has been pointed out as an ideal context to promote healthy lifestyles and adherence to physical activity. Under the lens of self-determination theory, recent studies have evidenced the effect that teachers and students' interactions might have on their behaviours through the satisfaction or frustration of the basic psychological needs (Aelterman et al., 2019). The needs of autonomy, competence, and relatedness can be frustrated when the teacher exercise power as an authority, ignore students' interests, or pressure them to perform the activities (Vansteenkiste et al., 2020), which could decrease students' intentions to be physically active in other contexts (Aibar et al., 2021). The objectives of the present study were to analyse the influence of BPN students' frustration on their intentions to be physically active.

Methods

The sample consisted of 294 Spanish PE students (164 male and 130 female) aged between 10 and 18 years old (M= 12.88; SD = 1.61). A validated questionnaire was administered, and a stepwise regression was performed.

Results

The analysis revealed that students' perceptions of both autonomy and competence frustration were inversely associated with their intention to be physically active (tautonomy = -3.06, $p < .01$; tcompetence = -2.54, $p < .05$). Relatedness frustration did not emerge as predictor of intention to be physically active ($t = .11$, $p > .05$).

Discussion

The results suggested that the frustration of BPN is related to the intention to practice physical activity in contexts other than the PE ones. When students perceived their autonomy and competence needs are being frustrated, they are unlikely to participate in physical activities outside the school, probably because they do not feel freedom to make decisions and to express one's own sentiments and opinions in PE classes, or do not feel capable to facing the proposed activities. This study highlights the important role that PE teachers could play in class by supporting BPN students needs of autonomy and competence.

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SELF-CONTROLLING TASK DIFFICULTY DURING SELF-REGULATED PRACTICE BENEFITS PERFORMANCE AND MOTIVATION.

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WINDESHEIM UNIVERSITY OF APPLIED SCIENCES

Introduction

Self-regulation skills allow children to actively engage in learning. As a result, learners who cyclically plan, monitor and evaluate practice, will experience increased motivation and self-efficacy. These effects may in turn enhance commitment and performance (Zimmerman, 2002). According to the challenge point framework (Guadagnoli & Lee, 2004), task difficulty should be attuned to skill level to facilitate learning. Self-regulation may be an effective way to adjust task difficulty. This study evaluates the effects of self-controlling and monitoring task difficulty in a classroom-based physical education (PE) setting.

Methods

In two practice sessions, 55 Students (Mage = 13) divided over three groups practiced a novel aiming task. All groups were informed that their practice goal was to increase the distance from which they could successfully hit a ball onto a target using a handpaddle. Children in the Goal-group (G) and monitoring-group (M) self-controlled task difficulty (i.e., distance to the target). The M-group additionally monitored task difficulty and score with a digital form. The regulated-group (R) also monitored task difficulty but adjusted task difficulty by a prescribed rule based on their preceding score. In a pretest, posttest and a 2-week retention test, performance, self-efficacy and motivation were examined. During practice, task difficulty was registered.

Results

Repeated measures ANOVA's showed that performance and self-efficacy increased for each group. Only for the R-group, motivation decreased during the experiment. A linear regression analysis identified task difficulty relative to pretest performance as a significant predictor for performance at the posttest and retention test.

Conclusion

Each group increased performance and self-efficacy during the experiment. The G- and M-group could self-control task difficulty, the M-group additionally monitored task difficulty and score to stimulate self-regulated learning. These protocols did not hinder performance or self-efficacy. In the R-group, motivation decreased during the experiment. This may have been caused by the absence of self-controlled practice. The linear regression confirmed that task difficulty is a predictor for learning. These findings support allowing children to self-control and monitor task difficulty during PE.

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EXPLORING INTERACTIONS IN PHYSICAL EDUCATION: TEACHERS' MOTIVATIONAL BEHAVIOURS AND SELF-EFFICACY TO CREATE INCLUSIVE CONTEXTS.

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Key Words: inclusion, self-determination theory, circumplex approach

Introduction

Recently, an innovative approach has been developed to enhance understanding of the interactions between teachers and students in physical education (PE) through the analysis of teaching behaviours (circumplex approach; Aelterman et al. 2019). The model distinguishes four different dimensions according to the level of directiveness y teachers' need support behaviours: autonomy-supportive, structure, chaotic and controlling behaviours. On the other hand, in the field of education, many studies have focused on the barriers to the inclusion of students with disabilities in PE from the perspective of teachers, identifying a lack of training as one of the main limitations pointed out by these professionals (Barber, 2018). The present study aims to advance in this research line by investigating whether the display of these behaviours can be related to the self-efficacy to include students with disabilities in their lessons.

Methods

The sample consisted of 375 Spanish PE teachers (251 male and 124 female) aged between 23 and 60 years old (M= 40.58 and SD = 8.10). The participants taught either in Primary (60%) or Secondary Education (40%). A validated questionnaire was administered, and a stepwise regression was performed.

Results

The analysis revealed that only teaching behaviours oriented to foster structure in the class were associated with self-efficacy to include students with disabilities in their lessons ($t = 11.11$, $p. <. .01$). None of the rest of teaching behaviours emerged as predictors of self-efficacy to include students with disabilities (autonomy-supportive: $t =1.42$; chaotic: $t = -.78$; controlling: $t = -1.34$).

Discussion

Findings suggested that a structuring teaching style might be aligned with inclusive practices in PE. When teachers engage in structure teaching behaviours, they can make use of guiding practices by, for instance, suggesting individual progressions to help the students to complete the task, or clarifying strategies such as being transparent and clear when communicating expectations from the lesson. This study has some relevant implications such as the potential of the circumplex approach to better understand and improve the quality of inclusive settings in PE.

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"DO WHAT I SAY, NOT WHAT I DO": PUPILS PERSONAL VALUES ARE INFLUENCED BY THEIR PHYSICAL EDUCATION TEACHERS' VALUES IN CONTEXT OF INTENSE EMOTIONAL STATES.

SCHWEIZER, T., MAUDUY, M., MARGAS, N.

UNIVERSITY OF LAUSANNE

Research point to the role of physical education (PE) teacher in teaching values. If teachers' values education is often integrated in physical education by using sport as a medium, still little is known about the possible direct effect of PE teachers' values on pupils' values. Because sport and PE are contexts of intense emotional states that can facilitate norm adherence (e.g., Swann & al., 2010), we propose that bodily commitment may enhance adherence to PE teachers' values, as attachment figures. Indeed, stressfull situations and intense emotions lead individuals to affiliate themselves with sources of security (e.g., Mikulincer et al., 2002).

The study involved 207 adolescents (Mage = 13.85; ± 0.83; 41.5% girls) distributed into a 2 (norm salience) x2 (bodily commitment) experimental design. Personal values of participants were initially assessed. Two weeks later, a PE teacher norm was made salient (healthy eating norm vs control norm) followed by a gymnastic task (strong vs weak bodily commitment) and measures of personal values, attitudes, emotional states and affiliation. Healthy eating behaviors of participants were collected one week later. Data were analyzed using contrast method for which 3 orthogonal contrasts were tested, namely (C1) norm salience condition effect, (C2) bodily commitment effect in the experimental norm salience condition and (C3) bodily commitment effect in the control norm salience condition. Mediating effects of threat and arousal states but also affiliation to the PE teacher were explored.

Bootstrap linear mixed models revealed that C1 (Estimate = 0.26, SE = 0.05, $p < .001$) and C2 (Estimate = 0.28, SE = 0.07, $p < .001$) positively and significantly predicted values of pupils at T1. Attitudes of participants at T1 were positively and significantly predicted by C1 (Estimate = 0.17, SE = 0.04, $p < .001$) and by C2 (Estimate = 0.12, SE = 0.06, $p < .05$). Multilevel longitudinal mediation models revealed significant indirect effects of C1 ($p = .03$) and C2 ($p = .01$) on behaviors via values at T1, and a significant indirect effect of C1 ($p = .01$) on behaviors ($p = .03$) via attitudes at T1. Finally, and concerning the underly-

ing processes, strong bodily commitment revealed significantly stronger affiliation to the PE teacher ($p < .001$) and most importantly, affiliation had a positive and significant effect on pupils' values ($p = .02$).

Highlighting the role of bodily commitment in the adherence to PE teachers' values gives new opportunities to stakeholders to orient pupils' values, but also warn about the values that are made salient during sport practice, intentionally or not.

Mikulincer, M. et al (2002). Activation of the attachment system in adulthood: Threat-related primes increase the accessibility of mental representations of attachment figures. JPSP

Swann, W. B., et al (2010). Identity fusion and self-sacrifice: Arousal as a catalyst of pro-group fighting, dying, and helping behavior. JPSP

09:30 - 10:45

Invited symposia

IS-PN01 The power-duration relationship: physiological determinants and practical applications

HISTORICAL BASES FOR THE CRITICAL POWER (CP) CONCEPT

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KANSAS STATE UNIVERSITY

The power or speed discriminating sustainable exercise from that leading to imminent exhaustion in a finite and predictable time (i.e., Critical Power, CP; Critical Speed, CS) has crafted human history. For instance, that CS for Homo Sapiens exceeds the trot-gallop transition speed for ungulate prey underpinned our species success in hunting and venturing out of Africa many millennia ago. Moreover, the performance of soldiers, labourers and elite athletes locomoting over land, in water and in flight, has been bounded by the CP (CS) and W (D) parameters. The Roman military genius Vegetius, required legionaries to march for several hours at the 'military step' (2.85 mph, 4.6 km·h-1) carrying 43.25 lb (19.6 kg) requiring a sustained metabolic rate between 1.4 and 1.7 L O2·min-1. The Roman's success as the World's supreme fighting force over centuries implies that the military step was not positioned far below CP (CS). A.V. Hill constructed hyperbolic speed-time curves from World records for runners, swimmers, rowers and cyclists - a strategy that fits current World records. Central to Hill (and Otto Meyerhoff) winning the 1922 Nobel prize was his demonstration that aerobic and anaerobic energy sources coordinated to power high-intensity muscle contractions and our present understanding of the power or speed-time relation is founded on that coordinated function. In 1965 Monod and Scherrer defined the CP of a muscle (or muscular group) as "the maximum rate (of work) that it can keep up for a very long time without fatigue". They extracted the two parameters, CP and a finite amount of work performable above CP ('energy store' component, later termed W). Subsequent experiments demonstrated that CP is determined by oxidative function and that W upon finite (mostly) anaerobic energy sources. In 1982 Whipp and colleagues utilized a simple 2-parameter hyperbolic fit to the Power-time relation: (P-CP)t =W' which may be transformed into its linear formulation: P = (W'/t) + CP. CP occurs at ~80% VO2 max in young, healthy individuals (higher in elite distance athletes) and, accepting determination imprecision, this represents the highest power (or, more correctly, metabolic rate) at which VO2 and blood [lactate] can be stabilized. Exercise just above CP induces a completely different metabolic response: VO2 rising inexorably to VO2 max and blood [lactate] increasing to exhaustion. CP therefore represents the upper boundary of the heavy and the lower boundary of the severe exercise intensity domain in which all power outputs lead to VO2 max: The tolerable duration of work being predicted from the P-t relation. As presented in this symposium, the highly conserved hyperbolic P-t relation, its mechanistic underpinnings, and tight coherence with systemic and muscle physiologic profiles support its pivotal role in defining muscular performance.

MECHANISTIC BASES OF THE POWER-DURATION RELATIONSHIP

VANHATALO, A.

UNIVERSITY OF EXETER

In this talk, new evidence concerning the physiological determinants of the power-duration relationship and the mechanisms of fatigue in the heavy and severe exercise intensity domains will be discussed. The critical power (CP) indicates the boundary between the heavy intensity domain, within which a physiological steady-state is attainable, and the severe domain, within which exercise is non-steady state and the pulmonary oxygen uptake (VO2) continues to rise until the VO2max is attained. The limited work capacity above the CP is quantified as the curvature constant of the power-duration relationship (W), which has been classically interpreted work that can be derived via 'anaerobic' metabolism. The power-duration parameters differ from any physiological indices of cardiovascular fitness in that they are based upon the measurement of mechanical work done and exercise tolerance rather than any single physiological index, such as blood lactate concentration or pulmonary gas exchange. Research into the physiological correlates of the CP and the W has improved our understanding of the mechanistic bases of severe-intensity exercise tolerance. CP has been shown to separate discrete exercise intensity domains which have distinct blood acid-base, muscle metabolic, neuromuscular, cardiovascular, and respiratory gas exchange profiles. CP is inversely proportional to the rate at which pulmonary O2 uptake rises at the onset of exercise, indicating a close relationship to mitochondrial respiratory capacity. The mechanistic bases

of the CP are inherently linked to those that govern the size of the W. During exercise above CP, the progressive loss of muscle homeostasis signals a stimulation of 'excess' VO2 (i.e., the so-called VO2 slow component), and thereby a loss of efficiency, which propels the VO2 on a trajectory towards VO2max. Positive correlation between the W and the amplitude of the VO2 slow component during severe exercise suggests that the W, defines the time frame for the development of the 'maximal' VO2 slow component. Interventions, such as high intensity interval training, which accelerate the VO2 kinetics at exercise onset and reduce the size of the slow component tend to increase the CP and reduce the size of the W. These changes are reflected as a rightward shift in the power-duration curve and improved exercise tolerance.

W MODELLING DURING INTERMITTENT EXERCISE: CURRENT LIMITATIONS AND FUTURE CHALLENGES OF PREDICTIVE MODELS

CAEN, K.

GHENT UNIVERSITY

As illustrated by the number of scientific publications and the demand coming from professional sports teams, the application of the critical power (CP) model to intermittent exercise has been sparking a lot of interest from both academia and cycling practice. One of the main reasons for this is because intermittent exercise strongly relates to many sports disciplines in which high-intensity efforts (i.e., performed above CP) are alternated with low-intensity intervals (i.e., performed below CP). Applying the traditional CP concept to this type of exercise provides a mathematical and physiological framework that can be employed to estimate both the depletion and the recovery of the so-called W: a fixed amount of energy that can be spent during exercise above CP and can be recovered during exercise below CP. Originally, the recovery of W was thought to occur linearly, just like its consumption, but the curvilinear character of the W recovery soon became clear. In 2012, Skiba et al. used this knowledge to develop a mathematical model to predict the balance in W (WBAL) at any time during intermittent exercise. In this model, W recovery is assumed to occur in a simple exponential way with the speed of the recovery being dependent on the recovery power output. The development of this model was innovative and promising as it could provide a better understanding of the physiological factors that limit interval exercise performance and therefore, could also enhance our ability to predict performance and prescribe exercise. Given the technological advances of data tracking, one potential application may be the real-time monitoring of athlete fatigue in endurance and team sports (e.g., to help athletes in setting an optimal pacing strategy during races or to assist coaches in the design of more individualized interval training). Over the past years, also other, often derivative, model forms have been proposed and tested in the literature. Still, the dynamic behavior of W during exercise is rather complex and W kinetics have shown to be highly variable between individuals, which makes it very challenging to capture within a single mathematical formula. In this context, recent studies have highlighted need for further model improvements, in particular to take better account of the specific modalities of the interval exercise and to incorporate individual characteristics. This also requires a better understanding of the physiological underpinnings of the W recovery. For these reasons, it is important to be aware of the limitations inherent to the existing models before applying them in practice. During this symposium, we will touch upon these limitations and discuss some of the future challenges in the domain of W modelling. Furthermore, we will also illustrate the practical use of predictive W models by examples of real-time monitoring of WBAL in cycling.

Oral presentations

OP-PN11 Cardiovascular Physiology II

ACUTE LOCAL AND SYSTEMIC RESPONSES TO A MODULATED EXERCISE STIMULUS USING BLOOD FLOW RESTRICTION.

JI, S.1, FRANZ, A.2,3, BEHRINGER, M.4, WAHL, P.1,5

1. GERMAN SPORTUNIVERSITY COLOGNE, 2. UNIVERSITY HOSPITAL BONN, 3. ATOS ORTHOPARC CLINIC COLOGNE, 4. GOETHE UNIVERSITY FRANKFURT, 5. THE GERMAN RESEARCH CENTRE OF ELITE SPORT

INTRODUCTION: Low-intensity (LI) exercise with blood flow restriction (BFR) has gained attention as an alternative to high-intensity training for enhancing physiological adaptations in both athletic populations and rehabilitation [1]. A specific feature of BFR is high metabolic perturbations elicited by relatively low-intensity exercise. However, the physiological mechanisms behind BFR-training are not fully understood and there is limited data on the acute changes that occur at the local and systemic level, especially regarding its similarities and differences to workload-matched high-intensity training. Thus, this randomized cross-over study aimed to compare cardiorespiratory demands and local and systemic metabolic perturbations during LI exercise with and without BFR, as well as high-intensity exercise.

METHODS: Ten healthy young males (26.9±4.6yrs) underwent three 20-min external workload-matched cycling trials. The cycling trials consisted of LI cycling (55%PPO), LI cycling with BFR (LI+BFR, 50% of individual arterial occlusion pressure), and high-intensity intermittent cycling (HI, 10x1min at 90%PPO interspersed with 1-min recovery at 20%PPO). Cardiorespiratory responses were measured using spirometry. To evaluate metabolic changes at a systemic (blood) and local (skeletal muscle interstitial fluid) level, a venous catheter and a microdialysis probe were inserted into an antecubital vein and vastus lateralis muscle, respectively.

RESULTS: No significant difference was found in oxygen uptake among the different exercise protocols ($p=.39$). Average heart rate, pulmonary ventilation, and ventilatory equivalent for CO2 were similar between LI+BFR and HI ($p>.67$) and

higher than LI (p<.01). LI+BFR and HI resulted in higher total energy expenditure compared to LI (p<.05), but a greater proportion of fat utilization was found for LI (p<.05). Venous pH decreased significantly during LI+BFR and HI (p<.05), but remined unchanged during LI (p>.95). Regardless of exercise protocols, blood and interstitial lactate concentration increased during exercise, with significant lower levels found in LI compared to the other protocols (p<.05). In LI+BFR, blood glucose level increased continuously up to 5 minutes post-exercise (post5), whereas no changes occurred in LI and HI, resulting in a significant difference at post5 between LI+BFR vs. LI and HI (p<.05). In contrast, LI+BFR showed a trend towards lower interstitial glucose levels compared to the other protocols.

CONCLUSION: Our results indicate that LI+BFR cycling elicits similar cardiorespiratory and metabolic demands as the workload-matched HI protocol. This highlights the effective nature of incorporating BFR in low-intensity exercise to increase energy demand and further modify the metabolic stress in different physiological systems. The potential alterations of glucose metabolism resulting from BFR exercise, both at the local and systemic level, need to be further investigated in terms of its impact on signaling pathways.

1.Ferguson et al. (2020)

MAXIMAL OXYGEN UPTAKE IS NOT REDUCED DURING A MAXIMAL INCREMENTAL RUNNING PROTOCOL WITH MUSCLE BLOOD FLOW RESTRICTION

CHRYSSANTHOPOULOS, C.1, SKARAKI, V.1, CHEROUVEIM, E.D.1,2, MICHAILIDIS, A.R.1, PATAKIOUTIS, K.1, KARATZANOS, E.1, POULOS, S.1, MARIDAKI, M.2, VASSILAKOPOULOS, T.1, PHILIPPOU, A.1

NATIONAL & KAPODISTRIAN UNIVERSITY OF ATHENS

INTRODUCTION: Numerous studies have been conducted examining the chronic benefits of blood flow restriction (BFR) to muscle strength and hypertrophy, as well as to aerobic and anaerobic capacity and performance [1]. However, the acute effect of BFR on maximal oxygen uptake (VO2max) has not been studied particularly in running. The purpose of this study was to investigate the influence of BFR application during a maximal incremental running protocol on parameters determining endurance performance, i.e., on VO2max, velocity at VO2max, running economy, and anaerobic threshold (AT) [2].

METHODS: Fifteen male club-level runners (age: 35.7±10.1 yrs, height: 176.3±5.7 cm, body mass: 73.6±5.0 kg, mean±SD) performed an incremental running protocol (speed increment 1 km/h per 90 s, inclination 0%) to volitional fatigue twice, i.e., with (BFR) and without (C) BFR in a random order. The occlusion pressure applied for BFR was at 40% of the arterial occlusion pressure (AOP) and cuffs were placed at the upper third of both thighs. Diet and physical activity on the day before and the day of the measurements were controlled.

RESULTS: No difference (p= 0.097) was observed in VO2max between the two conditions (BFR: 49.7±4.9 Vs. C: 51.4±5.2 ml/kg/min), whereas time to exhaustion (BFR: 476.7±83.3 Vs. C: 607.5±80.0 s) and velocity at VO2max (BFR: 16.4±1.6 Vs. C: 17.5±1.9 km/h) were significantly lower ($p < 0.01$) with BFR. Oxygen uptake at four common to both conditions submaximal speeds (about 12-15 km/h), reflecting running economy, was not different ($p > 0.05$), while velocity at AT (BFR: 13.3±1.3 Vs. C: 14.0±1.8 km/h) was significantly higher ($p = 0.01$) in C. Maximal perceived rate of exertion (BFR: 17.3±1.2 Vs. C: 16.2±1.7) and maximal pain in a 10-point scale (BFR: 7.8±1.2 Vs. C: 5.5 ± 2.1) were significantly lower ($p < 0.05$) in C, while maximal heart rate was similar between conditions (BFR: 185±9 Vs. C: 187±11 b/min) ($p > 0.05$).

CONCLUSION: The application of BFR at 40% of the AOP during a maximal incremental running protocol reduces time to exhaustion, velocity at VO2max and AT, but does not affect VO2max in male club-level runners.

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HEMODYNAMIC EFFECTS OF INTERMITTENT PNEUMATIC COMPRESSION IN SPORT

MAIA, F., NAKAMURA, F.Y., SILVA, G., MACHADO, M.V.B., RIBEIRO, J.

UNIVERSITY OF MAIA

INTRODUCTION: Over the recent years, the use of practical mechanical interventions for enhancing recovery in sports have found a wide adherence across athletic population [1, 2]. A rather new and poorly explored tool (highly appreciated by the athletes) is intermittent pneumatic compression (IPC) [1, 2]. In theory, IPC enhances blood flow through cyclic inflation and deflation pressure, promoting an acceleration in the recovery process [3]. Nevertheless, IPC physiological/hemodynamic effect remains unclear for athletic subjects, as they often differ from general population (e.g., body composition). The aim of this study was to assess the acute hemodynamic effects caused by a moderate vs high pressure IPC protocol across athletes of intermittent and continuous modalities.

METHODS: Twenty-two male athletes (age: 21.5±2.9yrs; height: 1.80±0.04m; weight: 70.7±2.65kg; week training hours: 9±2.7h) competing from local to international level (soccer and track-and-field) performed 2x 15-min protocols at moderate (80mmHg) and high (200mmHg) pressure in a randomized order (1-hour washout period). Peak systolic velocity, arterial diameter, end-diastolic pressure (ecodoppler on the common femoral artery) and heart rate (Polar H10), were measured pre, during (at the 8th min, with the cuffs deflated, fully and half inflated), and 2 min post each IPC protocol. A repeated ANOVA was performed to assess the variability between protocols and across time and phase of IPC cycle.

RESULTS: Both IPC protocols enhanced the peak systolic velocity: (F=55.9; p<0.001; ηp2=0,93) and end-diastolic pressure: (F=29.7; p<0.001; ηp2=0,87), but no effect was detected for arterial diameter (F=0.36; p=0.70 ηp2=0,03) and heart rate (F=1,51; p=0.25; ηp2=0,15). During the IPC cycle, the highest blood flow values were observed when the cuffs were fully deflated. The between protocol comparisons detected a higher peak systolic velocity (F=26,4; p< 0.01; ηp2=0,56) and end-diastolic pressure (F=26,2; p<0.01; ηp2=0,56) in high-pressure protocol compared to the moderate one.

CONCLUSION: This study demonstrated that during 15 min IPC protocols, athletes blood flow and venous return markers (end-diastolic pressure) are increased, especially if a high-pressure approach is used. This fact corroborates the theoretical IPC mechanism of action in athletes, suggesting that it may be considered a valuable tool. Nevertheless, longer duration protocols should probably be addresses to guarantee an augmented blood flow after the IPC application.

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2. Leabeater, A., et al., All the gear: The prevalence and perceived effectiveness of recovery strategies used by triathletes. Perform Enhanc Health, 2022: p. 100235.

3. Borne, R., Hausswirth C., and Bieuzen F., Relationship Between Blood Flow and Performance Recovery: A Randomized, Placebo-Controlled Study. Int J Sports Physiol Perform, 2017. 12(2): p. 152-160

IMPACTS OF ENDURANCE VERSUS RESISTANCE TRAINING ON DIASTOLIC FUNCTION IN HUMANS

COLLIS, J.J., NAYLOR, L.H., MARSH, C.E., THOMAS, H.J., LESTER, L., MASLEN, B., GREEN, D.J.

UNIVERSITY OF WESTERN AUSTRALIA

INTRODUCTION: Cardiac adaptations in response to exercise are modality–specific; different exercise modalities induce specific phenotypic adaptations to cardiac structure. Few exercise training studies have assessed the impact of exercise modality on cardiac function. This study aimed to investigate physiological changes in left ventricular (LV) systolic and diastolic function following distinct modes of exercise training, in healthy participants.

METHODS: 64 individuals participated in a randomised cross-over design trial, involving 12-weeks of endurance [END] and resistance [RES] training, separated by a 12-week washout. Comprehensive transthoracic echocardiograms were performed to assess systolic function by both ejection fraction (EF) and 2D LV global longitudinal strain (GLS), and diastolic function by mitral valve early velocity (E), tissue Doppler velocity (e'), their ratio (E/e'), and left atrial volume indexed to body surface area (LAESVi).

RESULTS: Following exercise training, resting heart rate (HR) differed significantly between modes of training. Post END there was a significant decrease in resting HR (58±8.5 bpm to 55±6.4 bpm, P<0.001), but not post RES. LV mass increased significantly following both modes of training (RES: 137±41 g to 141±39 g, P=0.001; END: 143±39 g to 152±39 g, P<0.001), with no difference between modalities (P=0.422). Significant changes were observed when LV mass was adjusted for lean mass (DXA) following END (P<0.001). LV internal dimension in diastole (LVIDd), increased following END (47.0±4.2 mm to 48.2±3.8 mm, P<0.001) but not RES (46.5±4.2 mm to 46.8±4.2 mm, P=0.475).

Diastolic function, measured as E/e' significantly differed between modes (P=0.001); E/e' decreased following END (6.7±1.1 to 6.3±1.0, P=0.011) but not RES (6.5±1.3 to 6.6±1.3, P=0.157). This was associated with a different response between modes for E (P=0.012), but not e' (P=0.378). E decreased with END (92±15 cm/s to 88±13 cm/s, P=0.039) whilst e' did not change (13.9±1.7 cm/s to 14.1±2.1 cm/s, P=0.521). Neither E nor e' changed with RES. LAESVi increased significantly following END (26.0±4.5 mL/m2 to 28.1 ±6.0 mL/m2, P=0.019) but not RES (24.9±4.8 mL/m2 to 25.9±4.9 mL/m2, P=0.113). EF and GLS were not impacted significantly by either mode of training.

CONCLUSION: In the absence of gross functional changes in systolic function, endurance, but not resistance training, improved diastolic function and LV adjusted for lean mass. Since diastolic dysfunction is an early and integral event in the development of intrinsic myocardial disease, END may be an effective early mitigation strategy for cardiovascular disease prevention.

NON-INVASIVE ASSESSMENT OF THE PULMONARY AND SYSTEMIC VASCULAR DISTENSIBILITY AT EXERCISE IN SEDENTARY VS. ATHLETIC SUBJECTS

CARPENTIER, M.

UNIVERSITÉ LIBRE DE BRUXELLES - ULB

INTRODUCTION: Physical activity improves cardio-vascular health condition. However, it remains uncertain how much training affects the vascular distensibility (α) of the pulmonary circulation, in regard to the systemic vascular distensibility. This is of particular interest as the right ventricle (RV) function is under heavy stress during exercise (1) at high cardiac output (Q). We hypothesized that a more distensible circulation (after physical training) would smoothen the RV afterload during exercise. We therefore compared the RV and pulmonary circulation response at exercise among athletes and sedentary subjects, in contrast with the exercise systemic vascular response.

METHODS: 17 international professional football players (24±3 years) matched by age and body mass index with 17 sedentary volunteers, performed an incremental cyclo-ergometric exercise echocardiography for right ventricular (RV) and pulmonary circulation evaluation. Gas exchanges and systemic arterial blood pressure were measured continuously during exercise. Q was calculated from the left ventricular outflow tract flow velocity-time integral, mean pulmonary arterial pressure (PAPm) was calculated from the peak tricuspid regurgitation velocity and right atrial pressure. The coupling of

RV function to the pulmonary circulation was evaluated by the tricuspid annular plane systolic excursion (TAPSE) to systolic PAP (PAPs) ratio. Pulmonary and systemic vascular distensibility, αpulm and αsys, were determined from multi-point mPAP/atrial pressure vs Q relationships, from an established equation.

RESULTS: While athletes displayed smoothened chronotropic (p<0.001) and enhanced inotropic (p=0.006) responses to exercise as compared to sedentary subjects, the exercise-induced increase in PAPm or the decrease in TAPSE/PAPs did not differ between the two groups. However, αpulm was higher in athletes than in sedentary people (1.37±0.41 vs 0.88±0.42%/mmHg, p=0.002) and correlated with the TAPSE/PAPs ratio (football players: p=0.006, r=0.63, sedentary: p<0.001, r=0.79). αsys was correlated to αpulm (p<0.05, r=0.33) suggesting a global (systemic and pulmonary) vascular training adaptation. Indeed, even if αsys was not different between the two groups, it was positively correlated to cardio-respiratory fitness indexes such as the VO2peak (p=0.02, r=0.37) and the stroke volume at maximal common effort (p=0.02, r=0.37).

CONCLUSION: Similar exercise-induced mPAP and TAPSE/PAPs response was observable in athletes and sedentary subjects, suggesting a preserved RV function in both populations. However, athletes present a higher vascular pulmonary distensibility, αpulm associated with better preserved RV-arterial coupling. How much this smoothened RV afterload and coupling changes are advantageous during long or intense exercise remains to be defined. The advantageous vascular distensibility effect seems to affect the exercise-induced response of both circulations systemic and pulmonary in relation to the aerobic capacity.

1. La Gerche (2014)

Oral presentations

OP-AP27 Power/Strength: Training and Testing

POST-ACTIVATION JUMP PERFORMANCE ENHANCEMENT IS DIMINISHED FOLLOWING A LOADED PLYOMETRIC EXERCISE RESULTING IN MINOR MUSCLE DAMAGE

LIMA, L.C.R., BARRETO, R.V., FONTANETTI, G., MANTOVANI, G.B., DENADAI, B.S., NOSAKA, K.

UNIVERSITY OF SÃO PAULO

INTRODUCTION: Post-activation performance enhancement (PAPE) refers to performance improvement in explosive movements following intense contractions of the muscles. PAPE is speculated to be associated with enhanced myosin head phosphorylation, increased muscle temperature, and other adaptations in the muscles. High-intensity eccentric contractions lead to exercise-induced muscle damage (EIMD), that predominantly affects type II muscle fibers, which have been shown to be associated with responsiveness to PAPE. The present study investigated the hypothesis that PAPE would be negatively affected by a bout of loaded plyometric exercise (PLYO) that induces muscle damage.

METHODS: Twenty-two healthy men with no prior experience with resistance training participated in the study. Following two familiarization sessions, the participants were confirmed to show PAPE, based on at least 4% increase in counter movement jump (CMJ) height (peak of 5 trials) following a pre-activation protocol consisting of 5 squats with a 5-RM load. Eleven participants were considered to be non-responders and excluded from further study. The final sample consisted of 11 PAPE responders (19.6±1.8 y, 69±9 kg, 176±8 cm). Maximal voluntary isometric contraction (MVC) torque of the knee extensors and quadriceps muscle soreness were assessed at baseline, 15 min, 24 and 48 h following PLYO consisting of 5 sets of 6 drop-jumps from a 52-cm box with a weight of 20% of individual body mass. Responsiveness to PAPE was assessed at baseline, 15 min, 24 and 48h following PLYO by CMJ height prior to and 4 min following the pre-activation protocol that had been shown to produce PAPE for the participants. Changes in MVC and muscle soreness were analyzed by one-way repeated measures ANOVAs. Changes in CMJ height from pre- to post-PLYO and over time were analyzed by mixed-model ANOVAs with Tukey's post hoc tests. Significance was set at p<0.05.

RESULTS: MVC decreased at 15 min following PLYO (-15.1±9.7%) but returned to the baseline by 24 h post-PLYO. Quadriceps muscle soreness developed at 48 h (21.0±20.3 mm) after PLYO. Baseline CMJ height was 30.5±5.2 cm and increased 7.6±3.8% after the pre-activation protocol, but no changes in CMJ height were observed following the pre-activation protocol at 15 min, 24 and 48 h following PLYO. However, CMJ values prior to pre-activation increased at 24 and 48 h (32.3±6.0 cm and 33.3±6.2 cm, respectively) following PLYO compared to pre-PLYO.

CONCLUSION: These results showed that PAPE disappeared at 15 min, 24 and 48 h after PLYO that induced acute strength loss and development of delayed-onset muscle soreness for healthy young men who showed responsiveness to PAPE before PLYO. It should be noted that CMJ height increased at 48 h post-PLYO without PAPE. PLYO induced minor muscle damage, which diminished PAPE, but produced a supercompensation-like effect at 24 and 48 h post-PLYO.

EFFECTS OF LOADING POSITIONS ON THE ACTIVATION OF TRUNK AND HIP MUSCLES DURING FLYWHEEL AND DUMBBELL SINGLE-LEG ROMANIAN DEADLIFT EXERCISES

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INTRODUCTION: The SLRDL is a popular exercise widely used by strength coaches or therapists for performance enhancement and rehabilitative purposes. However, regarding the effect of loading position on trunk and hip muscle activation, it is not extensively studied before. The study compared the surface electromyographic (sEMG) activities of trunk and hip muscles during single-leg Romanian deadlift (SLRDL) exercises using flywheel and dumbbell with different loading positions.

METHODS: Twelve young male subjects with at least two years of strength training experience participated in this study. sEMG in the percentage of maximum voluntary isometric contraction of four SLRDL exercises (ipsilateral and contralateral loading position for dumbbell and flywheel) in a randomized order. sEMG amplitudes of superior gluteus maximus (SGM), inferior gluteus maximus (IGM), gluteus medius (GM), biceps femoris (BF), erector spinae (ES), external oblique (EO), and adductor longus (AL) were measured whereas one-way repeated measure ANOVA with Bonferroni adjustment (statistical significance at 0.05) and magnitude-based decision was performed.

RESULTS: Results demonstrated a very high level of SGM (105.4 to 168.6%) and BF (69.6 to 122.4%) muscle activities. A significant moderate increase of sEMG signals in GM, IGM, and ES (dominant side) and a large increase in SGM in flywheel SLRDL when the load shifted from ipsilateral to the contralateral side. No significant difference was observed between flywheel and dumbbell SLRDLs.

CONCLUSION: SLRDL using either a dumbbell or the flywheel device with contralateral loading placement can effectively enhance the activation of BF, SGM, IGM, GM, ES-D, and ES-ND for strengthening purposes. Meanwhile strength coaches may adopt dumbbell or flywheel SLRDLs with contralateral loading positions to simultaneously strengthen the hip extensors and trunk stabilizers effectively.

ACUTE EFFECTS OF DRY LAND RESISTANCE TRAINING ON SWIMMING PERFORMANCE IN MALE AND FEMALE SWIMMERS

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INTRODUCTION: Competitive swimmers may apply dry-land maximum strength (MS) or strength endurance (SE) training prior to in-water swimming training [1]. MS or SE may affect performance and physiological response on a following swimming training in male swimmers [2,3], but no such information has been reported for female swimmers. The aim of the study was to examine the acute effect of MS and SE training sessions on performance, physiological and biomechanical variables during a subsequent maximum intensity swimming training session on male (M) and female (F) swimmers.

METHODS: Twenty-seven swimmers, 13 M (age: 17.8±3.1 years) and 14 F (age: 15.6±1.8 years) completed three experimental sessions: i) MS, 3 sets x 4 repetitions, load 90% of 1RM, 3 min rest between sets, ii) SE, 2 sets x 20 repetitions, load 55% of 1RM, 20 s between sets and iii) no dry-land training (CON). Twenty minutes following MS, SE and CON sessions swimmers participated in swimming training, consisting of 800-m warm-up and maximum efforts of 10-s tethered swimming, 4X50, and a 100-m front crawl. Force was measured during tethered swimming (TF), performance time, arm-stroke rate (SR), arm-stroke length (SL), arm-stroke index (SI), and arm-stroke efficiency (ηF) were measured during 4X50-m and 100-m. Blood lactate concentration [La-] was measured before and after each swimming effort and heart rate (HR) was recorded continuously. Shoulder isometric strength (ISO) and hand grip strength (HG) were measured before and after the dry-land and swimming training in all sessions.

RESULTS: Males swam faster than F swimmers in 4x50-m and 100-m following all sessions (P=0.01). Both M and F swam slower in the 4x50-m set following SE compared to MS and CON (M: 1.8±2.3%; F: 1.7±3.2%, P=0.01). However, 100-m time was no different between sessions in both M and F (P=0.34). ISO was decreased both in M and F after MS (M: 1.2±10.9%, F: 2.1±5.9%, P=0.01) and SE (M: 3.8±11.8%, F: 1.7±9.4%, P=0.01) compared to CON. HG and TF remained unchanged following all sessions in M and F (P=0.11). [La-] was not different between M and F in swimming 4x50 and 100-m (P=0.29) but was increased in both genders following SE compared to MS and CON sessions (P=0.01). HR was higher in F compared to M during 4x50 and 100-m in all sessions (P=0.01). During 4x50-m, M showed a higher SR and SI compared to F, while F showed a higher ηF compared to M in all sessions (P=0.01).

CONCLUSION: Dry-land SE session deteriorates repeated sprint performance time in both genders. SE or MS sessions are not altering biomechanical characteristics both in male and female swimmers during a subsequent maximum intensity swimming training.

1.Arsoniadis et al. (2022) 2. Arsoniadis et al. (2019) 3. Dalamitros et al. (2021)

Oral presentations

OP-PN08 Hormonal Biology II

MENSTRUAL CYCLE PHASES AND PERFORMANCE IN ELITE WOMEN SOCCER PLAYERS

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INTRODUCTION: The impact of the menstrual cycle (MC) on performance is one of the most critical topics in female sports. Hormonal fluctuation and symptoms related to different MC phases can influence performance in women soccer players. Indeed, as reported in previous studies, this fluctuation seems to affect parameters related to internal and external load (1,2). To date, different studies tried to investigate this topic, but results are still unclear. The aim of the present study was to investigate the effect of different menstrual phases on distinct performance parameters in an elite women soccer player during standard weekly training in the Italian first division.

METHODS: Sixteen female soccer players (Age: 24.59 ± 4.11 yrs; Height: 1.66 ± 0.07 m; Weight: 59.50 ± 6,31 kg) were involved in the current study. Players were pooled according to the MC phases. Four different MC phases were identified: Early Follicular (EC: days 1-7), Late Follicular (LC: days 8-14), Early Luteal (EL: days 15-21) and Late Luteal (LL: days 22-28). Information about MC phases, recovery status, quality of sleep, stress, fatigue, and muscle soreness was recorded by adopting a morning survey. External load parameters were collected during trainings using GPS system (OHCOACH). At the end of each training, the rating of perceived exertion (RPE) was recorded. The players that who took part in four weekly training sessions were selected. Weekly Training was divided in four training sessions: Day 1 (Strength training), Day 2 (Aerobic training), Day 3 (Repeated Sprint Ability - RSA training), Day 4 (Speed Agility Quickness - SAQ training). Weekly training load was the same during the weeks of intervention. One-way ANOVA, followed by Bonferroni post-hoc, was performed to analyze differences between the four MC phases for all the parameters collected.

RESULTS: High Speed Running (HSR > 19.8 km/h) distance, Explosive Acceleration (EX ACC > 2.5 m/s²) and Explosive Deceleration (EX DEC > 2.5 m/s²) distance were significant highest ($p < 0.05$) in the late luteal phase.

CONCLUSION: A greater running intensity above 19.8 km/h combined with a greater number of EX ACC and EX DEC in the late luteal phase in female soccer players were evidenced by our results. As reported in previous studies, the distance covered above 19.8 km/h is highly correlated with the high-intensity, intermittent running test commonly performed to evaluate the RSA of soccer players (3). We can speculate that this variation in RSA performance was related to the high levels of progesterone and estradiol of the late luteal phase. This result highlights the important role of female sex steroid hormones as determinant of RSA performance of women soccer players in different phases of MC.

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THE INFLUENCE OF MENSTRUAL CYCLE PHASE ON PHYSIOLOGICAL ENDURANCE PERFORMANCE-DETERMINING VARIABLES IN ENDURANCE - TRAINED ATHLETES

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INTRODUCTION: The main determinants of endurance performance are maximal oxygen uptake (VO 2 max), oxygen uptake (VO 2) at lactate threshold, anaerobic capacity, and work economy/efficiency . It is currently unknown if the fluctuating levels of estrogen (E) and progesterone (P) across the menstrual cycle (MC) influence these performance-determining variables. Accordingly, the primary aim of this study was to investigate the effect of MC phase on physiological performance-determining variables in endurance-trained athletes.

METHODS: Twenty - one eumenorrheic endurance - trained female athletes (mean ± standard deviation : 27 ± 9 years; 62 ± 6 kg; VO 2 max 53 . 8 ± 5. 6 mL ⋅ kg - 1 ⋅ min - 1) completed standardized fitness tests during three hormonally distinct phases of the MC : 1) the early follicular phase (EFP), within 1– 4 days after the onset of menstrual bleeding ; 2) the ovulatory phase (OP), within 36 h after a positive ovulation test result, and ; 3) mid-luteal phase (MLP), 7– 9 days after ovulation. MC phases were determined using calendar-based counting and at-home urinary ovulation tests, and retrospectively verified from fasted serum hormone analysis of E and P on each test day. Testing consisted of an incremental lactate profile and a VO 2 max test on a treadmill with 10.5% incline, and a 30 s all - out double-poling sprint test on a ski ergometer. VO 2 and blood lactate concentration ([La-]) were recorded during the sessions. Performance was determined as time to exhaustion (TTE) in the VO 2 max test. VO 2 at the lactate threshold was expressed as %VO 2 max at 4mmol⋅L-1 [La-] (VO 2 @4mmol) and running economy (R E) as VO 2 in mL⋅kg-1⋅km-1 at the individual speed closest to 80% of 4 mmol⋅L-1 [La-where RER was < 1.0. Participants completed one familiarization session and six MC phase-specific tests over two MCs. Data were analyzed using linear mixed- effect models in R.

RESULTS: A total of 98 test sessions were included in the analysis (EFP=36, OP=30, MLP=35). MC phase did not affect TTE (seconds, EFP=382 ± 67, OP=388 ± 82, MLP=372± 74, p =.16), VO 2 max (VO 2 in mL•kg -1 min -1 : EFP =54.2 ± 4.3, OP=54.4 ± 5.3, MLP=53.8± 5 .0, p =.53),VO 2 @4mmol(%,EFP= 86.3 ± 4.6 , OP= 85.4 ± 4.4 , ML P = 86.7 ± 4.6 , p = .36), average power output during the double-poling test (PO30s in W : EFP=187 ± 40W, OP=193 ± 40W, MLP= 184 ± 34W, p=.08) ,or RE (VO2 in ml•kg-1•km-1 : EFP =3 50 ±23, OP=34 6 ± 20, MLP =347 ± 17, p = . 40) . However, notable within - and between - participant differences across MC phases were observed in all outcome variables.

CONCLUSION: MC phase did not have a significant effect on the physiological variables most commonly used to assess and understand endurance performance. Specifically, TTE, VO 2 max , VO 2 @4mmol , PO 30s and RE did not differ on a group level between MC phases. However, , as within -and between-participant differences existed, it could be important to document MC phase when testing female athletes.

THE PREVALENCE OF MENSTRUAL DISTURBANCES IN FEMALE ENDURANCE ATHLETES: THE INFLUENCE OF PERFORMANCE LEVEL AND COMPARISON OF METHODOLOGIES

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1> NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY, 2> UIT THE ARCTIC UNIVERSITY OF NORWAY, 3> NORD UNIVERSITY

INTRODUCTION: The prevalence of subtle menstrual disturbances (MD) in exercising women (50%) has been shown to be much higher than in sedentary women (4.2%) (1). However, it is unclear if the prevalence in female athletes is dependent on performance level. Therefore, the primary aim was to investigate the association between performance level and the prevalence of MD in endurance-trained women. A 3-step method, consisting of calendar-based counting, urinary ovulation testing, and serum hormone verification, has been suggested for the identification of subtle MD (2). However, a less invasive and time-consuming method, consisting of calendar-based counting and urinary ovulation testing (i.e., the 2-step method), would be preferable for sports practice. Therefore, the secondary aim was to investigate the degree of agreement between the 2-step and 3-step method for the detection of MD.

METHODS: In total, 238 unique menstrual cycles (MCs) of 66 menstruating endurance athletes were analyzed. Athletes were classified based on their average weekly training volume and performance metrics as tier 2/trained (n=24), tier 3/highly trained (n=36), or tier 4/elite (n=6) (3). MC status was initially determined using the 2-step method. MCs were classified as either normal, anovulatory, short luteal phase (i.e., a luteal phase <10 days)1 or oligomenorrheic (MC >35 days) (1). A subsample of 32 female athletes also provided a serum hormone sample 7-9 days after a positive ovulation test for 49 MCs, which was analyzed for an inadequate luteal phase (mid-luteal phase progesterone value <16 mmol•L-1) (1,4). The data from this subsample was used to compare the two methodologies. Logistic mixed model analysis was used to investigate the association between performance level and MD prevalence, while the degree of agreement between the two methodologies was evaluated using Cohen's kappa (κ).

RESULTS: Performance level was associated with the prevalence of MD, with tier 3 athletes being 21.6 (95%CI: 4.6, 101.3) times more likely to present a MD than tier 2 athletes (p=.002). No other differences were found between performance levels (p=.38-.58). An almost perfect agreement was found between the 2-step and 3-step method (κ=0.95), with the 3-step method identifying only one extra MC with a MD (13/49), when compared to the 2-step method (12/49).

CONCLUSION: Tier 3 athletes showed a significantly higher prevalence of MD than tier 2 athletes. The lack of significant differences between tier 2 and tier 3 vs. tier 4 athletes, might be related to the small number of elite athletes included. The almost perfect agreement between the 2-step and 3-step method indicates that practitioners will detect almost all disturbed MCs when their athletes use the more practically feasible 2-step method.

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PREVALENCE AND PERCEIVED IMPACT OF HORMONAL CONTRACEPTIVE USE ON PERFORMANCE IN A GLOBAL POPULATION OF WOMEN'S RUGBY

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INTRODUCTION: Research has highlighted hormonal contraceptives may impair performance in some sportswomen. With the increasing popularity and growth in participation of women's rugby, there is a need to understand the potential impact hormonal contraceptive use may have, which should be a priority to understanding both the health and performance of players. Therefore, this study aimed to determine the prevalence of hormonal contraceptive use in a global population of women's rugby, investigating reported associations with training and performance to inform future practice and support.

METHODS: A total of 1,598 participants from 62 countries (26 ± 6 years; 7.5±5.1 year's playing experience) completed an online survey. The survey captured information on hormonal contraceptive use including type, reason for use and symptoms experienced along with whether training and performance was perceived to be altered. Participant eligibility includ-

ed being ≥18 years and either actively playing women's rugby fifteens and/or sevens, or having done so in the past decade, at any level, in any country.

RESULTS: Six hundred and six participants reported the use of hormonal contraceptives from across 33 countries, with the combined oral contraceptive being the most used (44%). Almost half (43%) tracked symptoms related to hormonal contraceptives but did not relate it to training despite over 10% reporting performance is altered in rugby due to symptoms related to contraceptive use and 22% requiring use of medication to manage symptoms. In relation to rugby, 11% use contraceptives just to control or stop periods caused by the menstrual cycle. Only 3 participants reported not taking part in rugby whilst experiencing a withdraw bleed irrespective of playing level.

CONCLUSION: There is a need to recognise the use of hormonal contraceptives in women's rugby especially in relation to training and performance. Associated symptoms varied in severity, in some cases causing altered performance, use of medication for management or even not taking part. In a team sport it is important to understand the prevalence and effect of hormonal contraceptive use on individuals to effectively provide support, management and optimise team performance.

ON-FIELD METHODOLOGICAL APPROACH TO MONITOR THE MENSTRUAL CYCLE AND HORMONAL PHASES IN ELITE FEMALE ATHLETES

DUPUIT, M.

INSEP

INTRODUCTION: Currently, there are no guidelines for implementing the follow-up of menstrual status including the natural menstrual cycle (NC) or oral contraception (OC) in a sports setting. We aimed to provide a feasible, on-field methodological approach for monitoring NC and OC in female athletes.

METHODS: We developed a smartphone app with daily questionnaires to monitor both NC and OC phases in 19 elite female soccer players (23.7 ± 4.4 years) over 7 months. Adherence and compliance were evaluated. The NC and OC phases were based on calendar data in order to establish an individual menstrual profile for each athlete.

RESULTS: Initial questionnaire revealed that vast majority of female players (4 out of 5) presented a large interest in monitoring their menstrual status. The online monitoring yielded high athlete adherence (87.0 +/- 14.2%) with a slight decrease over the winter break and at the end of the championship, which necessitated adaptations to promote compliance. Monitoring identified the specific menstrual pattern of each athlete and highlighted large inter-individual variability.

CONCLUSION: This study assesses for the first time the interest of female player's in monitoring their menstrual status. It provides a new methodological approach as well as guidelines for optimizing on-field monitoring. It also anticipates some obstacles sport staffs may encounter when trying to implement such follow-up. It is essential to better understand the menstrual profile of athletes and determine its potential impacts on wellbeing and performance.

Invited symposia

IS-MH07 Physical activity for cognitive health across the lifespan: when, what and how?

PHYSICAL ACTIVITY EFFECTS ON COGNITIVE AND BRAIN HEALTH IN SCHOOL AGE CHILDREN

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Physical activity (PA) can improve physical, mental, cognitive, and brain health throughout the lifespan. During childhood, the benefits of PA for cognitive and brain health have been increasingly studied, with evidence indicating enhanced executive function and improved academic performance, along with adaptations to underlying brain structure and function in specific regions and networks that support these aspects of cognition. Such findings are especially relevant given that there is a growing public health burden of unhealthy behaviors (e.g., physical inactivity, excessive energy intake) among children of industrialized nations. In recent years, children have become increasingly inactive, leading to concomitant increases in the prevalence of being overweight and unfit. Poor PA behaviors during childhood often track throughout life and have implications for the prevalence of several chronic diseases during adulthood. Particularly troubling is the absence of public health concern for the effect of physical inactivity on cognitive and brain health. It is curious that this has not emerged as a larger societal issue, given its clear relation to childhood obesity and other health disorders that have captured public attention.

Relative to cognitive and brain health, the literature has predominantly focused on preadolescent children, with a comparatively smaller body of evidence in preschool age and adolescent children. Such a contrast is even more striking relative to the use of neuroimaging tools to assess PA on brain health. To date, the vast majority of neuroimaging studies have investigated preadolescent children, using electroencephalography and functional magnetic resonance imaging, and found that PA and aerobic fitness benefit neural structures and networks that support executive function and memory, including the prefrontal cortex and hippocampus. Such findings have been linked to cognitive outcomes including aspects of executive function such as inhibition, working memory, and mental flexibility as well as other cognitive outcomes including relational memory and academic achievement.

Despite evidence that PA promotes cognitive and brain health during development, a growing number of schools have minimized PA opportunities across the school day. Accordingly, this generation of children have become increasingly inactive, contributing to public health and educational concerns. By dedicating time to active play, sports, physical education, and other forms of PA, children are best-positioned to thrive in both the physical and cognitive domains. Such discoveries are timely and important for public health concerns related to chronic disease prevention as a function of childhood inactivity and obesity. These findings link pervasive societal concerns with brain health and cognition, and have implications for the educational environment and the context of learning.

ADULTHOOD - LOOKING TO BOOST A COGNITIVE AND BRAIN RESERVE

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During adulthood, healthy individuals typically report few cognitive complaints. As a result, the role of physical activity in cognitive health either receives little attention or finds very few relationships. This is likely also a result of the cognitive engagement many adults have through education, vocational, and social settings. There are however observations that physical activity during adulthood does impact later life. Physical activity for cognitive health during early and middle adulthood therefore focuses on general health, reducing the potential harm to brain structures and processes that are associated with several lifestyle-related diseases.

Outside of reducing harm through physical health, physical activity may play a crucial role in building a cognitive reserve, potentially improving cognitive performance, but importantly protecting against later-life declines. Taking advantage of physical activity benefits, such as increases in cerebral blood flow and neurotrophic factors, offers an opportunity to maximise neural plasticity. In this session optimising the dose characteristics of physical activity will be discussed.

Interventions that specifically attempt to take advantage of plasticity-supporting physical activity are those that ensure cognitive activity is in close temporal proximity. Sequentially- or concurrently-programming physical exercise with a cognitive intervention are gaining popularity, with most evidence currently in older adults. This session will provide an update on the latest evidence for concurrent training in healthy adulthood.

It is hypothesized that an increased availability of factors such as brain-derived neurotrophic factor during targeted cognitive interventions improve the gains that such training can provide. However, depending on the outcome, some propose that concurrent activity may also work through the combination of effortful behaviours impacting individuals capacity, or tolerance for work. This fatigue-linked pathway may also impact cognitive health when engaged over longer periods, or when individuals are asked to report subjective cognitive complaints. These potential pathways will also be discussed in terms of informing the when, what, and how of physical activity interventions for cognitive health.

PHYSICAL ACTIVITY FOR COGNITIVE HEALTH IN OLDER ADULTS

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There is consistent evidence to suggest that being more fit in young adulthood is associated to having better cognitive function in both young and older adulthood. We also know that being aerobically high fit is associated with having executive abilities that make it easier to attain and sustain healthy habits. While such information may be interesting, it tells us very little on whether physical activity promotion among low fit inactive individuals might have a positive influence on their future cognitive health. In midlife, lack of time is a commonly perceived barrier towards physical activity. Still, as we retire, individuals who were inactive in midlife tend to stay inactive after retiring, despite now having more spare time at hand. When preaching that it is never too late, we need to take care not to shame those whose shoes we have not walked in. Remember, that although we have all equal human value, we have different opportunities, both genetically and in terms of socioeconomic circumstances.

When we compare the brain health of senior athletes to that of their less active peers, this is not helping anyone. That is why I prefer randomized controlled trials for the purpose of figuring out what type of exercise might work for whom. The Finnish Geriatric Intervention Study to Prevent Cognitive Impairment and Disability evaluated whether a 2-year multicomponent intervention with exercise, cognitive training, diet and vascular risk monitoring could slow down the cognitive decline in an at-risk population. They show that such intervention actually can have small effects on the trajectories of cognitive decline, but we are still not close to understanding what the active component is. Large scale exercise RCTs using advanced neuroimaging to investigate neurophysiological mechanisms are under way, but these are very expensive. Major breakthroughs in plasma biomarkers of neurodegenerative disease progression have been exposed recently. Such new techniques should be exploited in future RCTs by researchers who want to investigate if support to increased physical activity can really change the cognitive trajectories of physically inactive individuals who want to spare their brain health. This presentation will explore our current understanding of how and physical activity affects cognitive health in older adults and suggest new avenues of exploration.

Oral presentations

OP-BM12 Running I

THE ROLE OF POSTURE IN REDISTRIBUTING THE RELATIVE CONTRIBUTION OF THE LOWER-LIMB JOINTS TO TOTAL LIMB MECHANICAL POWER DURING UNEVEN RUNNING

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INTRODUCTION: Proactive or reactive responses to gait perturbation paradigms allow insights into the biomechanical properties of human locomotion (1). This is deemed essential for the development of running-related injury management strategies (2). Despite ample studies on the biomechanics of human steady-state running, there is scarce research on the mechanical behaviour of lower-limb as a function of posture during perturbed running. Thus, this study aimed to characterize the redistribution of the relative contribution of the lower-limb joints (hip, knee and ankle) to total limb positive and negative mechanical powers as a result of changes in ground surface and trunk posture.

METHODS: Twelve recreational runners ran in the laboratory across even and uneven ground surfaces (10 cm anticipated drop-step) with three trunk angles from the vertical (self-selected, ~15°; anterior, ~25°; posterior, ~0°) while 3D kinematic and kinetic data were collected using a 3D motion capture-system and two embedded force-plates. Joint moment and power output were calculated for the ankle, knee, and hip. Two-way repeated measures ANOVAs ($\alpha = 0.05$) compared the relative contribution of the lower-limb joints to total limb negative and positive mechanical powers of an anticipated drop-step with that of level-step across trunk angle conditions.

RESULTS: Total limb negative and positive power increased in the drop-step (Step effect) with a proximodistal shift in the relative joint contribution to total limb negative power, which was more pronounced when leaning the trunk backward. Backward versus forward trunk lean (Posture effect) was associated with increased total limb negative power and decreased total limb positive power. Furthermore, there were increased relative contributions from the hip joint and decreased relative contributions from the knee joint to total limb positive power.

CONCLUSION: Insights from this study shed light on the mechanical behaviour of perturbed lower-limb as a function of trunk posture modifications. The accommodation of drop-steps, regardless of the running trunk posture, demands higher total limb negative and positive mechanical power. This involves a predominant relative contribution from the ankle to energy absorption or generation, which tends to be increased when the trunk is leaned backward. These findings provide implications for injury management, particularly, in the context of outdoor running, where accommodating changes in the substrate height is ubiquitous.

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MECHANICAL PROPERTIES OF MODERN RUNNING SHOE FOAMS ARE HIGHLY VARIABLE AND CORRELATED WITH RUNNING ECONOMY IMPROVEMENTS

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UNIVERSITY OF MICHIGAN

INTRODUCTION: Recent advances in running shoe design have created a new footwear category—the so-called super-shoe—that improves running economy (RE) and racing performance (1-4). One of the primary engineering developments that has facilitated these improvements was the introduction of novel polymer foams with higher resiliency (i.e., energy return) combined with lower material stiffness (i.e., more compliant or softer). While many running shoe manufacturers have released so-called super shoes, only the Nike VaporFly (NVF) has had the material properties of its novel foam characterized (1). Moreover, the RE enhancement afforded by shoes of these other manufacturers is highly variable (4). Finally, no data exist describing the spatial variation of shoe properties (i.e., heel to forefoot) , which may provide insight into the personalized benefits of shoe properties across different types of runners.

METHODS: The material properties of 9 models of racing shoes from 7 manufacturers (Nike, Asics, Adidas, Brooks, New Balance, Saucony, Hoka) were characterized, with 3 sizes of left and right shoes examined. An MTS MiniBionix 858 was used for uniaxial load-deformation assessment, delivering 350 and 500 kPa via a 20cm2 cylindrical stamp at a contact of 10 ms, simulating a heel strike impact transient from a 70 kg and 100 kg individual, respectively (5). Energy input, output, and material stiffness (MS) were assessed in 3 regions (heel, midfoot, forefoot). Material properties of the shoes were compared against a previous assessment of RE in each model (except for Adidas) (4). Multiple linear regression models were used to assess the influence of model, location, size, and load on the energy return and material stiffness of the shoes.

RESULTS: The energy returned (ER) from load impact varied across shoes by model, loading location, and their interactions ($p < 0.001$), but not by absolute load. ER values from the heel varied from 71.6% (Hoka Rocket X) to 84.4% (Nike Alphafly and Adidas Adios Pro 2). MS varied by model, loading location, and their interactions ($p<0.001$), as well as absolute load, indicating a degree of non-linearity in the elastic properties. MS in the heel ranged from 43.0 kN/m (Nike Alphafly) to 86.3

kN/m (Asics Hyperspeed). Previously measured RE in each shoe in a population of 12 runners (4) was inversely associated with ER (r = -0.91) and was positively associated with MS (r=0.91), with the most economical shoe (Nike Alphafly) being the most compliant and most resilient.

CONCLUSION: Significant heterogeneity exists in the mechanical properties of modern racing shoe foams, both across models and within shoes. Shoes with the highest ER and lowest MS are associated with the greatest improvements in running economy. Moreover, several shoes demonstrated large regional differences in these properties that may affect how runners respond to individual footwear design.

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3) Bermon et al. 2021

4) Joubert and Jones 2021

5) Ribiero et al. 2011

INCREASING LOAD CARRYING OR RUNNING SPEED DIFFERENTIALLY AFFECT THE MAGNITUDE, VARIABILITY AND COORDINATION PATTERNS OF MUSCLE FORCES

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INTRODUCTION: Military training and ultra-endurance races require running with loads and/or at varying speeds (1). These situations lead to an increased stress on the musculoskeletal system and are therefore associated with an increased risk of injury (2-3). The aim of this study was to analyze the effects of load carriage or speed variations on inter- and intra-individual muscle force amplitudes, variability, and coordination patterns during running.

METHODS: Nine healthy participants ran on an instrumentalized treadmill with an empty weight vest at two velocities (2.6 m/s and 3.3 m/s) or while carrying three different loads (4.5, 9.1, 13.6 kg) at 2.6 m/s while kinematics and kinetics were synchronously recorded. A musculoskeletal model was used to estimate the forces of the major lower limb muscles. Muscle force amplitudes and variability, as well as coordination patterns, were compared at the group and at the individual levels using respectively statistical parametric mapping (4-5) and covariance matrices combined with multidimensional scaling (6).

RESULTS: Increasing the speed or the load during running increased most of the muscle force amplitudes ($p<0.01$, up to 185% of BW increase). Muscle force amplitudes and variabilities were more affected by changes in running speed than by changes in load carriage. During the propulsion phase, increasing the load increased muscle force variabilities around the ankle joint (change in standard deviation up to 5% of body weight (BW), $p<0.05$) while increasing the speed decreased variability for almost all the muscle forces (up to 10% of BW, $p<0.05$). A specific and individual muscle force coordination pattern signature was also shown for each runner ($p<0.05$). Furthermore, each runner significantly adapted his pattern in response to the perturbation associated with each experimental condition ($p<0.05$).

CONCLUSION: Muscle force amplitudes, variability, and coordination patterns during running were differentially affected depending on the perturbation (weighted vest or speed increase). These differences allow the runners to explore and develop new coordination patterns that could broaden the internal distribution of constraints. Therefore, from a training/clinical approach, due to a more progressive mechanical load on the lower limb muscles relative to an increased speed, running with a weighted vest at slow speed may be preferred in the early stages of training for novice runners (e.g., military cadets, novice trail runners) or to ensure a safer progression back to training after an injury.

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5) Kowalski et al., J. Biomech., 2021

6) Slowinski et al., J R Soc Interface, 2016

COMPARISON OF PASSIVE AND ACTIVE MECHANICAL WORK IN HUMAN RUNNING AT DIFFERENT STEP FREQUENCIES

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UCLOUVAIN

INTRODUCTION: During steady-state running, if the foot is not skidding and wind speed is negligeable, the negative work done to (i) move centre of mass of the body (CoM) relative to the surroundings (Wext) and (ii) move the limbs relative to the CoM (Wint) is equal to the positive work done over a step (1). Instead, when considering joint work performed on rigid segments, there is a discrepancy between positive and negative work, resulting in a net-positive difference (2). It has been suggested that the discrepancy between the total amount of work done (Wtot= Wext+Wint) and the joint work reflects the passive 'soft tissue' work, done by the deformation of 'softer' parts of the body. Because muscles must actively offset any

net dissipation, soft tissue deformations may induce a deviation from the spring-like behaviour of the limb during stance, and in turn of lower-limb stiffness (3). The purpose of the present study is to estimate and compare the passive and active work contributions done during human running with different imposed step frequencies (SF). This modification in SF results in an adjustment of the lower-limb stiffness. We hypothesise that the amount work done by the soft tissues (ST) is greater at low SF and at fast running speeds, due to greater impacts on the ground, and that the offset between positive and negative active work is reduced when the lower-limb stiffness increases, with a higher SF.

METHODS: Eight recreational male runners ran on a treadmill at 5 different speeds and 5 different step frequencies from 2 to 3.6 steps s-1. The lower-limb segment motion and the ground reaction forces were recorded. The increments of Wtot+/- were calculated as the respective sum of Wext+/- and Wint+/- as in (4). Wj was calculated with inverse dynamics (5) and the same limb joints were summed to account for energy transfer. ST+/- were computed as the respective differences between Wtot+/- and Wj+/-.

RESULTS: Our results confirm our hypothesis: ST+ and ST- increase with speed and decrease with frequency. Accordingly, as the spring stiffness increases with increasing SF, the discrepancy between active positive and negative work decreases.

CONCLUSION: Optimal SF has been a topic of discussion in the literature. Elite runners have been reported to increase (6), decrease (7) or not show significant differences (8) compared to recreational runners. A deviation of the preferred SF adapts the amount of dissipative tissue work. This modification has key implications on running mechanics and performance and should be taken into account in such debate. Future studies should investigate ST modifications in conditions where net muscular work is uneven.

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ESTIMATION OF RUNNING EVENTS WITH FOOT-MOUNTED INERTIAL SENSORS FOR DIFFERENT RUNNING PACES

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INTRODUCTION: Stride- and step-segmented running parameters provide valuable information in the study of the running biomechanics and performance [1]. However, segmentation requires accurate identification of initial and final foot contact events (IC and FC). Inertial sensors (IMUs) are the most effective solution for in-field running analysis. Although the morphology of the inertial signals exhibits great changes with running speed, most of the methods proposed for IC and FC detection are tested only on specific paces, limiting applicability to in-field use. In this work, a comparative evaluation among state-of-the-art IMU-based methods for the estimation of IC and FC was performed on a wide range of running speeds. In addition, a novel speed-adaptive method was proposed.

METHODS: Three datasets were used: 1) 11 amateurs running on treadmill and track at 8-10 km/h; 2) 10 amateurs running on treadmill at 14 km/h; 3) 9 athletes performing sprints on track at 20-32 km/h. All the runners were instrumented with two IMUs (fs=200Hz for dataset 2, 100Hz for 1 and 3) attached on the shoelaces. Eight methods [2-9] based on peak detection were implemented and a novel method based on dynamic time-warping (DTW) was proposed [10]. DTW was used to calculate the similarity between each analyzed running cycle and 20 templates, i.e., mid-swing to mid-swing inertial signals from all the datasets labeled and confirmed by a gold standard (stereophotogrammetric system or instrumented pressure insoles). IC and FC of an analyzed running cycle were derived from the gold standard events of its most similar template. Friedman test with Bonferroni correction was used to investigate the errors obtained with each method varying running speed.

RESULTS: Errors obtained with [2-9] highly varied across different datasets (RMSE on IC within 13-25 ms for dataset 1, 26-54 ms for dataset 2 and 22-83 ms for dataset 3; RMSE on FC within 21-90 ms for dataset 1, 20-66 ms for dataset 2 and 44-94 ms for dataset 3), reaching significant differences with [2-7] ($P<0.05$). The overall best performance was achieved with the proposed method (RMSE below 33 ms for IC and 49 ms for FC), followed by [2] (RMSE below 40 ms for IC and 59 ms for FC). A significant decrease of errors on contact and flight time at 8-10 km/h was found with the proposed method than with [2] ($P<0.05$).

CONCLUSION: This study highlighted that state-of-the-art methods for the estimation of IC and FC during running are speed-dependent. The proposed DTW-based method is the most suitable for the events identification at 8-32 km/h, encompassing the speeds used by the slowest and fastest runners, and thus for the outdoor running analysis. However, its accuracy relies on the number and morphology of the templates.

Funding provided, in part, by Diadora S.p.A.

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Oral presentations

OP-PN09 Energy Metabolism II

THE INFLUENCE OF BIOLOGICAL SEX ON OXYGEN UPTAKE KINETICS DURING MODERATE AND HEAVY INTENSITY EXERCISE

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INTRODUCTION: The rate at which oxidative ATP provision can meet the energy demand of exercise is a determinant of contractile dysfunction [1]. Evidence suggests that females experience less contractile dysfunction than males for the same duration and intensity of exercise [2], however whether this is caused by bioenergetic differences or contractile properties is unknown. Therefore, this study compared the pulmonary oxygen uptake (VO2) kinetics during moderate and heavy intensity exercise in males and females.

METHODS: Sixteen healthy adults (8 of each sex, 27 ± 5 years) completed three experimental visits. First, an incremental exercise test (+25 W every 5 minutes) was performed to identify lactate threshold (LT), then an incremental exercise test (25 W.min-1) to exhaustion to identify VO2peak and power at VO2peak (Pmax). Visits two and three involved three six-minute cycling bouts at 80% of LT (moderate intensity), interspersed with six minutes of unloaded pedaling, and one 30-minute bout at a work rate 30% between LT and Pmax (heavy intensity).

Data from the final two visits were filtered and linearly interpolated (1s intervals), then pooled to form a dataset of six moderate and two heavy intensity transitions. The first 20 s of each transition was removed. Thereafter, three minutes of pre-transition data and six (moderate) or two (heavy) minutes of post-transition data were fit with a mono-exponential curve to obtain the parameters of the phase II kinetics. The VO2 slow component was also quantified for the heavy intensity bouts.

RESULTS: Absolute VO2peak was greater in males (3.47 ± 0.58 vs 2.49 ± 0.44 L.min-1, p=0.002), however relative values were not statistically different (46.2 ± 6.6 vs 40.5 ± 6.7 ml.kg-1.min-1, p=0.111). Males achieved greater power outputs at VO2peak and LT (p≤0.023), meaning power outputs for subsequent bouts were 30% greater compared to females.

The primary amplitude of the moderate intensity transition was not different between male and females (24 ± 3 vs 24 ± 5 %VO2peak, p=0.949). The time constant was also not different (27.9 ± 7.5 vs 24.8 ± 6.6s, p=0.385). Similarly, in the heavy intensity domain, neither the primary amplitude (43 ± 5 vs 38 ± 7 %VO2peak, p=0.179) or time constant (28.8 ± 7.9 vs 27.2 ± 7.1s, p=0.633) were different. Likewise, the amplitude of the VO2 slow component was not different between sexes (12 ± 7 vs 11 ± 3 %VO2peak).

CONCLUSION: No sex differences were observed in the VO2 response to exercise in the moderate or heavy intensity domains, implying there was no sex difference in the bioenergetic stress experienced. Combined with evidence of no hormonal effect [3] on these parameters, this suggests females should not be excluded from studies of cardiopulmonary responses to exercise. Data from near infrared spectroscopy will also be shared.

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FAT OXIDATION IS POSITIVELY ASSOCIATED WITH RUNNING PERFORMANCE AFTER STRENUOUS CYCLING IN YOUNG TRIATHLETES

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INTRODUCTION: Endurance performance can be predicted by maximal oxygen uptake (VO2peak), sustainable percentage of VO2peak, and energy cost of movement (C) (1). However, during prolonged exercise, the ability to maintain these physiological attributes, i.e., durability, has recently been shown to characterize elite performance, e.g., in cycling (2). Mainly, two metabolic mechanisms are discussed to adversely affect durability: an increase in C, e.g., due to reduced neuromuscular efficiency, and/or increased reliance on fat oxidation (FO) due to gradual glycogen depletion during prolonged exercise. Since the prediction of prefatigued cycling performance has recently been improved by considering FO (3) and in triathlon, running always occurs after cycling, this study investigated C and substrate metabolism in triathletes before and after strenuous cycling to determine their relevance to prefatigued running performance.

METHODS: Fifteen young squad triathletes (16 ± 1 yrs; 60.8 ± 5.5 mL·min-1·kg-1) completed a combined cycling and running incremental protocol. After three 5-min running stages on a treadmill (2.8 + 0.4 m·s-1, 30 s rest), athletes performed a 15-s sprint test, followed by a 20-min recovery phase, and a 3-min incremental test to exhaustion (~1.5 W·kg-1 + 20 W) on a cycling ergometer. Following an 8-min rest, another 5-min incremental test to exhaustion (2.8 + 0.4 m·s-1, 30 s rest) was performed on the treadmill. C, carbohydrate oxidation (CHO), and FO were estimated from spirometric data via indi-

rect calorimetry and compared in the first three running stages under fresh (before) and prefatigued (after cycling) conditions using rmANOVA. Associations between VO2peak, C, and CHO/FO and time to exhaustion (tlim) in the exhaustive incremental running test, were examined by correlation and stepwise regression analysis.

RESULTS: In contrast to unaltered C (4.59 ± 0.34 and 4.53 ± 0.36 J· kg-1·m-1, p = 0.12), mean CHO (2.82 ± 0.45 and 2.07 ± 0.37 g·min-1, p < 0.001) decreased, while FO (0.14 ± 0.13 and 0.41 ± 0.18 g·min-1, p < 0.001) increased from fresh to prefatigued running. Besides VO2peak (r = 0.59, p = 0.02), tlim (1610 ± 176 s) correlated with the change in FO (ΔFO) from fresh to prefatigued running (r = 0.49, p = 0.06). Regression analysis identified VO2peak, C, and ΔFO as the most informative model for tlim (adj. R2 = 0.59, p = 0.01).

CONCLUSION: In young triathletes, CHO significantly decreased and FO increased during running after strenuous cycling compared to before, while C remained constant. Due to the correlation between ΔFO and tlim and higher accuracy when ΔFO was added to the model for tlim, substrate metabolism should be considered for predicting prefatigued running performance in triathlon. In addition, the positive association between ΔFO and tlim suggests that high FO rates may be beneficial for performance and should thus be improved, e.g., by training with low glycogen availability.

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3 Maunder et al., 2022, EJAP

METABOLIC PROFILE IN BADMINTON MATCH PLAY

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INTRODUCTION: The intermittent nature of badminton suggests high involvement of anaerobic energy supply [2]. However, recent research showed that energy supply of match play might be predominantly aerobic [1]. To clarify the physiological requirements in badminton the present study aimed to analyse the metabolic profile using two different calculation models based on PCr-La-O2 method.

METHODS: 7 internationally ranked badminton players (5 males: age 21.2 ± 2.3 y, height 184 ± 7 cm, body mass 77.4 ± 9.8 kg; 2 females: age 18.5 ± 0.7 y, height 172 ± 11 cm, body mass 67.5 ± 9.1 kg) performed two sets of 15 min match play under training conditions. Rally and rest times, oxygen uptake (VO2), RER, and blood lactate concentrations (La) were obtained. Net metabolic cost (Etot) and percentage contribution to aerobic (Eaer), anaerobic alactic (Epcr), and lactic (Ela) energy supply were calculated by indirect calorimetry from VO2 and RER during exercise, fast component of postexercise oxygen kinetics (EPOC) and net La. The continuous model (con) considered replenishment of anaerobic energy stores only at the end of exercise. The intermittent model (int) accounted for replenishment of creatine phosphate (PCr) during the match by applying the EPOC model to each resting phase. Repeated measures ANOVA was used to compare the models.

RESULTS: On average 91 ± 11 rallies with mean duration of 7.1 ± 0.7 s and 12.3 ± 1.9 s rest in between were observed. Mean VO2, RER and La were 36.0 ± 5.3 ml·min-1·kg-1, 0.89 ± 0.05, and 2.2 ± 1.1 mmol·l-1. Etot was 675 ± 98 J·kg-1·min-1. Comparison between models revealed significant differences for Eaer and Epcr (con: Eaer 97% ± 1%, Epcr 3 ± 1%; int: Eaer 56% ± 9%, Epcr 43 ± 9%). Ela remained below 1% for both models. No differences could be observed between the sets or male and female players.

CONCLUSION: The study showed that selection of the underlying calculation model is crucial for the results. Consistent with a previous study, continuous model suggests that badminton is predominantly aerobic [1]. In contrast, the intermittent model revealed a considerably higher proportion of anaerobic alactic energy supply, while aerobic capacity is needed to replenish PCr stores during rest. This would be in line with general findings for metabolic profile in intermittent exercises [2]. However, since La dynamics cannot be reflected seamlessly by punctual measurements, the lactic content might be underestimated in both models.

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ALL IN ONE TESTING OF ĊLAMAX AND V̇O2MAX: MODELLING ĊLAMAX OUT OF POST LACTATE VALUES AFTER A RAMP TEST – A CASE STUDY

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INTRODUCTION: Lactate concentrations during a graded exercise test are commonly used as indicator for endurance performance. Mader (2003) implemented a theoretical framework of human energy metabolism using mathematical equations which was further developed as a computer simulation. For a determination of the physiological responses of

exercise two key parameters are needed: the maximal glycolytic (ċLamax) and oxidative (VO2max) flux rates. As the maximum rate of lactate formation increases, the maximum lactate values post-exercise increase as well. For endurance athletes the ċLamax is considered as an important variable as they usually have high percentages of type 1 fibers, which usually contain low concentrations of anaerobic enzymes. Based on the simulation, Heck et al. (2022) proposed that ċLamax can be inferred from post lactate values after a VO2max-ramp test. We aimed to validate this approach to determine ċLamax via an exponential function.

METHODS: Recreational cyclists and triathletes (n=3) with a weekly training volume above 6h were recruited. A 15s sprint test to measure ċLamax followed by a ramp test until exhaustion to measure VO2max with a break of 45min between both test was completed. Testing was conducted on a Cyclus 2 ergometer on subject's own bike. Blood Lactate concentration was measured before and each minute after the respective test. Gas exchange was measured in the ramp test via the MetaMax 3B-system. ċLamax was calculated by using the formula: ċLamax = 0.18+0.00996*exp(0.241*maximal post lactate value). This formula based on assumed values for an average cyclist. One step further, we individualized this formula based on our measures. In the simulation, PCr-values for exhaustion were set at 1, 3 and 5 mmol per kg muscle mass (kgm), respectively. Descriptive statistics were used for comparing the experimental versus simulation-derived version.

RESULTS: Determination of ċLamax in the sprint test was higher [0.56 mmol/l/s (0.54-0.57)] compared to the calculation based on the post-exercise lactate values after the ramp test [0.47 mmol/l/s (0.33-0.66)]. The absolute difference showed a 30% difference from the measured value (0.17 mmol/l/s). With individualized formulas and different exhaustion criteria based on PCr, results also differed from measured values (1mmol/kgm: 0.37 mmol/l/s (0.24-0.53)]; 3mmol/kgm: 0.92 mmol/l/s (0.44-1.54); 5mmol/kgm: 2.85 mmol/l/s (1.33-4.83)].

CONCLUSION: Preliminary results show a high incongruent relationship between estimated and measured values. A fixed criterion for exhaustion based on the PCr-value does not seem to useful and should also be individualized. These results suggest that it might not be possible to calculate ċLamax after a VO2max-ramp test yet and should further be examined. For a more accurate assumption if the formula can be used, should be adjusted or if the criterion of exhaustion should be fixed or adjusted on an individual basis, a greater sample size is required.

MIR-29 FAMILY PLAYS A RELEVANT ROLE IN ENDURANCE PERFORMANCE THROUGH THE UPREGULATION OF EXERCISE-ASSOCIATED ENERGY MOLECULAR PATHWAYS

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UNIVERSITY OF OVIEDO

INTRODUCTION: Endurance exercise has been widely reported to have numerous beneficial effects on the oxidative capacity of skeletal muscle, mainly mediated by an increase in the number and size of mitochondria via PGC1α 1. This increase is largely related to improved exercise capacity and maximal oxygen uptake (VO2max) 2. In recent years, the miR-29 family has been reported to play a key role in both the modulation of mitochondrial homeostasis, targeting PGC1α, and glucose and fatty acids metabolism, two of the main substrates used during exercise 3,4. The aim of this study was to assess the role of the miR-29a/b1 cluster in endurance capacity through the regulation of energy metabolism pathways

METHODS: 14-week-old male mice deficient in the miR-29a/b1 cluster (KO; n=8) and their corresponding wild-type controls (WT; n=8) were used. After 2 weeks of adaptation, maximal endurance capacity was assessed using an incremental test on a treadmill, where blood glucose and lactate levels were monitored each 3 minutes. Animals were sacrificed 48 h after the test and skeletal muscle samples (quadriceps and soleus) were collected. The expression of miR-29a-3p, miR-29b-3p, and miR-29c-3p and several genes involved in glucose and fatty acid metabolism were measured by qPCR: Pgc1α, Glut1, Glut4, Ampk, Pfkm1, Acadvl, Acadm, Slc27a1, and Slc27a4

RESULTS: KO mice showed a significantly lower maximal endurance capacity. Accumulation of blood lactate during the test was observed in WT but not in KO animals, where this parameter remained low and stable. No expression of miR-29a-3p was confirmed in the KO group, showing also a significantly lower miR-29b-3p expression (Qua, p = 0.0001; Sol, p = 0.0001). Interestingly, as for miR-29c-3p, it was significantly reduced only in the soleus (p=0.012) but not in the quadriceps of KO mice (p=0.949). Unexpectedly, no differences in Pgc1α expression were observed between the two groups in either tissue. However, in relation to the expression of genes related with energy metabolism, both quadriceps and soleus showed an increase in Glut4 and Acadvl, while no changes were detected in Slc27a1 and Acadm. A muscle-type specific response was observed for Pfkm1, which was overexpressed in quadriceps, and Glut1, Ampk, and Slc27a4, in soleus.

CONCLUSION: The miR-29 family plays an important role in endurance capacity through the upregulation of the metabolism of the most important substrates for energy production via oxidative phosphorylation in skeletal muscle, in a muscle-specific manner. This response may be due to the specific downregulation of the other cluster member, miR-29c-3p, in soleus.

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Invited symposia

IS-MH05 The power of water: Hydrotherapy for the prevention and treatment of cardiovascular disease

H2-GO! THE PHYSIOLOGY AND CLINICAL IMPACTS OF WATER-BASED EXERCISE IN THE UPRIGHT POSTURE IN HUMANS

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THE UNIVERSITY OF WESTERN AUSTRALIA

Results of a randomised controlled 6 month intervention comparing water and land based walking in older adults: This talk will summarise our novel findings regarding the acute effects of water immersion on systemic haemodynamics, and in particular the impacts on blood flow and shear stress through cerebral and peripheral arteries in vivo. These findings, including the impacts of exercise in the water on physiological outcome measures, led us to undertake a comprehensive randomised controlled superiority trial of the impacts of 6 months of supervised centre-based exercise at matched intensity, performed in either waist-to-chest deep euthermic water, or on land, versus a usual care control group. Outcomes included cognition, cardiopulmonary fitness, body composition (DXA), blood pressure, blood lipids, peripheral endothelial function (FMD) and cerebrovascular function assessed using transcranial Doppler ultrasound responses to autoregulation, neurovascular coupling and CO2 exposure. Our findings will encourage further investigation and potential uptake of this novel and safe interventional strategy, particularly in older less active individuals at risk of falls and musculoskeletal injury.

JUST ADD HOT WATER: TURNING UP THE HEAT ON CARDIOVASCULAR DISEASE

COTTER, J.

UNIVERSITY OF OTAGO

Many people find traditional exercise programmes a challenge due to medical conditions or physical limitations. Examples include those awaiting hip and knee joint replacement surgery, and those with peripheral arterial disease: both limited by pain and poor mobility. As a consequence of their immobility, fitness, mobility, cardiovascular status and quality of life can deteriorate, and risk of surgical complications increases, as these patient populations often proceed to surgical interventions beyond initial conservative management. Alternative cardiovascular therapies are needed for such clinical populations.

Recent work from our group and others has shown that regular heat exposure can be protective against cardiovascular disease. Heat induces transient cardiovascular and metabolic responses that are not unlike those occurring during a bout of exercise, including elevated core temperature, reduction in blood pressure and increased peripheral blood flow. The addition of individualised, non-weight-bearing, mild resistance exercise is important for increasing glucose uptake, neural activation, blood flow and muscle growth. This talk will focus on the role of heat therapy via hot-water immersion with mild resistance exercise in patients who find traditional exercise difficult. The intended outcomes of this program are to improve strength and functional capacity and reduce cardiovascular risk and associated cardiovascular pathology, and to improve quality of life.

MAKE A SPLASH - AQUATIC ACTIVITY AS AN OPTIMAL THERAPEUTIC EXERCISE STRATEGY FOR STROKE SURVIVORS

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Regular exercise is a recommended strategy to improve physical function, fitness and quality of life after stroke, and to prevent subsequent strokes. However, current exercise guidelines for stroke survivors are the same as the general population, which do not account for the reduced physical capacity of stroke survivors to exercise due to their stroke-acquired disability. Moreover, stroke-related loss of function and reduced physical fitness and muscle strength mean that traditional exercise approaches such as moderate intensity jogging are not realistic for many stroke survivors living in the community with permanent disability. Therefore, alternative approaches that are accessible to all stroke survivors are needed to allow these patients to access the health benefits of exercise.

Immersion in water applies an external environmental pressure on the body that helps return blood to the heart and improve blood circulation through blood vessels. This movement of blood through the vessels releases key compounds linked with better vascular function. Consequently, water-based exercise has great potential to enhance the benefits of exercise on vascular health; benefits that span from lowering resting blood pressure to improving brain blood vessel function, both of which are key risk factors for stroke. This talk will present findings from our work investigating the effectiveness of aquatic treadmill exercise to improve vascular health and physical function in stroke survivors.

Oral presentations

OP-PN12 Hypoxia I

EFFECT OF REPEATED SPRINT TRAINING IN HYPOXIA ON THE REDOX BALANCE IN WELL TRAINED ATHLETES

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INTRODUCTION: Elite athletes use altitude or hypoxic training in the belief that it will enhance their ability to compete successfully at the international level. Beyond traditional "live high-train high" or "live high-train low" models, simulated altitude training modalities using hypoxia intermittently as an additional stressor have been widely investigated. The repetition of short 'all-out' sprints with incomplete recoveries in hypoxia - the so-called repeated sprint training in hypoxia model- has seen unprecedented scientific interest after the seminal study published by our group in 2013. Hypoxic exercise was however also shown to increase the oxidative stress through overproduction of reactive oxygen species. There is hence only scarce knowledge on the impact of RSH on the oxidative stress and antioxidant systems. Besides the significant molecular and systemic adaptations already reported after RSH, this work focused specifically on the effect of RSH on oxidative stress and antioxidant response. A potential positive effect of RSH compared to repeated sprint training in normoxia on the redox balance was hypothesized.

METHODS: 50 male well-trained road cyclists and mountain-bikers volunteered in the study. They were matched into two different intervention conditions (hypoxia; RSH vs normoxia, RSN) and tested twice near seal-level (before, pre-, and after, post-, a 4-week training protocol) for the determination of repeated sprint ability, endurance performance and anaerobic capacity, muscular signaling pathways, oxidative stress and antioxidant status. Antioxidant enzymes activity (SOD; GPX; and catalase), NO metabolites (NOx), ferric reducing antioxidant power, MDA, nitrotyrosine, carbonyls were measured in plasma. Only biochemical data will be analysed and discussed here.

RESULTS: MDA and carbonyls increased in the RSN group ($p<0.05$) but not in the RSH group, after training at rest and also after the RSA test. Carbonyls were increased in both groups after the RSA test ($p<0.05$). Catalase increased after the RSH training intervention, after the RSA test ($p<0.05$), regardless of the hypoxia or normoxia group. SOD and nitrotyrosine were decreased ($p<0.05$) at rest and after RSA post training, regardless of the group. NOx decreased after RSA, both before and after the training intervention, regardless of the group ($p<0.05$).

CONCLUSION: Our results show that 4 weeks of RSH blunted the increase in oxidative stress markers (MDA, carbonyls) both at rest and in response to RSA test, when compared to the same training intervention in normoxia. Training down-regulates SOD activity maybe due to an overproduction of ROS . The decrease of NO, illustrated by the decrease of NOx and nitrotyrosine, in response to the RSA test could be explained by radical overproduction, with a concomitant eNOS inhibition caused by the ROS. Our results may lead to a paradigm shift with a better enzymatic adaptation in response to the oxidative stress after RSH and/or a different ROS production between RSH and RSN.

SEX DIFFERENCES IN PULMONARY LIMITATIONS DURING MAXIMAL-INTENSITY EXERCISE IN NORMOXIA AND HYPOXIA

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INTRODUCTION: Pulmonary system is generally not considered as limiting for endurance performance. However, in some specific population (endurance-trained athletes) or environmental condition (altitude), this system may not meet maximal exercise demand. In endurance-trained athletes, the excessive strain placed on the respiratory system (relative to its capacity) could lead to expiratory flow limitation (EFL) and exercise-induced hypoxemia (EIH). Moreover, because of smaller airways and lung size, women are suspected to be more prone to develop pulmonary limitations to endurance performance. These mechanisms may be exacerbated in hypoxia due to lower alveolar-to-arterial diffusion.

The aim of the present study was to investigate the impact of sex and aerobic fitness on pulmonary limitations at maximal intensity in normoxia and hypoxia.

METHODS: 50 young healthy participants were divided in four groups according to their sex and aerobic fitness; trained women (TW, n = 12, VO2max = 54.9 ± 3.9 ml.min-1.kg-1), control women (CW, n = 12, 45.4 ± 4.7 ml.min-1.kg-1), trained men (TM, n = 12, 68.9 ± 6.0 ml.min-1.kg-1) and control men (CM, n = 14, 54.3 ± 4.3 ml.min-1.kg-1). They performed two maximal incremental cycle tests in normoxia and hypoxia ($FiO2 = 0.14$) with gas exchanges measurements. Standardized spirometry tests were used. Pulmonary limitations were evaluated using the maximal flow volume loop and pulse O2 saturation monitoring.

RESULTS: EIH was more prevalent ($p = 0.012$) and contradictory EFL less common ($p = 0.022$) in women than men. EIH prevalence was different ($p = 0.014$) between groups (28% TW, 43% CW, 24% TM, and 5% CM). All EIH men but only 40% of EIH women exhibited EFL. The normoxia- to-hypoxia decrease in VO2max (%VO2max) was correlated to EIH severity only in TM ($r = -0.63$, $p = 0.028$). In normoxia, EFL was associated to higher slope ratio ($p = 0.029$), higher ventilation (VE) ($p < 0.001$), larger %VO2max ($p = 0.019$) and lower hypoxia-related VE increase ($p < 0.001$). In hypoxia, EFL was only associated to higher VE ($p < 0.001$).

CONCLUSION: Our results show sex differences in the pulmonary limitations to exercise in normoxia and hypoxia. The well-described relationship (in male athletes)1 between EIH severity and %VO2max is not present when women are considered. Although women are more hypoxemic than men in normoxia, they are less impacted by hypoxia. EFL seems always involved in EIH men. Individuals with EFL in normoxia are not able to increase their VE in hypoxia and hence exhibited a higher drop in VO2max. Overall, these results highlight that pulmonary limitations have different origins (e.g., mechanical constraints) and consequences in women compared to men that required specific investigations.

1. Chapman et al. Degree of arterial desaturation in normoxia influences VO2max decline in mild hypoxia. MSSE 1999.

ACUTE RESPONSES OF THE INTER-EFFORT RECOVERY HYPOXIA ON PHYSIOLOGICAL, CARDIORESPIRATORY PARAMETERS AND MUSCLE OXYGENATION DURING HIGH-INTENSITY INTERVAL EXERCISE IN RUNNING.

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INTRODUCTION: Exposure to hypoxia associated with interval training (IT) improves physical performance [1], but contradictory responses to the addition of hypoxia have been demonstrated depending on the variation of the IT. Apparently, the main benefits of adding hypoxia to training on performance seem to be evidenced when the absolute intensity of the training is preserved [2]. Additionally, a greater FiO2 variation seems to be an important stimulus for adaptations resulting from hypoxia exposure [3]. The aim of this study was to investigate the acute responses of inter-effort recovery hypoxia on physiological, cardiorespiratory parameters, and muscle oxygenation during high-intensity IT of running.

METHODS: Twelve amateur runners performed three IT sessions randomly distributed, composed of ten 1-min efforts at 120% of VO2PEAK with 2 min recovery between each effort in three different conditions: efforts and recovery in normoxia (GNN; FiO2=20.5%), efforts and recovery in hypoxia (GHH; FiO2=13.5%), and efforts in normoxia with recovery in hypoxia (GNH; FiO2=13.5%). Oxygen consumption, respiratory exchange ratio (RER), and vastus lateralis muscle oxygenation were monitored. During recovery, subjective perceived exertion (RPE), blood lactate ([La-]), and arterial oxygen saturation (SpO2) were measured. For all variables, mean values during effort (E), recovery (R), and mean differences between E and R (Δ=E-R) were compared by the Friedman test with Durbin-Conover post hoc ($p<0.05$).

RESULTS: No differences were found between conditions for [La-]. GHH showed higher mean RPE during efforts ($p=0.002$) and a lower success rate (85.7±15%) of complete efforts than GNN (100%; $p=0.003$) and GNH (100%; $p=0.003$). The ΔFiO2 of GNH (5.4±0.1%) was higher than GNN (0.01%; $p<0.001$) and GHH (0.1%; $p<0.001$). The mean SpO2 in GNN (94.8±2.2%) during recovery was highest than GNH (87.7±2.4%; $p<0.001$) and GHH (79.2±7%). Surprisingly, GHN presented the highest mean VO2 during the efforts (43.8±2.4 ml/Kg/min) than GNN (41.6±5.3ml/Kg/min; $p<0.001$) and GHH (31.7±5 ml/Kg/min; $p<0.001$). During recovery, GNN showed higher VO2 than the other conditions ($p=0.002$). The highest ΔVO2 was in the GHN, followed by GNN and GHH ($p<0.001$). During efforts, the RER of GHN (0.86±0.03) was lower than GNN (0.97±0.08; $p=0.007$) and GHH (1.08±0.2; $p<0.001$). The deoxy-hemoglobin (HHb) during recovery was higher for GHH (31.4±10.3μM) when compared to GNN (23.3±8.4 μM; $p<0.001$) and GNH (27.6±8.9μM; $p<0.001$). GNN also showed lower ΔHHb when compared to the other conditions ($p>0.025$).

CONCLUSION: It can be concluded that the inter-effort recovery hypoxia does not affect RPE nor limit performance but promotes increases in the aerobic contribution (i.e., VO2) during efforts of high-intensity exercise. Furthermore, the responses of RER suggest that HH is prone to buffering action during efforts, differently from HN, demonstrating the potential use of the aerobic pathway.

1. Vogt et al. (2003); 2. Girard et al. (2017); 3. Zebrowska et al. (2019)

EFFECT OF HYPOXIA ON AEROBIC VS ANAEROBIC ENERGY EXPENDITURE DURING HIGH INTENSITY INTERVAL EXERCISE

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INTRODUCTION: Exercise in hypoxia decreases VO2max and markers of the maximum metabolic steady state (MMSS). Consequently, a given absolute exercise intensity in normoxia equates to an elevated relative intensity in hypoxia. Thus, exercise at given absolute workrate in hypoxia is characterized by a shift towards greater anaerobic energy contribution compared with normoxia. Few studies normalize relative intensity to MMSS nor select the magnitude of hypoxia based on known prediction equations. The purpose of this study was to examine the impact of hypoxia on aerobic, glycolytic and alactic energy expenditure (EE) during high intensity interval exercise (HIIE) at matched relative, and absolute intensity.

METHODS: Eleven active adults (M=6; F=5) completed a ramp-step incremental test on a cycle ergometer to determine the gas exchange threshold (GET) and respiratory compensation point (RCP). Normoxic MMSS was determined from RCP corrected for mean response time and hypoxic MMSS was estimated using a prediction equation. Thereafter, a HIIE session (5 or 6x3min intervals) was performed in three conditions: i) heavy domain normoxia (NORM-H: 12%MMSS), and iii) severe domain normoxia (NORM-S:12%>MMSS). Thus, NORM-H and HYPO were matched for absolute intensity, while HYPO and NORM-S were matched for relative intensity. Total work was matched for all conditions (147±49kJ). Aerobic, glycolytic and alactic EE were determined via indirect calorimetry, delta lactate and the fast component of the VO2 recovery curve respectively.

RESULTS: Total EE was higher in NORM-S (1063±266kJ) compared to NORM-H (975±233kJ; P=0.01) but not HYPO (1016±229kJ; P=0.13). Efficiency was lower in NORM-S (14.9±6.9%) than NORM-H but not significantly (16.2±8.2%; P=0.07), and was similar to HYPO (15.5±7.3%). Aerobic EE was lower in HYPO (697±154kJ) compared to both NORM-H (752±178kJ;

P=0.007) and NORM-S (745±189kJ; P=0.047), whereas glycolytic EE was higher in both HYPO (196±59kJ) and NORM-S (199±46kJ), than NORM-H (99±32kJ; P<0.001). No significant differences were observed for alactic EE between conditions. Consequently, the % contribution to total EE from glycolysis was lowest for NORM-H (10.3±2.8%) compared to HYPO (19.3±3.8%; P<0.001), and NORM-S (19.0±3.0%; P<0.001), whilst the opposite was true for % aerobic contribution (NORM-H: 77.4±4.5%; HYPO: 68.7±2.5%; NORM-S: 70.2±4.0%; P<0.001).

CONCLUSION: When exercise was matched for absolute intensity, aerobic EE was reduced in hypoxia and this was compensated for by increased glycolytic EE. When matched for relative intensity, glycolytic EE in hypoxia was equivalent to normoxic HIIE i.e. conducted at a higher absolute workrate. Thus when relative intensity was normalized to MMSS, the anaerobic EE of HIIE in hypoxia 'mimics' that of normoxic exercise, but at a reduced absolute workrate. It is primarily glycolytic EE that was altered in hypoxia as opposed to alactic EE.

Oral presentations

OP-MH23 Metabolic syndrome and diabetes I

AEROBIC EXERCISE IMPROVES FAT OXIDATION CAPACITY AND REDUCES INSULIN RESISTANCE LEVELS IN PATIENTS WITH TYPE 2 DIABETES MELLITUS: PRELIMINARY RESULTS OF THE EDUGUTION STUDY

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INTRODUCTION: The practice of physical exercise is essential in patients with type 2 diabetes mellitus (T2DM). However, it is currently unclear which type of exercise is the best therapeutic tool for T2DM management. Thus, the aim of this randomized controlled trial was to analyze the effect of an aerobic training program, moderate-intensity continuous training (MICT) vs. high-intensity interval training (HIIT), on glycemic control and the maximal fat oxidation capacity during exercise (MFO) in people with T2DM.

METHODS: A total of 27 adults (n=11 females; 54.5±8.9 years; Body Mass Index=34.2±5.6 kg/m2) with T2DM were randomized into three groups: HIIT (n=7), MICT (n=9), and control group (CG) (n=11). The 12-week training consisted of three sessions per week, HIIT included 10×1 intervals pedaling at 90% of peak power output, and MICT consisted of continuous pedaling at 10% above the first ventilatory threshold for 50 minutes. Before and after the intervention, fasting blood samples were taken and glucose, insulin, and glycosylated hemoglobin (HbA1c) were analyzed. The homeostatic model assessment for insulin resistance (HOMA-IR) was calculated. The MFO was determined by indirect calorimetry with a gas analyzer with 15W/3-min increments. Then, after a 5-min resting period, a maximal test with 1-minute steps (15W) was performed until exhaustion. To examine the effect of the intervention, a 3×2 mixed ANOVA with repeated measures was used.

RESULTS: No statistically significant differences were found between groups at the beginning of the intervention (p>0.05). After the intervention, a main effect of time was observed for basal insulin levels (F(1,24)=5,73; p=0.025; ηp2=0.19) and HOMA-IR (F(1,24)=4,75; p=0.039; ηp2=0.17). Moreover, a significant time x group interaction was observed for MFO (F(2,24)=8,69; p=0.001; ηp2=0.42). Specifically, after the intervention, significant differences (p=0.008) were observed between the MICT group (0.36±0.10) and the CG (0.23±0.08). In fact, significant improvements in MFO were observed in MICT group (0.29±0.07 vs. 0.36±0.10; p=0.003), while the CG decreased MFO (0.27±0.10 vs. 0.22±0.08; p=0.016). No significant effects were observed for blood glucose or HbA1c (p>0.05).

CONCLUSION: A 12-week aerobic exercise program is effective for improving MFO and insulin sensitivity in adults with T2DM. In fact, MICT appears to be superior to HIIT, although no significant differences were found. However, more studies are needed, since it seems that the benefits of HIIT and MICT are different depending on the adaptations that each training produces. Thus, HIIT could be more effective for improving cardiorespiratory fitness, although it depends on the HIIT protocol used, while for the improvement of glycemic parameters, both trainings are equally beneficial.

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DOES TRAINABILITY DIFFER BETWEEN PATIENTS WITH TYPE 2 DIABETES AND OBESE CONTROLS?

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INTRODUCTION: Aerobic exercise improves insulin sensitivity, reduces glycated hemoglobin (HbA1c), and increases maximal oxygen uptake (VO2max) in patients with type 2 diabetes (T2D)(1). However, adaptations following training vary between individuals(2), and it has been suggested that patients with T2D have a less pronounced increase in VO2max in response to the same intervention. This study investigates changes in VO2max and its relation to glycemic control in T2D and obese controls (CON) following an aerobic training intervention.

METHODS: Seven patients with T2D (7 males, age: 49.1 ± 7.4 years, BMI: 33.5 ± 3.7 kg/m2, VO2max: 24.7 ± 3.7 ml/min/kg, HbA1c: 67.3 ± 23.6 mmol/mol, time since diagnosis: 3.2 ± 2.1 years) and 8 CON (7 males, ne female, age: 51.9 ± 8.0 years, BMI: 35.2 ± 4.0 kg/m2, VO2max: 27.3 ± 3.4 ml/min/kg, HbA1c: 36.9 ± 5.3 mmol/mol) completed a

training intervention (12 wks; two bike sessions and one rowing session of 45 minutes with intervals of 3-8 minutes at an intensity equivalent to 80 % of VO2max or heart rate reserve. All participants completed between 35 and 37 sessions). The study is ongoing and actively enrolling, and preliminary data are presented. Aerobic capacity was measured before and after intervention by the Breath-by-Breath mode (COSMED, Rome, Italy). HbA1c was measured and taken as an index of glycemic control. Hba1c and VO2max data were analyzed using paired t-tests, and two-way ANOVA with repeated measures for changes between groups. Correlation between VO2max and change in HbA1c was done by Pearson's correlation coefficient. Results are presented as mean ± SD.

RESULTS: VO2max increased to the same extent (p=0.0914) both T2D and CON (+7.2 ± 1.6 ml/min/kg (29 ± 4 %), p<0.00001; +4.5 ± 3.9 ml/min/kg (18 ± 15 %), p=0.0138, respectively). HbA1c decreased significantly in T2D group (–6.4 ± 8.1 mmol/mol, p=0.0403) but not in CON (+0.6 ± 4.4 mmol/mol, p=0.3511). The change in glycemic control in T2D did not correlate with the change in VO2max (Pearson's correlation coefficient, R2=0.00574).

CONCLUSION: 12 weeks of aerobic training improves VO2max in both T2D and CON with no difference between groups. While no difference in trainability was observed, the T2D had a relatively lower baseline VO2max, which may impact the outcome. T2D had a significant change in HbA1c after training. The change in VO2max did not correlate to the change in HbA1c in T2D. Changes in VO2max were very similar for all subjects with T2D, whereas the changes in HbA1c were scattered. The broad range of baseline HbA1c partly explains this. A larger population with the possibility to stratify on baseline HbA1c perhaps elicit a different outcome.

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THE EFFECT OF ACUTE KETONE MONOESTER INGESTION ON MUSCLE OXYGENATION AND SYSTEMIC VASCULAR FUNCTION AT REST AND DURING INCREMENTAL CYCLING EXERCISE IN ADULTS WITH TYPE 2 DIABETES MELLITUS

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INTRODUCTION: Type 2 diabetes mellitus (T2DM) is characterised by chronic hyperglycaemia and progressive insulin resistance, ultimately leading to systemic and microvascular dysfunction. Insulin regulates muscle microvascular perfusion and blunts skeletal muscle microvascular function at rest and during exercise in people with T2DM [1]. Acute exogenous ketone monoester (Kme) ingestion is associated with improved glucose tolerance and peripheral muscle oxygenation in healthy adults, but this has not been investigated in people with T2DM. This study examined the acute effects of Kme ingestion on peripheral muscle oxygenation and systemic vascular function in adults with T2DM at rest and during incremental cycling exercise.

METHODS: Thirteen adults with T2DM (age=66±9 y; mass=90.3±15.2 kg; HbA1c=54±7 mmol/mol) participated in this double-blind, placebo controlled, randomised crossover trial. Participants attended the laboratory on 2 separate occasions, ingesting upon arrival either a Kme drink (0.115 g/kg (R)-3-hydroxybutyl (R)-3-hydroxybutyrate) or placebo drink, matched for taste. At rest and throughout incremental cycling exercise peripheral muscle oxygenation [tissue saturation index (TSI%)] of the gastrocnemius medialis was assessed using near-infrared spectroscopy, systemic vascular resistance (SVRi) was measured by thoracic impedance cardiography and pulmonary gas exchange and ventilation were quantified using a metabolic cart.

RESULTS: Circulating [ßHB] was higher throughout the experimental protocol (mean diff. 1.38 mM; 95%CI: 0.85, 2.1; P=0.001) after Kme ingestion, compared to placebo. After Kme ingestion, TSI% was higher during moderate-intensity [mean diff 9.8%, (95%CI: 1.7, 13.1; P=0.019)] and peak (mean diff 13.8%, 95%CI: 5.6, 18.2; P=0.001) cycling exercise compared to placebo. SVRi was lower at rest [mean diff -705 dyn·s/cm5·m2 (95%CI: -1,336, -75; P=0.031)] and during moderate-intensity cycling exercise [mean dif. -916 dyn·s/cm5·m2 (95%CI: -1,526, -253; P=0.014)] in the Kme versus placebo condition. No differences were found between conditions for oxygen uptake ($\dot{V}O_2$) or ventilation ($\dot{V}_E$) during moderate-intensity exercise [$\dot{V}O_2$, mean diff 0.3 mL/kg/min, (95%CI: 0.1, 0.9; P=0.438)]; [$\dot{V}_E$, mean diff 1.9 L/min, (95%CI: -11.2, 15.1, P=0.766) and at peak exercise [$\dot{V}O_2$, mean diff 0.2 mL/kg/min, (95%CI: 0.1, 0.8; P=0.256)]; $\dot{V}_E$ mean diff 3.5 L/min (95%CI -9.6, 16.7, P=0.591)].

CONCLUSION: In people with T2DM, acute ingestion of Kme improves peripheral muscle oxygenation during incremental cycling exercise and lowers systemic vascular resistance at rest and during exercise, but does not influence oxygen consumption or ventilation.

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12 WEEKS OF AEROBIC TRAINING INCREASES MITOCHONDRIAL RESPIRATORY CAPACITY IN SKELETAL MUSCLE AND SUBCUTANEOUS WHITE ADIPOSE TISSUE IN PATIENTS WITH TYPE 2 DIABETES

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INTRODUCTION: Physical activity is well accepted to improve mitochondrial content, however, the current knowledge of mitochondrial adaptations to regular exercise in patients with type 2 diabetes (T2D) is inadequate in skeletal muscles and even further limited in adipose tissue. This ongoing project aims to study the impact of aerobic exercise training on mitochondrial respiratory capacity and reactive oxygen species production in skeletal muscle and subcutaneous white adipose tissue (scWAT). This will be studied in untrained patients with T2D and controls matched for age, sex, BMI, and maximal oxygen consumption (VO2max). We hypothesize that the training intervention will increase mitochondrial respiratory function and decrease mitochondrial production of reactive oxygen species in both groups.

METHODS: 30 obese patients with (n = 15) and without (n = 15) T2D will be subjected to a 12-week aerobic training intervention consisting of 45 minutes supervised bike exercise (2 times/week) and 45 minutes supervised rowing exercise (1 time/week). Skeletal muscle (vastus lateralis) and scWAT biopsies will be obtained at baseline and after the intervention to assess mitochondrial respiratory capacity for complex I, complex I+II and the total electron transport respiratory capacity. Also, production of H2O2 during leak respiration will be measured. The mitochondrial functional analysis will be performed using high-resolution respirometry and fluorometry. Mitochondrial functional data will be analyzed using linear mixed models.

RESULTS: At the moment, 10 obese males with (n = 7. Mean ± SD: age = 49.1 ± 7.3 years, BMI = 34.9 ± 3.8 kg/m2, VO2max = 25.6 ± 3.6 ml/min/kg , HbA1c = 62.4 ± 14.8 mmol/mol, time since diagnosis = 3.2 ± 2.1 years) and without (n = 3. Mean ± SD: age = 47.2 ± 2.8 years, BMI = 35.2 ± 3.8 kg/m2, VO2max = 26.5 ± 4.2 ml/min/kg , HbA1c = 38.3 ± 4.9 mmol/mol) T2D have completed the study. At baseline, no differences in mitochondrial respiration or ROS production were present between the groups. When analyzing all participants, the intervention resulted in a 24.0 ± 3.8 % increase in VO2max (p-value = 0.004). The training intervention resulted in an overall increase in mitochondrial respiratory capacity in both skeletal muscle and scWAT in the participants with T2D (skeletal muscle: p-value = 0.0166, scWAT: p-value < 0.001). The training intervention had no effect on respiratory capacity in the control group. No effect of training was found on H2O2 production normalized to respiratory flux in either of the groups. Further analysis will clarify whether the increase in respiratory capacity is a result of increased mitochondrial content or increased respiratory capacity of each mitochondrion.

CONCLUSION: In patients with T2D, 12 weeks of aerobic training improved mitochondrial respiratory capacity in skeletal muscle and scWAT. Lack of changes in the control group may be due to the small sample size.

THE EFFECT OF REPEATED HOT WATER IMMERSIONS ON INSULIN SENSITIVITY, GLUCOSE TOLERANCE, EHSP70 AND INFLAMMATION IN INDIVIDUALS WITH TYPE 2 DIABETES MELLITUS: A PRE- POST-EXPERIMENTAL TRIAL

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INTRODUCTION: Type 2 diabetes mellitus (T2DM) is characterised by chronic hyperglycaemia, insulin resistance and hyperinsulinemia. Previous research suggests that chronic passive heating using hot water immersion (HWI) has the potential to improve insulin sensitivity and improve glycaemic control in healthy individuals [1], but data are limited in individuals with T2DM.

METHODS: 14 individuals with T2DM participated in this pre- vs. post-intervention study, with outcome measures assessed in fasted and post-prandial states (2 hr post 75 g glucose ingestion). HWI consisted of 1 hr immersion in 40°C water to the clavicle, with body position adjusted to maintain rectal temperature between 38.5 and 39°C; this was repeated 8-10 times over a 14 day period. Outcome measures included, insulin sensitivity, plasma [glucose] and plasma [insulin] (fasted and post-prandial). Other fasted outcome measures included plasma extracellular heat shock protein 70 ([eHSP70]), [interleukin-6] ([IL-6]) and interleukin-10 ([IL-10]), resting metabolic rate (RMR) and substrate utilisation.

RESULTS: Fasted insulin sensitivity increased (p = 0.03, d = 0.64) and fasted plasma [insulin] decreased (p = 0.04, r = 0.56) post-HWI intervention. In contrast, fasting plasma [glucose] (p = 0.83, r = 0.06), fasting plasma [eHSP70] (p = 0.08, d = 0.54), fasting plasma [IL-6] (p = 0.55, r = 0.16), fasting plasma [IL-10] (p = 0.59, r = 0.14), post-prandial insulin sensitivity (p = 0.19, r = 0.38), post-prandial plasma [glucose] (p = 0.40, d = 0.23) and post-prandial plasma [insulin] (p = 0.47, r = 0.19) were not significantly different post intervention. RMR was significantly reduced following the HWI period (p < 0.05, d = 0.59), although carbohydrate (p = 0.43, r = 0.21) and fat oxidation (p = 0.99, d < 0.01) rates were unchanged.

CONCLUSION: This study shows that 8-10 HWI's improves insulin sensitivity and lowers plasma [insulin] in the fasted state in individuals with T2DM, but not when glucose tolerance is challenged. A reduced RMR suggest improved metabolic efficiency. Together, these results are clinically important and may have implications for health outcomes and well-being in this population. Future work should investigate longer-term use of HWI, in addition to safety trials and establishing the minimum beneficial HWI 'dose' in individuals with T2DM.

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Oral presentations

OP-PN19 Thermoregulation I

AN OVERVIEW OF ELITE ATHLETE PREPARATION, KNOWLEDGE/PERCEPTIONS AND REAL/PERCEIVED BARRIERS TO THE IMPLEMENTATION OF EVIDENCE INFORMED BEST PRACTICE FOR COMPETITION IN THE HEAT.

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INTRODUCTION: At the 2015 IAAF Championships, in a manner not seen previously, elite athlete preparation for competition in the heat was explored. Increasing globalisation of sport and global temperatures mean elite sporting events are ever more likely to take place in extreme heat (e.g., Doha 2019 IAAF Championship, Tokyo 2020ne, etc.). Understanding elite athletes: (i) use of evidence informed best practice [i.e., heat acclimation/acclimatisation (HA)] to protect against heat induced health and performance decrements; (ii) knowledge/perceptions of exercise in the heat best practice; and (iii) the real/perceived barriers to implementing these, appears prudent. Therefore, this review aims to provide comprehensive insight into elite athlete preparation across three elite championships, regarding the above (i-iii).

METHODS: Review survey data from three recent major championships in the heat: i) Doha 2019 World Championships (DOHA); ii) Tokyo Olympics 2020ne (TOKYO) and iii) Muscat World Team Race-walking Championships 2022 (MUSCAT). Specifically assessing elite athlete preparation, knowledge, perceptions and barriers to the use of evidence informed best practice prior to competition in the heat. Comparisons between sex [male (MALE) vs. female (FEMALE)] and climate athletes live/train in [hot (HOT) vs. temperate/cold (TEMP)] are made where appropriate.

RESULTS: Across these championships there is an enduring disconnect between evidence and practice. HA strategies were used by ≤68% of athletes surveyed (MUSCAT: 57%, DOHA: 60% non-road race and 63% road race, TOKYO: 61% non-road-race and 68% road race). In the road race events at DOHA and MUSCAT those who HA prior to championships ranked higher than those who did not and were less likely to visit the medical tent. Athletes who live/train in HOT are more likely to HA. Limited knowledge of exercise in the heat best practice was exhibited at DOHA and MUSCAT; FEMALE exhibited significantly less knowledge at MUSCAT than MALE ($p \leq 0.024$). Access to facilities (including cost) were highlighted as the main barriers to implementing HA, particularly among those from TEMP, likely accounting for the lower uptake of HA in these athletes.

CONCLUSION: HA use prior to competition in hot conditions has increased since 2015 (15% vs up to 68% in the data from this review) but is not yet universal, despite clear benefits for health/performance (i.e., higher ranking and less medical tent visits by those who HA). Knowledge of best practice among athletes is limited and is lower in FEMALE. Significant barriers to the use of HA exist. Significant efforts from sport governing bodies are required to provide continuously updated educational material to athletes to reduce the gap between evidence-based and real-world practice translation (particularly in FEMALE). Access to facilities should be a priority for federations of athletes in TEMP. Assessment of elite athlete practice must continue prior to competition in the heat.

CONCURRENT VALIDITY OF THE CORE WEARABLE SENSOR WITH BODYCAP TEMPERATURE PILL TO ASSESS CORE BODY TEMPERATURE DURING AN ELITE WOMEN'S FIELD HOCKEY HEAT TRAINING CAMP

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INTRODUCTION: Wearable temperature sensors offer the potential to overcome several limitations associated with current laboratory- and field-based methods for core temperature assessment. However, their ability to provide accurate data at elevated core temperatures (Tc) has been recently questioned in a laboratory setting. Therefore, this investigation aimed to determine the concurrent validity of a wearable temperature sensor (CORE) compared to a reference telemetric temperature pill (BodyCAP) in an ecologically valid setting during a team sport heat training camp prior to the 2020 Olympic Games.

METHODS: Female field hockey players (n=19) in the Australian national squad completed 4 sessions in hot conditions where their temperature was monitored via CORE and BodyCAP. Concurrent validity of the wearable CORE device was determined with reference to the ingested BodyCAP pill. Three bands for temperature error were defined as: low (±0.1°C), moderate (±0.3°C), and high (>0.3°C), based on previously established thresholds.

RESULTS: Lin's Concordance Correlation Coefficients determined there was 'poor' agreement between devices during all sessions. Mean bias demonstrated that CORE underestimated Tc in all sessions (-0.06°C to -0.34°C), with wide mean 95% confidence intervals (±0.35°C to ±0.56°C). Locally estimated scatterplot smoothing regression lines illustrated a non-linearity of error, with greater underestimation of Tc by the CORE device, as Tc increased. The two devices disagreed by

more than ±0.1°C for 78-84% of all data samples in each session, and by ±0.3°C for 41-60% of all data samples in each session.

CONCLUSION: Our findings do not support the use of the CORE device as a valid alternative to telemetric temperature pills for Tc assessment in elite female team sport athletes, particularly during exercise in hot conditions where elevated Tc are expected.

EFFECT OF A NOVEL 'CONDENSED' HEAT ACCLIMATION INTERVENTION ON THE THERMOPHYSIOLOGICAL RESPONSES TO EXERCISE-HEAT STRESS.

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INTRODUCTION: Heat acclimation (HA) induces phenotypic adaptations that decrease thermal strain and heat- illness risk and improve performance in the heat. Short duration HA interventions (≤5 daily heat exposures), although attractive to time-poor individuals, result in incomplete adaptations compared to longer interventions (≥7 daily heat exposures). This is possibly due to the lower total accumulated thermal exposure over the shorter timescale. The aim of this study was to compare the phenotypic adaptations to a 'traditional' 8-day intervention with those induced by a 2-day 'condensed' HA intervention matched for total 'thermal exposure'.

METHODS: Using a between-groups design, healthy males performed either: 1) traditional 8-day HA (n =10; V̇O2max=47.7±8.1 mL.min-1.kg-1) consisting of 1×75-minute HA session·day-1 for eight consecutive days, or; 2) condensed 2-day HA (n=10; V̇O2max=50.8±5.6 mL.min-1.kg-1) consisting of 4×75-minute HA sessions·day-1 for two consecutive days. HA sessions used the controlled hyperthermia approach (ambient conditions=45˚C, 20% RH; target rectal temperature [Trec]=38.5˚C) and thermophysiological responses to 60-minute exercise-heat stress test (HST) were assessed pre- and post-intervention (ambient conditions=40˚C, 50% RH). Two-way mixed model ANOVA was used to investigate the main effects of condition (traditional vs. condensed HA), time (pre vs. post intervention) and their interaction (condition×time) on indices of thermophysiological adaptation; between groups differences in resting plasma volume expansions were analysed by independent samples t-test. Significance was set at $p<0.05$. These data represent an interim analysis of the final study sample.

RESULTS: A significant main effect of time was observed for resting Trec (-0.22˚C; $F=21.81$, $p<0.001$), peak exercise Trec (-0.39˚C; $F=135.10$; $p<0.001$), mean exercise heart rate (-7 beats·min-1; $F=24.55$; $p<0.001$) and peak exercise heart rate (-8 beats·min-1; $F=12.21$, $p=0.03$). In each instance there were no significant main effects of condition, or their interaction. Likewise, plasma volume expansion was similar between groups (traditional +8.1±4.0% vs. condensed +9.0±7.7%, $p=0.74$). A significant main effect of time ($F=148.36$, $p<0.001$) and interaction ($F=5.75$, $p=0.03$) was evident for whole-body sweat rate (WBSR), which was increased by +0.33 L·hr-1 with traditional HA and +0.22 L·hr-1 with condensed HA; the main effect of condition was not significant ($F=0.767$; $p=0.39$).

CONCLUSION: Both HA programs induced hallmark adaptations to heat that evidence an improved ability to thermoregulate. The novel finding from this preliminary analysis is that, excluding WBSR, a novel condensed HA program is capable of inducing robust thermophysiological adaptations within 2 days in healthy young males that are not different from the changes achieved in 8 days where thermal exposure is matched.

THE EFFECTS OF A COMBINED ACTIVE AND PASSIVE HEAT ACCLIMATION PROTOCOL IN ENDURANCE TRAINED TRIATHLETES.

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INTRODUCTION: To investigate the effects of a combined active and passive heat acclimation (HA) protocol on thermal and perceptual responses to heat stress after 4 and 7-days. In addition, the effects of 8-days HA and temperate exercise on self-paced cycling exercise in the heat.

METHODS: Twenty (15 men, 5 women) endurance-trained triathletes were randomised to 8-days HA (32 °C, 70% RH ; HOT; n =10) or temperate exercise intervention (20°C, 50% RH; TEMP; n =10). Active HA sessions (x5) involved cycling in the heat (maximum 90 minutes/day) to elicit a core body temperature of 38.5-39.3 °C. Passive HA sessions (x3) involved an initial 30-minute treadmill run in temperate conditions, followed immediately by hot water immersion (HWI; ≤40-min; 39.5 °C). Participants in the TEMP group completed 5-days temperate exercise training, involving cycling exercise (maximum 90 minutes/day). Sub-maximal cycling heat stress tests (45-minutes, 32 °C and 70% RH) were completed on the first (HST1), fifth (HST2) and seventh (HST3) day of HA. In contrast, the TEMP group completed HST's pre (HST1) and post-intervention (HST3). Physiological (rectal temperature [Tre], heart rate [HR], sweat rate) and perceptual (rating of perceived exertion, thermal sensation, and thermal comfort) responses were collected during HST's to evaluate heat adaptation responses. Venous blood was analysed pre- and post- HST1 and HST3 to evaluate changes in sympathetic activity (normetanephrine [NMET]) and fluid-regulatory stress (copeptin). 20-km cycling time-trials in the heat (32 °C and 70% RH) were performed pre and post 8-days of HA and following the temperate exercise intervention.

RESULTS: A lower resting and exercising; Tre (-0.25 °C, p = 0.001 and -0.25 °C, p = 0.001) and HR (-7 bpm-1, p = 0.003 and -10 bpm-1, p = 0.012) was evident after 4-days HA, with no further change after 7-days HA (HST1 vs HST3) in resting and exercising Tre (-0.04 °C, p >0.999 and -0.07 °C, p = 0.834) or HR (-2 bpm-1, p >0.999 and -2 bpm-1, p >0.999). Only

sweat loss increased (+23%, p = 0.020) from HST1 to HST3. Plasma volume increased (+9.6%, p = 0.025) after 7-days HA, and there was significant reductions in NMET (-40.4%, p = 0.001) and copeptin (-30.2%, p = 0.025) at the post-HST timepoint (HST1 vs HST3). There were no physiological or perceptual changes in the TEMP group (p > 0.05) post-intervention. There was no change in performance during the 20-km cycling TT in either group (p > 0.05).

CONCLUSION: In conclusion, 4-days combined active and passive HA was just as effective as 7-days HA for reducing physiological and perceptual strain. Though, 7-days HA was associated with significant reductions in surrogate markers of sympathetic activity and fluid-regulatory stress along with greater sweat loss and plasma volume expansion. However, 8-days of combined active and passive HA had no impact on self-paced performance in the heat.

EFFECT OF HEAT ACCLIMATION WHEN EXISTING TRAINING LOAD REMAINS CONSTANT – A PILOT STUDY WITHIN INTERNATIONAL TRIATHLETES

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INTRODUCTION: The acute nature of the induction and decay of heat acclimation (HA) adaptations often necessitates that HA is conducted in the weeks immediately preceding a competition, potentially interfering with a planned training taper. Therefore, we investigated the effect of a mixed active and passive heat acclimation protocol, during the 3 weeks prior to the 2022 U23 Triathlon World Championships, when the planned external training load was maintained.

METHODS: Six international triathletes (3 male, 3 female) completed eight heat acclimation sessions (5 active: running/cycling, 3 passive: hot water immersion [HWI]), across two weeks. To maintain the external training load, outdoor high-intensity training sessions were supplemented by 30-50 min HWI, whilst low-intensity cycling/running sessions were relocated to be completed in a hot environment (thermostatically controlled chamber). HWI sessions were designed to achieve and subsequently maintain, a core temperature of 38.5°C. A standardized 30-min run was completed in the hot environment (35°C, 60%) on days 1, 5, and 8, whilst hematological monitoring was conducted on 6 out of 13 days. Body temperature was monitored throughout all sessions using gastrointestinal pills (BodyCap, France) and sweat concentration was measured in duplicate at the sites of the upper arm and upper back on days 1, 5, and 8.

RESULTS: Compared with Day 1, there were changes in exercising core temperature (Day 8: -0.27±0.45°C, p<0.05), finishing heart rate (Day 8: -26±21 b.min-1, p<0.03), and sweat sodium concentration (upper arm Day 5: -33%, p<0.02; upper back Day 5: -33%, p<0.01; Day 8: -27%, p=0.04). There was no statistical difference in plasma volume (Day 5: +2.6±10%; Day 8: +2.4±7.8%; both p>0.05) whilst sweat potassium concentration increased (upper arm Day 8: +39%, p=0.01; upper back Day 8: +61%, p<0.01). Throughout the training period, no trends were evident for increases in cortisol (C), testosterone (T), C:T ratio, urea, platelets (all Δ<20%), or white blood cell count (Δ<28%). Similarly, there were no changes in athlete perceptions of training demands, muscle soreness, sleep quality, or appetite (all p>0.05).

CONCLUSION: A mixed active and passive heat acclimation protocol, implemented without altering the existing training programme volume, reveals various markers of heat adaptation, with no apparent detrimental effects on athlete health or training stress markers.

Oral presentations

OP-MH20 Respiratory disease

THE EFFECT OF ADDING COGNITIVE TRAINING TO PULMONARY REHABILITATION PROGRAM IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASES: A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Cognitive training (CT) has positive effects on some general cognitive functioning and selected cognitive abilities in patients with mild cognitive impairments. However, the combined effect of the CT and pulmonary rehabilitation (PR) program on selective cognitive abilities in patients with chronic obstructive pulmonary diseases (COPD) has not been evaluated yet. The aim of our study was to investigate the effectiveness of CT added to PR in patients with COPD.

METHODS: Thirty-nine patients with COPD were assigned to an intervention group (n = 21, age = 65.3 ± 2.79) and a control group (n=18, age = 65.3 ±3.2). The intervention group underwent PR combined with CT (PR: 45 minutes + CT: 30 minutes) and the control group underwent only PR (PR: 45 minutes), 3 times per week during 3 months. Spirometry, 6-minute walking tests (6MWT) and cognitive performances [Montreal cognitive assessments (MOCA) and P300 test] were evaluated. Measures were taken at baseline and after 3-months of training programs.

RESULTS: We showed a significant improvement of the 6MWT parameters (six-minute walk test distance, peripheral oxygen saturation, dyspnea and heart rate) after the rehabilitation period in both groups (P< 0.001). Both groups showed a significant improvement (P< 0.001) in cognitive performance (score MOCA and P300 test) latency in three midlines electrodes. However, these improvements in cognitive performances (Latency of P300 at Fz, Cz, Pz and the score of MOCA) were greater in the group that combined PR and CT.

CONCLUSION: The use of CT added to PR is more effective in improving cognitive abilities than PR alone for patients with COPD. This may offer to clinician a complementary approach to improve cognitive abilities in patients with COPD. It may be also useful for clinicians to help design new rehabilitation therapies.

NUTRITIONAL STATUS, METABOLIC PROFILE, PRO/ANTI-OXIDANT STATUS AND GUT MICROBIOTA COMPOSITION AS MEDIATORS OF NEUROMUSCULAR FATIGABILITY IN COVID-19 PATIENTS SIX MONTHS AFTER ICU DISCHARGE

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INTRODUCTION: It is well established that intensive care unit (ICU) stay alters neuromuscular function, potentially promoting long-term neuromuscular fatigability. The COVID-19 pandemic has strongly increased the number of patients admitted to ICU, especially frail people (i.e. with immunodeficiency or metabolic disorders). It has also been shown that SARS-CoV-2 infection exacerbates gastrointestinal disorders, affects appetite, alters gut microbiota, and promotes dysbiosis leading to inflammation. As these parameters are connected to muscle dysfunction, the aim of this study was to evaluate the potential implications of nutritional status, metabolic profile and gut microbiota composition on neuromuscular fatigability in post-COVID-19 patients six months after ICU discharge.

METHODS: 29 COVID-19 ICU patients (64 ± 11 years; duration of stay: 35 ± 17 days) were recruited 6 months post-ICU discharge. Knee extensors maximal voluntary contraction (MVC), voluntary activation (VA), quadriceps potentiated twitch force (Tw pot) were evaluated during a quadriceps intermittent fatigue test (%loss compared to rest). Neuromuscular parameters were correlated with perceived fatigue (FACIT-F version 4), body composition, metabolic profile, nutritional status (food questionnaires and blood parameters) and gut microbiota composition.

RESULTS: 79% of patients had overweight or obesity (46% and 23%, respectively); 30% had low-grade inflammation (CRPus >3mg/L), but no link was found between CRPus and neuromuscular properties. Perceived fatigue was not associated with any neuromuscular parameter. As expected, MVC and Tw pot were associated with weight and fat-free mass ($p < 0.05$). Fiber, vit D and zinc intakes were lower than the current recommendations. Although selenium intake was twice compared to the usual recommendations, plasma selenium was below the expected normal ranges and was associated with MVC, Tw pot and %loss Tw Pot ($r = 0.458$, 0.599 and -0.472, respectively; $p < 0.05$). Prealbumin was correlated with %loss Tw pot and %loss VA. Plasma 25-hydroxyvitamin D also was associated with %loss Tw pot. Plasma superoxide dismutase was associated with the number of contractions (i.e. local endurance performance), and plasma glutathion peroxidase with MVC and Tw Pot ($r = 0.617$, 0.574, and 0.824 respectively; $p < 0.05$). Porphyromonadaceae and Clostridiaceae were associated with the number of contractions and Bacteroidaceae with %loss Tw Pot ($r = 0.478$, 0.482, and 0.502 respectively; $p < 0.05$).

CONCLUSION: Six months post-ICU discharge, perceived fatigue and systemic inflammation were not related to neuromuscular fatigability in COVID-19 patients. Conversely, body composition, blood concentrations of selenium, pre-albumin and 25-hydroxyvitamin D, pro/anti-oxidant balance and different bacterial families were associated with neuromuscular properties. These preliminary results suggest that nutritional management may improve neuromuscular function recovery in COVID-19 ICU patients.

O2 SUPPLEMENTATION IMPROVES O2-UPTAKE KINETICS AND EXERCISE CAPACITY IN PATIENTS WITH PULMONARY VASCULAR DISEASE

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INTRODUCTION: Supplemental oxygen (O2) is commonly used to treat pulmonary vascular disease (PulmVD). The mechanisms by which O2 therapy confers benefits in patients with PulmVD during exercise remain unclear.The aim of this study was to understand the physiological mechanisms underlying the benefit of supplemental O2 in patients with PulmVD during exercise.

METHODS: Patients with PulmVD (Pulmonary Arterial Hypertension (PAH) or Chronic Thromboembolic Pulmonary Hypertension (CTEPH)) completed two symptom-limited ramp cardiopulmonary tests, and eight constant work-rate tests (CWRTs) at 80% of the work-rate (WR) at the gas exchange threshold (GET) (four repetitions for each condition). Patients performed the tests while breathing room air (RA, $FiO2 = 0.21$) or 30% oxygen ($FiO2 = 0.30$, a clinically relevant concentration of O2). Healthy individuals performed a maximal test only with $FiO2 = 0.21$, and CWRTs with both conditions ($FiO2 = 0.21$ and 0.30). O2-uptake (VO2) kinetics were calculated from the CWRT results using mono-exponential modelling. Results in the two test conditions (FiO2 0.21 and 0.30) were compared by repeated-measure statistics (Wilcoxon test).

RESULTS: Ten patients (age 54 ± 17 yrs; 8 females), with a diagnosis of pre-capillary pulmonary hypertension (8 PAH, 2 CTEPH) and 11 healthy individuals (age 51 ± 17 yrs; 5 females) participated. Peak WR and peak VO2 increased significantly from 76±26 watts and 15.4±3 ml/kg/min with RA to 85±26 watts and 17.4±5 ml/kg/min with $FiO2 = 0.30$ ($p=0.011$ and $p=0.015$, respectively). VO2 at the AT increased from 640±120 ml/min with RA to 764±180 ml/min with $FiO2 = 0.30$ ($p=0.012$). Compared with RA, the peak VO2/HR was higher with $FiO2 = 0.30$ (7.4 ml/min vs. 8.4 ml/min, $p=0.008$). In CWRTs, the time constants (tau) of phase II of VO2 kinetics were significantly faster in PulmVD patients while breathing with

FiO2= 0.30 (36±4 sec) compared to RA (43±6 sec; p=0.009). Plateau end tidal CO2 (ETCO2), ventilation (VE) and ventilatory equivalent for O2 (VE/ VO2) were calculated as the average of the last 60 sec of four CWRTs. ETCO2 increased from 28 mmHg with RA to 30 mmHg with FiO2= 0.30; VE decreased from 31 L/min with RA to 28 L/min with FiO2= 0.30, and VE/ VO2 decreased from 37±4 L/min with RD to 35±4 L/min with FiO2= 0.30 (p=0.01, p=0.02, p=0.011 respectively); In healthy individuals there was no improvement in VO2 kinetics with FiO2= 0.30 in contrast to RA (tau 34±5 sec vs. 35±6 sec, respectively, p=0.916).

CONCLUSION: Oxygen supplementation (30%) in PulmVD patients leads to significant increases in peak work-rate and peak VO2, and accelerates VO2 kinetics, presumably by increasing pulmonary blood flow in pulmonary capillaries and reducing pulmonary vascular resistance, thus increasing cardiac output and muscular oxygen delivery. Ventilatory efficiency also seems to improve with FiO2= 0.30.

THE INFLUENCE OF SEX AND BMI ON PULMONARY FUNCTION TRAJECTORIES IN YOUTH WITH CYSTIC FIBROSIS

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INTRODUCTION: Cystic Fibrosis (CF), the most common genetic disorder in Caucasian populations, is characterised by nutritional deficiency and frequent respiratory infections, with the foremost cause of morbidity and mortality remaining respiratory failure. There have been significant advances in the treatment and management of CF but, despite this, females with CF continue to have worse outcomes, including a poorer disease experience and shorter life expectancy, even when controlling for modulator therapy. This survival disadvantage is especially striking as it is in direct contrast to the superior survival associated with female sex in the general population. Whilst much research has focused on the role of sex hormones during puberty, this sex disparity is likely multi-factorial, with nutritional status believed to play an important role. Indeed, puberty is also associated with significant changes in nutritional status but, despite recognition that malnutrition and low body mass index (BMI) are associated with a poorer pulmonary function and increased risk of mortality, little is known regarding the influence of BMI trajectory on pulmonary function.

METHODS: This retrospective, longitudinal analysis used CF Trust registry data up to 2015 of those aged 6 – 17 years. Linear mixed models analysed the effect of sex and BMI percentile (BMIp) on percentage predicted forced expiratory volume in one second (ppFEV1) across time, with random effects for age using an autoregressive heterogeneous covariance matrix. The initial compact model used linear terms for age, BMI and their interaction with sex. This model was subsequently extended by progressively adding quadratic or cubic terms for age, BMI, and their interaction. Categorical differences in ppFEV1 in response to BMIp were explored in an independent model in which pairwise comparisons were adjusted using Tukey-Kramer.

RESULTS: The analysis involved 15,755 values of FEV1 and BMIp from 4,137 CF patients in the United Kingdom. According to the compact model, ppFEV1 declined with age, with a faster decline in girls (-2.3±0.1 vs. -1.75± 0.1%). In the full model, for every percentage change in BMIp, girls demonstrated a significant decrease in ppFEV1 that was not evident for boys. According to the categorical model, significant declines in ppFEV1 for every BMIp <50th (P<0.001) were evident in girls, compared to only <25th percentile for boys. Irrespective of sex, achieving a BMIp >75th percentile was associated with the most favourable ppFEV1 over time, with lower declines in ppFEV1 between the ages of 7-14 years.

CONCLUSION: This study shows that ppFEV1 declines from around puberty, with the rate of change influenced by BMIp, especially <50th percentile. Furthermore, the declines in ppFEV1 are influenced by sex, with females' ppFEV1 influenced by BMIp to a greater extent than their male counterparts. This highlights that BMI represents a key, sex-specific, intervention target to help ameliorate the sex disparity in CF-related outcomes.

Oral presentations

OP-SH12 Psychology in team sports

STRESS AND PERFECTIONISM AMONG MALE AND FEMALE AGE-SPECIFIC NATIONAL TEAM PLAYERS IN FOOTBALL, HANDBALL, AND ICE-HOCKEY

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Introduction. Junior elite age-specific national players are expected to be future senior elite players. These expectations come with pressure both from the player him/herself and from significant others in their development environment. This study investigated how national team players (male and female) in football, handball, and ice-hockey in Norway experienced stressors (global score) (SG) and how the two perfectionism dimensions evaluative concerns (EC) and personal strivings (PS), as well as playing time (club), and an overload injury impact on SG. We also controlled for gender, age, sport, and playing level of the players. Methods. The sample in this study was 274 male and female (45,6% female and 54,4% male) (players selected to an age-specific national team of U16-U19, (M=16.23, SD=1.06). Cronbach´s alpha was calculated to test the scale reliability of the factors; SG (□=.88), EC (□=.76), PS (□=.79). A linear regression analysis was conducted with SG as the dependent variable. Results. The regression model explained 19% of the variance in SG and turned out statistically significant (p<.001). EC (p<.01) and overload injury (p<.05) had a significant positive association with

SG, while playing time had a significant negative (p<.01) association on SG. Women scored significant (p<.01) higher on SG. There was no significant difference in PS, age, sport, and playing level on SG. Discussion. To be evaluated, both by yourself and others, is a natural part of being in a talent development environment. However, if a player has (or develops) evaluative concerns one needs to be aware that this might increase their level of overall stress. Finding PS not to be associated with SG is interesting. One might expect that players scoring higher on personal strivings also would score higher on stress. One explanation of our findings could be the sample of national team players, where all players naturally are striving for being a better athlete. Another explanation could be that being evaluated (of others) is more stressful than your own strivings. Furthermore, it is important that talented athlete`s significant others (i.e., coaches, parents) are aware that both reduced playing time and experiencing overload injury increases a player's level of stress.

EXPERTISE AND TRAINING OF ANTICIPATION IN GOALKEEPING

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Goalkeepers across sports frequently experience high spatio-temporal pressure and have to anticipate the action of their opponents to prevent them from scoring a goal. The aim of the present study was to summarize the current state of research on expertise and training of an-ticipation in goalkeeping through two systematic reviews and provide a detailed basis for the development of diagnosis and training of anticipation in youth and adult goalkeepers.

For the review on expertise in anticipation, the search term (anticipat* AND (expert* OR skill*) AND goalkeep*) was entered into the databases Web of Science, PubMed, Scopus and SURF. Primary studies from all years published in the English or German language that compared anticipatory performance in at least two differently skilled groups of goalkeepers were included in the study. For the review on training of anticipation, the search term (anticipat* AND train* AND (handball OR soccer OR football OR field hockey OR water polo OR lacrosse)) was entered into the aforementioned databases. Here, primary studies from all years published in the English or German language that investigated training of anticipation in a goalkeeping task were included in the review.

For expertise, N = 24 studies (179 total hits; n = 13 soccer, n = 10 handball, n = 1 field hockey) were identified. A total of n = 18 studies revealed that skilled goalkeepers show superior anticipatory performance compared to less-skilled goalkeepers. For training, N = 12 (492 hits; n = 6 soccer, n = 3 handball, n = 3 field hockey) studies were identified. Training interventions differed greatly regarding type of intervention, ranging from implicit over guided discovery to explicit approaches, as well as training duration and frequency. Notably, the research area on anticipation in sports appears quite atheoretical, that is, studies are not developed and findings are not interpreted with regard to an underlying theory but rather based on earlier findings in the field.

The results provide important insights into anticipatory performance in varying skill levels and reveal the effectiveness of different training methods. The development of theories on, for instance, expertise and training of anticipation as well as the implementation and testing of existing theories might prove fruitful for future research in the field. Further, particularly the lack of diversity in research regarding sports and tasks as well as the sparsity of research on potential differences in expertise and training effectiveness between youth and adult athletes should foster future research to ultimately gain a thorough understanding on expertise and training of anticipation that provides both research and practice with conclusive evidence for developing and maintaining anticipatory skill from youth to adult (elite) sports.

INFLUENCE OF SOCIAL IDENTITY ON EMOTIONS AND GROUP DYNAMICS IN TWO WOMENS TEAM SPORTS

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Influence of social identity on emotions and group dynamics in two womens team sports

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Introduction : Emotions are a widely studied topic in the field of sport psychology. In particular, the IZOF model (Hanin, 2000) and the Cognitive Relational Motivational Theory (Lazarus, 2000) have contributed to a better understanding of emotional phenomenon in competitive situations. To go further, some authors have pointed out the need to take more into account the social dimension of emotions, notably by mobilizing Haslam's social identity approach (Rees et al., 2015). Another limitation of the study of emotions is the lack of consideration of their intrinsic lability due to the constant evolution of the relationship between the individual and his environment (Cerin et al., 2000).

Purpose : This study aimed to investigate the dynamic relationship between individual emotions, team-referent emotions and perception of group dynamics through the self-categorization prism (personal or social identity). To approach the dynamic aspect of these relationships, we used the Mouse Paradigm developed by Vallacher, Nowak & Kaufman (1994) which allow us to continuously access to the emotional experience of the participant.

Method : A pre-match questionnaire composed of a measure of cohesion, two measures of identification was administered to ten female volleyball players and six female rugby players, all playing at a national level. After the match, a self-confrontation interview using the mouse paradigm was used to collect their dynamic evaluation of their emotions, the emotions of their group and the group dynamics of their team.

Results : Linear mixed-effects models showed that: a) individual and group emotions were correlated and that this relationship was moderated by the identity level, b) emotions (both individual and team-referent) were correlated with the perception of group dynamics.

Conclusion : These results confirmed Campo et al. (2019) study, and highlight the need to consider identity levels to understand emotions in sport, as well as their per-competition variability.

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Oral presentations

OP-MH30 Neurological diseases

PERSONS WITH MULTIPLE SCLEROSIS CHANGE THEIR HABITUAL PHYSICAL ACTIVITY OUTSIDE EXERCISE SESSIONS AS A BEHAVIOURAL COMPENSATION TO EXERCISE: A PILOT STUDY.

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INTRODUCTION: To date, exercise is a cornerstone in Multiple Sclerosis (MS) rehabilitation. However, recent systematic reviews indicate that objective physical activity (PA) levels of Persons with MS (PwMS) do not increase following an exercise intervention, while they self-report a higher exercise participation. This suggests that PwMS change their habitual PA outside exercise sessions (i.e. non-exercise PA) as a behavioural compensation to exercise, which might blunt the exercise effects. This pilot study aimed to explore non-exercise PA changes of PwMS and healthy controls (HC) when they participate in a structured exercise intervention, and how non-exercise PA changes interact with the exercise effects.

METHODS: Twenty nine mildly-disabled PwMS and 26 HC completed a 10-month home-based, running exercise program. Exercise adherence was tracked with sports watches. Primary outcomes were non-exercise PA (low- and moderate-to-vigorous intensity PA; LIPA and MVPA) and sedentary behaviour (SB; total SB and uninterrupted SB), which were monitored by accelerometry (activPAL3™) for 7 consecutive days at baseline (T1), after 5 (T2) and 10 (T3) months of exercise training. PA and SB were averaged over all days with an exercise session (EX days) and over all days without exercise session (NONEX days). Secondary outcomes included exercise effects on MS symptoms and physical function.

RESULTS: Exercise adherence was similar between groups (92.4±13.1% p=0.234). PwMS decreased their non-exercise MVPA significantly from T1 to T2 (-1.6±0.5% of waking time/day) and from T1 to T3 (-1.3±0.4% of waking time/day), with no difference between EX and NONEX days (group×time interaction effect p=0.017). These non-exercise MVPA reductions approximately matched the exercise duration at T2 and T3 (T2: -105 VS. 114±9min/week and T3: -84 VS. 105±9min respectively). Non-exercise MVPA did not change in HC. PwMS also significantly increased their uninterrupted SB on NONEX days compared to EX days (+0.7±0.3h, group×EX day interaction effect p=0.003), while HC did not. Non-exercise PA changes were not associated with demographics, baseline secondary outcomes nor exercise duration. Secondary outcomes improved similarly in both groups and were not associated with non-exercise PA changes.

CONCLUSION: In line with our hypothesis, PwMS changed their habitual PA outside exercise sessions. This was not seen in HC. Explanatory factors should be explored in future research, but based on the current findings it could be hypothesised that that is due to the specificity principle. Hence, future exercise interventions for PwMS should also include intervention components to target habitual non-exercise MVPA and uninterrupted SB. Although exercise effects were not impacted, the present findings in physically fit PwMS (on average >100% of their predicted cardiorespiratory fitness at baseline) with no to mild disability warrant further research in more disabled and/or deconditioned PwMS.

BENEFITS OF INDIVIDUALIZED TRAINING IN FATIGUED PATIENTS WITH MULTIPLE SCLEROSIS

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INTRODUCTION: Chronic fatigue is the most common and debilitating symptom in people with multiple sclerosis (PwMS). Recently, physical activity has proven to alleviate chronic fatigue and to improve muscular, cardiorespiratory, and cognitive functions. However, the effects of exercise may vary between PwMS, as MS is a heterogeneous disease and does not affect each individual in the same way. Tailoring the training intervention to the potential fatigue causes (e.g. reduced

muscle strength, deteriorated cardio-respiratory capacity, sleep disorders) could optimize the beneficial effects of training on fatigue. The objective of this study was to compare the effectiveness of an individualized (IND) vs a traditional (TRAD) exercise intervention in reducing chronic fatigue and improving quality of life of PwMS.

METHODS: Twenty-nine PwMS with high chronic fatigue (score of ≥ 4 on the Fatigue Severity Scale and a score of ≥ 38 on the Modified Fatigue Impact Scale) were randomly assigned to 12 weeks of either a TRAD or IND exercise intervention. TRAD comprised aerobic and resistance exercises according to the guidelines for PwMS. IND specifically addressed the deficits or areas for improvement identified in the initial lab visits (loss of muscle strength, cardiorespiratory deconditioning or sleep disorders). Participants visited the laboratory before and after training for the following assessments: patient reported outcomes (fatigue, quality of life, sleep and depression questionnaires), incremental cycling test (maximal oxygen uptake (VO2max), maximal power output (Pmax)), and cycling fatigue test (maximal voluntary contraction (MVC), rating of perceived exertion (RPE)).

RESULTS: IND induced a significant greater increase in VO2max (+21.0 ± 13.9 vs 6.8 ± 11.5%) and Pmax (19.4 ± 11.8% vs 3.4 ± 6.6%) than TRAD. A greater reduction in RPE at a given submaximal intensity was also observed in IND compared to TRAD (-30.3 ± 18.9 vs -12.1% ± 20.4%, p<0.001) whereas MVC increased similarly in both groups. Despite a greater improvement of depression in IND vs TRAD (-41.0 ± 23.4 vs -30.5 ± 45.4%, p<0.001), the improvements in fatigue, sleep and quality of life were not different between groups (p>0.05).

CONCLUSION: Tailored physical activity appears more efficient than traditional exercise interventions to increase some objective (VO2max, Pmax) or subjective (depression, RPE at a given submaximal intensity) parameters in fatigued PwMS. However, MVC and other subjective parameters (fatigue, quality of life, sleep quality, level of physical activity) improved similarly after the two training interventions. Tailored training could be advised to health practitioners in order to optimize rehabilitation for PwMS.

EFFECTS OF A TAILORED EXERCISE TRAINING PROGRAM IN PATIENTS WITH AMYOTROPHIC LATERAL SCLEROSIS

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INTRODUCTION: Amyotrophic Lateral Sclerosis (ALS) is a neurodegenerative disease characterised by the progressive loss of motor neurons, which leads to a reduction in muscle strength and physical function. Although "Exercise as Medicine" is accepted for many diseases, the role of exercise in individuals with ALS is still debated. However, evidence supporting a beneficial role for moderate-intensity exercise in these patients is emerging. The aim of this study was to evaluate the effects of a combined, moderate-intensity, aerobic and strength training program on strength and physical function in individuals with ALS.

METHODS: Twelve individuals with ALS were randomly assigned to either a training (3 times a week for 12 weeks; TRAIN, n=6) or a control (continued their usual standard of care; CTRL, n=6) group. At the end of the usual standard of care period, 4 participants in the CTRL performed the 12 weeks of training and these results are presented in TRAIN. The strength of both the lower- and upper-limb muscles were evaluated during a 1-Repetition Maximum (1RM) test on the leg press, leg extension, biceps curl, vertical chest press before and after 12 weeks. A handgrip maximal isometric test was also performed to evaluate the strength of the muscles of both hands. Participants performed the "Timed Up and Go" test (TUG) and the "6 min walking test" (6MWT)". The ALS Functional Rating Scale revisited (ALSFRS-R) was also measured.

RESULTS: There were 2 drop-outs in TRAIN and 1 in CTRL. The adherence to training was 84±2%, and the satisfaction regarding the training program, measured with the Visual Analog Scale, was 9.6±0.1 (out of 10). In TRAIN, the 1RM during leg press and leg extension increased significantly by 42±9% (from 98±17 kg to 139±22 kg, p=0.01) and by 46±13% (from 31±5 kg to 43±6 kg, p=0.01), respectively. In CTRL, the same parameters did not change significantly during the 12 weeks. There were no significant changes for the 1RM vertical chest press in both groups. For the biceps curl, we detected a significant difference between the changes in percentage for the two groups: the 1RM values increased by 20±6% in TRAIN while decreased by 36±17% in CTRL (p= 0.003). The maximal isometric strength during handgrip decreased significantly in CTRL by 11±3% (from 32±8 kg to 29±8 kg, p=0.004), while in TRAIN the value was maintained. The increase in strength of the leg muscles in TRAIN translated in a tendency toward a significant improved 6MWT performance from 461±57 m to 484±55 m (+6%, p=0.09), while in the CTRL there was not difference in the 6MWT (-2%, p=0.86). The TUG did not change in both the TRAIN and CTRL groups.

CONCLUSION: This study showed that individuals with ALS who trained for 12 weeks presented an improvement in lower- and upper-limb strength. Even if preliminary, these results support the beneficial role of tailored moderate-intensity exercise training in counteracting the muscle disuse in individuals with ALS.

RESULTS OF THE PHYSICAL ACTIVITY AND CAROTID ATHEROSCLEROTIC PLAQUE HEMORRHAGE STUDY

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INTRODUCTION: Carotid atherosclerotic plaques can remain silent until their rupture triggers an ischemic stroke. Intraplaque hemorrhage (IPH) and intercurrent inflammatory processes cause plaque instability. IPH is the factor that better predicts plaque rupture. Benefits of endarterectomy surgery remains controversial in patients asymptomatic of ischemic stroke. In previous cross-sectional study, we demonstrated that patients with moderate physical activity (PA) had lower

rates of IPH and pro-inflammatory monocytes. We hypothesized that an individualized home-based PA intervention can reduce IPH and modulate inflammation, as well as monocyte phenotype in asymptomatic patients with a non-endarterectomized carotid atherosclerotic plaque.

METHODS: Fifty-seven patients, asymptomatic of ischemic events for more than 6 months and present a carotid stenosis >50%, had been included in this study. At inclusion and after 6 months, IPH was measured with a high-resolution MRI, the inflammation state was determined by the monocytes phenotype, physical fitness was evaluated with the 6minutes walking test (6MWT) and finally, sedentary behavior and PA levels were assessed by questionnaire. Patients were randomly allocated to the control or to the PA intervention group. In the PA group, patients should reach daily goals of steps of 7000, measured by a connected watch. Daily steps goal was re-evaluated twice a month, in order to encourage patients to increase their walking habits. Patients in the control group receive their usual care during the protocol.

RESULTS: Fifty-two patients finished the study, 26 where randomized in each group. At inclusion, blood test, frequency of comorbidities, associated treatments and risk factors were equivalents between groups. The PA group had higher daily step count compared to the control group throughout the 6 months intervention (between +50% and +78%). The 6MWT was significantly improved in the PA group compared to the control group (respectively +6% vs - 0 %, $p<0.05$). BMI decreased in the PA group (-4.3%, $p<0.05$) while it remained stable in the control group. IPH was significantly reduced in the PA group while it remained stable in the control group (respectively -43% vs +3%, $p \leq 0.05$). Thus, MRI seems a reliable tool to measure IHP variations du to PA. Moreover, the PA intervention stabilized the rates of classical pro-inflammatory monocytes, while it increased in the control group (+29%, $p<0.05$), according to the progression of the disease.

CONCLUSION: This study reports for the first time, that in asymptomatic stroke patients with carotid atherosclerotic plaque, an individualized home-based PA intervention reduces BMI and IPH measured by MRI, stabilizes monocyte phenotype, and increases 6MWT. It is therefore possible to implement an efficient home-based individualized PA intervention using connected devices for patients presenting with asymptomatic carotid atherosclerotic plaque and such additional treatment should be considered in these patients.

NEUROPHYSIOLOGICAL CORRELATES OF COGNITIVE-MOTOR DUAL-TASKING IN EARLY PARKINSONS DISEASE DURING A BALANCE TASK

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Parkinsons Disease (PD) has been linked to changes in the waveforms of event-related potentials (ERPs), specifically the P3 component (Tokic et al., 2016). However, little is known about how cortical markers of information processing are modulated in the early disease stage and by concurrent demands posed on the motor system. Therefore, this study aimed to better understand the cortical signature associated with cognitive processing in early PD and to investigate how a balance task might affect it.

We present preliminary results of an ongoing clinical trial in which 9 healthy participants ($M = 67.1$ yrs; $SD = 4.0$; 6 women) and 9 early-stage on-medication PD patients ($M = 61.7$ yrs; $SD = 5.8$; 4 women) performed a cognitive-motor dual-task (DT) paradigm while behavioral and electroencephalography (EEG) data were recorded. The motor task consisted of balancing while standing in a semi-tandem stance (ST-Balance) on a force plate which computed the center of pressure path length (PL). The cognitive task encompassed the color-word Stroop stimuli while silent counting of a specific word-ink color combination occurrences had to be performed in a seated position (ST-Stroop). The DT combined simultaneous performance of the balancing and Stroop counts. ERPs locked to the stimuli onset were computed and the P3 mean amplitudes were extracted from the POz electrode across three consecutive 100 ms long time windows between 300-600 ms post-stimulus. A mixed within-between design was used for the analyses (2 [task: ST vs DT] x 2 [Stroop: attend vs ignore] x 2 [group: healthy vs patients). The significance level was kept at $\alpha = .05$.

Healthy participants were older than the patients, $t(16) = 2.29$, $p = .036$. For the PL, we observed the interaction between task and group ($p = .042$), and Bonferroni corrected simple effects showed healthy participants performing worse in an ST ($M = 53.3$; $SD = 14.7$) compared to the patients ($M = 35.2$; $SD = 8.4$; $p < .01$), but not in the DT (healthy: $M = 49.0$, $SD = 16.8$; patients: $M = 37.2$, $SD = 9.7$, $p = .086$). A main effect of the factor Stroop demonstrated the attended stimuli evoked greater P3 amplitude ($M = 2.0$; $SD = 1.7$) compared to the to-be ignored stimuli ($M = .44$; $SD = 1.8$) across the whole 300-600 ms time window ($p \leq .001$). No other effects were significant.

Worsening of the PL behavioral results in healthy participants could be attributed to the general age difference between the groups or a lesser degree of attention focusing on the balancing task in the healthy. The ERPs show no indication of PD-related modulation of cortical potentials. Beyond the significance levels, however, considerable differences were observed in the ERP waveforms between the groups following a visual inspection. We aim to address these speculations upon recruitment of an adequately powered sample size.

Tokic K, Titlic M, Beganovic-Petrovic A, Suljic E, Romac R, Silic S. P300 Wave Changes in Patients with Parkinsons Disease. Med Arch. 2016;70(6):453-456

Oral presentations

OP-PN30 Nitrate

INFLUENCE OF BIOLOGICAL SEX ON BLOOD PRESSURE AND ENDURANCE PERFORMANCE DETERMINANTS AFTER ACUTE NITRATE SUPPLEMENTATION

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INTRODUCTION: Dietary nitrate (NO3-) supplementation has been reported to lower systolic blood pressure (SBP) and improve athletic performance in males, but a paucity of research has investigated these effects in females. Typically NO3- supplementation is more effective at lowering SBP when SBP is higher, and improving exercise performance in individuals with a more glycolytic phenotype. Compared to females, males typically present with an elevated SBP and glycolytic phenotype, with females taking oral contraceptive pills (OC) commonly exhibiting higher SBP compared with females with a menstrual cycle (MC). Therefore, this study tested the hypothesis that NO3- supplementation would lower SBP and improve determinants of endurance performance to a greater extent in males and OC compared with MC.

METHODS: Recreationally active males (n = 22) and females (n = 25) ingested 140 mL of concentrated NO3rich (BR; 13 mmol NO3-) or NO3depleted (PL) beetroot juice. Baseline brachial and aortic SBP were assessed with these measures repeated 2.5 h following BR and PL ingestion, and a ramp incremental cycling test was subsequently completed. Menstruating females (MC, n = 13) were assessed between days 1-4 of the early follicular phase and combined, monophasic oral contraceptive pill users (OC, n = 12) were assessed between days 17-21 of active pill consumption. All experimental trials were administered in a double-blind, repeated-measures, cross-over experimental design. Data were analysed using independent-measures ANOVAs and independent- and paired-samples t-tests. Values are presented as means ± SD with statistical significance accepted as P≤0.05.

RESULTS: There was a main effect for supplement for brachial (P=0.046) and aortic (P=0.002) SBP, but no main effects for group or group x supplement interactions (P>0.05). Brachial SBP was lowered following BR compared to PL in OC (Δ -3 ± 3 mmHg; P=0.002), but not MC (Δ -2 ± 9 mmHg; P>0.05) or males (Δ -2 ± 6 mmHg; P>0.05). Aortic SBP was reduced after BR compared to PL in OC (Δ -4 ± 4 mmHg; P=0.005), MC (Δ -4 ± 6 mmHg; P=0.026) and males (Δ -2 ± 6 mmHg; P=0.042). There was no main effect for supplement for peak aerobic power (PAP), VO2peak, exercise economy (VO2-work rate slope) or gas exchange threshold (GET) (all P>0.05); however, there was a main effect for group, with all parameters higher in males than females (all P≤0.05), and no differences between MC and OC (all P>0.05).

CONCLUSION: Acute NO3- supplementation lowered central SBP in all groups, only lowered peripheral SBP in OC, but did not alter physiological determinants of endurance performance or PAP during the ramp exercise test in any group. Compared to males, females exhibited lower PAP, VO2peak and GET, but better exercise economy.

NITRATE-RICH WHOLE FOOD AS A NOVEL NUTRITIONAL STRATEGY TO REDUCE ORAL DISEASE RISK

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INTRODUCTION: Athletes are at higher risk of oral disease. High carbohydrate diets, exercise induced dehydration and transient perturbations to immune function can increase risk in this group. Nitrate (NO3-) is an ergogenic aid which is now being considered as an oral health prebiotic. Our previous work has shown that ingesting NO3- in the form of concentrated beetroot shots attenuates the expected reduction in salivary-pH following carbohydrate supplements and exercise-induced dehydration[1], indicating that NO3- can be considered as a novel nutritional strategy to reduce the risk of developing acidity related oral health conditions. It is currently unknown if NO3- rich whole vegetables will have a similar protective effect. The aim is to determine responses to a single dose of NO3- in the form of whole vegetables and assess whether high NO3- vegetables can offset oral acidity following repeated sugar mouth rinses.

METHODS: Twelve healthy adults (6 male, 31 ± 8 years, stature 177 ± 7cm and body mass 79 ± 15.4kg) completed a randomised cross over study comprising of two experimental trials. After baseline measurements, participants rinsed their mouth with 10% unflavoured dextrose solution for at least 1 min 30 min prior to consuming either high NO3-salad (HN) (120g or ~4,2mmol/L) or low NO3-salad (LN) (negligible NO3- content). Further dextrose rinsing was carried out immediately after salad consumption, and at 90- and 160-min. Unstimulated saliva samples were collected at each timepoint for analysis of NO3-, nitrite (NO2-), pH, lactate, glucose, and ammonia. Blood pressure was recorded, and venous blood collected at 150 min post vegetable consumption. Values are reported as mean ± SD. A two-way repeated measures ANOVA with Tukey's correction was used to detect differences.

RESULTS: As expected, plasma and salivary nitrite (NO2-) and NO3- increased from baseline in the HN condition and were higher in HN than LN (all P<0.001). Systolic blood pressure significantly decreased in the HN condition (P<0.001). Diastolic blood pressure reduced in females only (P 0.007). Sugar rinsing caused the pH to drop in both conditions (all P <0.05), but pH was higher in the HN trial than LN (all P <0.001). Lactate and glucose were higher in the LN trial than the HN at 100 and 160 min (both P <0.001). Ammonia was greater post vegetables ingestion in HN compared to LN and stayed elevated for the whole trial duration (AUC, P < 0.034).

CONCLUSION: Ingesting NO3- in whole vegetable form attenuates oral acidity following repeated sugar exposure. NO3-rich salads could be considered by athletes as a novel nutritional strategy to reduce the risk of developing acidity related oral health conditions.

EFFECTS OF DIETARY NITRATE ON MITOCHONDRIAL EFFICIENCY AND EXERCISE CAPACITY IN ELDERLY INDIVIDUALS AND PATIENTS WITH TYPE 2 DIABETES

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INTRODUCTION: Several studies have shown that dietary nitrate can increase exercise capacity and reduce whole body oxygen uptake during submaximal exercise, yet the underlying mechanisms remain largely unknown. Some have suggested that nitrate may improve mitochondrial efficiency, by lowering proton leak, but studies are scarce and equivocal. Previous studies have primarily included young healthy participants, and thus the potential in various patient populations has yet to be fully explored. The aim of the current study was to examine the effects of dietary nitrate supplementation, in the form of beetroot juice, on exercise capacity and mitochondrial efficiency in patients with type 2 diabetes (T2D), elderly individuals and overweight individuals.

METHODS: 29 subjects (9 elderly individuals (OLD), 10 T2D patients (T2D) and 10 healthy overweight controls (CON)) took part in two similar experimental days, after ingesting either beetroot juice or placebo for three days prior to each experimental day, in randomized order. Experimental days included measurements of resting metabolic rate (RMR), blood pressure, blood samples, and a 45-minute cycling test at submaximal intensity (70% of VO2max). Muscle biopsies were obtained before and after the exercise test, and mitochondria were isolated from the muscle biopsies and examined for mitochondrial P/O ratio, leak respiration and respiratory capacity (MRC) by high-resolution Respirometry.

RESULTS: P/O ratio was unchanged in all groups after nitrate supplementation, and there was no difference in P/O ratio between groups at baseline. Likewise, leak respiration and MRC was unaffected by nitrate supplementation, with no differences between groups. Whole body oxygen uptake at rest and during exercise was unchanged, but tended to be lower in the OLD group during exercise.

CONCLUSION: The present study shows no effect of nitrate on mitochondrial efficiency and function, which is in line with most, but not all, existing studies. However, only very few human studies exist, and thus studies like this are important to clarify if nitrate does indeed have potential in modulating parameters of mitochondrial function. It is possible that the lack of an effect on exercise capacity could be attributed to the duration and intensity of the exercise test, as newer meta analyses have shown the largest effect sizes in short term high intensity tests. Since previous studies have primarily included young healthy participants, and have shown mixed results in terms of the ergogenic effects of nitrate, future studies are needed to clarify the effects in various patient populations that may suffer from exercise intolerance. These findings indicate that the ability of nitrate to enhance mitochondrial efficiency is unlikely, and therefore future studies should focus on alternative mechanisms of action that may seem more promising.

A DOUBLE-BLIND PLACEBO-CONTROLLED RANDOMISED CROSSOVER TRIAL TO EVALUATE BROWN FAT QUALITY, QUANTITY AND ACTIVATION WITH INORGANIC NITRATE SUPPLEMENTATION IN PEOPLE WITH TYPE 2 DIABETES MELLITUS

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INTRODUCTION: Identifying cost effective exercise/drug-alternative interventions for type 2 diabetes mellitus (T2DM) is imperative. Diets rich in dietary nitrate have cardiovascular benefits and have been shown to increase brown adipose tissue (BAT) expression by 'beiging' white adipose tissue in mice through a nitric oxide dependent process. Recent developments in the ability to non-invasively measure BAT quantity, quality and activation using magnetic resonance imaging (MRI) and infrared thermography (ITR) has opened the possibility to study the effects of nitrate on BAT in humans. This study hypothesises that nitrate can increase BAT activation in people with T2DM.

METHODS: A double-blind placebo-controlled randomised crossover experimental trial recruited 13 participants with T2DM (Age: 62±8 years; BMI: 29.1±3.1 kg·m-2) to examine the effect of beetroot juice supplementation (14-days) on BAT activation and quantity. Outcome measures for supraclavicular 1) fat quantity and quality, imaged by MRI (T2*, fat fraction), and 2) BAT activation, indicated by a relative change in skin temperature imaged with IRT (compared with sternum control), were taken pre- and post-cooling intervention (1 hour, 8.1±1.2°C water perfused jacket) and following placebo (140 ml·day-1, 0.1 mmol·L-1 inorganic nitrate) and experimental trial (140 ml·day-1, 12.4 mmol·L-1 inorganic nitrate) with a 7-day washout.

RESULTS: Supraclavicular fat quantity can be determined from MRI using proton density fat fractions (PDFF) in people with T2DM, in a representative example we have found a change in PDFF following this cooling protocol (i.e. 76.9% to 75.8%) and the impact of nitrate supplementation on BAT quantity will be established. Mean skin temperature was reduced in both conditions (nitrate -0.8±0.7°C, placebo -0.6±0.6°C, $p<0.05$) while relative skin temperature determined by IRT did not change after cooling following placebo (0.3±0.5°C) or nitrate (0.1±0.5°C) intervention ($p>0.05$).

CONCLUSION: Dietary nitrate supplementation does not increase brown fat activation. Possible explanations for the lack of effect include 1) an insufficient cooling protocol, 2) the IRT measurements of relative skin temperature may be insufficient

to elucidate potential changes in brown fat activation or, 3) that nitrate does not increase BAT in people with T2DM. However, MRI may be used to quantify BAT quantity and quality in this population following nitrate supplementation, with fat fraction being a superior biomarker for BAT and this may be associated with glucose metabolism and adiposity.

BEETROOT AND PARAXANTHINE BASED SUPPLEMENTS TO ENHANCE COGNITIVE PERFORMANCE: POSSIBLE APPLICATION IN SPORT?

CANNATARO, R., CIONE, E., CAROLEO, M.C., JAGER, R., INNOCENTI, B., VACCARO, M.G., BONILLA, D.A., ABREGO-GRANDIQUE, D.M.

UNIVERSITY OF CALABRIA

INTRODUCTION: Cognitive performance is also attracting growing interest in sports, particularly in activities that require a commitment from the point of view of concentration; it would be important to optimize this aspect.

METHODS: Here, we evaluate two possible supplements to improve cognitive performance: beetroot (BR) extract and paraxanthin (a modified form of caffeine). Both studies were operated in a double-blind, randomized, placebo-controlled, two-period crossover clinical trial; in the case of paraxanthin, the subjects underwent a caffeine washout of at least five days. In the first case, a sample of 44 subjects was administered three beetroot-based chewable tablets with an extract standardized in nitrates an hour and a half before being subjected to a battery of neuropsychological tests (RAVLT, Digit Span, SDMT, FAB, COWAT, STAI, and PRMQ). In the second, a sample of 39 subjects was administered three capsules containing 300mg of paraxanthin; after 30 minutes, they were subjected to a battery of neuropsychological tests.

RESULTS: Significant improvements with moderate effect size were found on memory consolidation in the short- and long-term only after BR supplementation via the Rey Auditory Verbal Learning Test (RAVLT) immediate (+20.69%) and delayed (+12.34%) recalls. Likewise, enhancement in both frontal lobe functions (+2.57%) and cognitive flexibility (+11.16%) were detected after BR-CT. There was no significant change ($p<0.05$) in verbal memory of short-term digits, working memory, and information processing speed. Mixed results were found on mood and anxiety through the Beck Depression Inventory-II (BDI-II) and the State-Trait Anxiety Inventory (STAI-Y1 & STAI-Y2); however, sequence and period effects were seen on STAI-Y2. In the paraxanthine group, only RAVLT delayed, and Digit Span showed a significant difference (+14,9% and +13,1% respectively); RAVLT immediate, even with $p=0.19$, showed an increase of 3,1%, the others tests did not show any appreciable change.

CONCLUSION: These two evaluations show how, even acutely, the cognitive ability of healthy subjects can be improved; BT supplementation appears to be more effective overall, but the timing of intake may also have affected the final effect; a subsequent study could be to combine the two principles to have a synergistic effect; it should be emphasized that no side effects have been recorded, not even in the long term (6-month follow-up). Therefore, the supplements are safe; new, exciting possibilities could open up in improving cognitive performance applied to sports.

Oral presentations

OP-MH22 Physiotherapy

EFFECTS OF BLOOD-FLOW RESTRICTED VERSUS CONVENTIONAL RESISTANCE TRAINING ON LOWER LIMB STRENGTH, FUNCTIONAL PERFORMANCE AND PAIN IN CLINICAL PATIENTS - A SYSTEMATIC REVIEW AND META-ANALYSIS

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INTRODUCTION: Heavy-load resistance training (HL-RT) is usually deemed necessary to produce gains in muscle strength and mass. HL-RT can, however, be contraindicated in some patient populations. Emerging evidence on the use of low-load blood flow restricted exercise (BFR-RT), suggests it applied to increase muscle strength and mass as well as functional performance in patients. This systematic review aimed to compare the effect of HL-RT and BFR-RT on gains in muscle strength, muscle mass, functional performance, and patient-reported outcome.

PROSPERO ID (CRD42022337173).

METHODS: Systematic searches for published randomized controlled trials (RCT) were performed in Web of Science, Cochrane Central, Medline, Embase and SportDiscus. Two reviewers independently included studies comparing HL-RT and BFR-RT, extracted data, and assessed the risk of bias. Random effects meta-analyses were used to synthesize the results. Certainty of evidence was rated by the Grading of Recommendations Assessment and Evaluation approach. Outcome measures were isometric knee extensor strength, repetition maximum (RM) knee extensor strength, RM leg press strength, quadriceps cross-sectional area, sit-to-stand performance, patient reported pain and function. Prediction intervals were reported for all meta-analyses with three or more studies.

RESULTS: Seven RCTs comprising 293 participants (BFR-RT: n=147; HL-RT: n=146) were identified. BFR-RT and HL-RT showed similar gains in RM knee extension strength, RM leg press strength, quadriceps cross-sectional area, sit-to-stand perfor-

mance, and patient reported pain and function. However, there was a moderate effect favoring BFR-RT for evoking gains in isometric knee extensor strength. Certainty in the evidence was low to very low.

CONCLUSION: HL-RT and BFR-RT seems equally effective in producing gains in lower limb muscle strength, muscle mass, functional performance and patient-reported outcomes in young-to-old clinical patients, although greater gains in isometric knee extensor strength seem to occur with BFR-RT than conventional HL-RT. However, the certainty in the estimates was low to very low, and the results are likely to change with the inclusion of higher-quality trials.

THE EFFECTIVENESS OF HIGH-VELOCITY ELASTIC-BAND TRAINING IN REDUCING THE OCCURRENCE OF HAMSTRING INJURIES IN FOOTBALL PLAYERS

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INTRODUCTION: Hamstring muscle injuries rates showed an increase in football players in recent years (Ekstrand et al. 2022). Significant portion of hamstring injuries occurs during high-velocity activities (Askling et al. 2012; Gronwald et al. 2022). However, current popular prevention strategies mainly target the development of maximal strength, which entails exercises performed at low velocity. We hypothesized that high-velocity elastic band training will reduce hamstring injury risk in football players.

METHODS: Male players from Lithuanian and Spanish semi-professional and professional teams (n = 608, age: 22.0 ± 5.0 years, playing experience: 14.8 ± 5.3 years) were recruited for this study. However, variations in methodology occurred due to disparities in the schedules of their respective championships as well as environmental factors. As a result, the analysis was conducted solely on data collected during the Lithuanian championship, which involved a total of 319 players from nine teams in the premier league and six teams in the 1st division. The players were assigned to either the intervention (INT) or control (CON) group for a five-week exercise period, followed by a ~4-month follow-up period where hamstring injuries and exposure time were recorded. In addition to regular football training, the INT group had 2–3 sessions per week of elastic-band training with low-load, high-velocity leg curls while lying prone; the CON group performed self-paced football-specific drills.

RESULTS: The INT group reported 8 hamstring injuries in 123 players (6.5%), whereas the CON group reported 18 injuries in 196 players (9.2%). Although the injuries rate was observed to be 29.2% lower in the group of individuals who underwent the intervention, the distribution of injuries between the INT and CON groups was not found to have a statistically significant difference (p>0.05).Moreover, no differences (P > 0.05, odds ratio [OR]= trivial-to-small) in distribution between the groups were found in hamstring injury characteristics (leg side, leg dominance, recurrence, typology and mechanism) except for the distribution of injuries that occurred during matches or training (P = 0.036; OR = 11.0, very large).

CONCLUSION: The high-velocity elastic-band training program did not effectively prevent

hamstring injuries in football players, despite showing some potential of including this exercise in injury prevention programs.

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UNRAVELLING THE CHALLENGES OF REHABILITATION AND TREATMENT OF MUSCULOSKELETAL DISORDERS IN PROFESSIONAL BALLET DANCERS

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UNIVERSITÉ DE SHERBROOKE

INTRODUCTION: Dancers are among the most injured athletes, which will cause repercussions on their physical and mental health, as well as their career (1,2). It is essential to establish strategies to prevent and manage these injuries. However, some challenges arise when preventing and treating injuries, as reported by dancers and health professionals (3). This study explored the experiences and challenges faced by the dancers and staff in a ballet company regarding the rehabilitation and treatment of injuries.

METHODS: We conducted twenty-two semi-structured interviews with dancers, members of the health team, the artistic staff, and administrative staff for this qualitative study. All participants were employed with the Dutch National Ballet. We audio-recorded and transcribed all interviews, and our analyses followed a thematic analysis.

RESULTS: According to dancers and other stakeholders, musculoskeletal disorders in dancers cannot be entirely prevented.

"How do you make ballet safe? Dont do ballet. Its not safe. Lets be realistic about it. It isnt safe, and making it safe, I think, impacts the art form."

The changes in repertoire during a season and the scheduling were among the challenges most often mentioned by participants.

"The changes in the repertoire. You just dont really have a choice. You just get in there. You wake up one day and then all of a sudden youre in a new ballet world."

However, it was noted that strength and conditioning programs designed by the health team to prepare the dancers for these changes in the repertoire were perceived as helpful in reducing the risk of musculoskeletal disorders.

"Yes, it is one of the reasons I go extra to the gym. To be able to have more strength in the role that I do. So that you wont get injured as quickly."

Other factors deemed important in a dancer's prevention and management of musculoskeletal disorders were communication with the health, artistic and administrative staff and the trust established between all stakeholders.

CONCLUSION: Considering the context around the current practices in preventing and managing musculoskeletal disorders in dancers is essential. By better understanding the context, programs will be more effectively targeted to the dancers' needs.

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11:00 - 12:15

Invited symposia

IS-BM01 Exercise and mental training as medicine for the brain

PREDISPOSITIONS AND EXERCISE-INDUCED PLASTICITY IN THE HUMAN BRAIN

TAUBERT, M.

UNIVERSITÄT MAGDEBURG

The human neocortex is essential for cognition, action and perception. Its complex morphology is tightly regulated by genetic factors, but is also malleable by environmental influences throughout the lifespan. Physical exercise (e.g., aerobic exercise or learning motor skills) is able to modulate cortical structure, with potential implications for healthy cognitive development and aging. However, recent studies highlight the fundamental role that more stable morphological features of the neocortex could play in predicting exercise effects on human behavior. The emerging view is that exercise effects on learning and cognition are mediated by predisposed traits and induced changes occurring at different levels of the neocortical architecture. This presentation will synthesize and integrate new knowledge in the field and consider its relevance to sports science and practice.

EXERCISE AND BRAIN HEALTH WITH A SPECIAL FOCUS ON GABAERGIC (INHIBITORY) PROCESSES

TAUBE, W.

UNIVERSITY OF FREIBURG

It is known that physical activity positively influences (cognitive) brain function not only in elderly but also young people; in both the short- and long-term. Furthermore, physical activity is a key factor to prevent neurodegenerative diseases. One aspect, which is commonly impaired in many neuro-pathologies but also in patients with motor control deficits, cognitive decline, insomnia or some types of depression is the cortical inhibitory system. Only very recently, it was discovered that sports activities have the potential to up- (e.g. balance training) or downregulate (e.g. strength training) the strength of the inhibitory circuits of the GABAergic system (i.e. cortical interneurons). The present talk will present evidence that physical activity strongly acts on the inhibitory system and that this impact may explain - at least partly - the positive influence of sports activities on pathologies that are known to go along with impaired (reduced) inhibitory capacity.

ENHANCING MENTAL TRAINING WITH NEUROFEEDBACK

WENDEROTH, N.

ETH ZURICH

Mental training is frequently applied in sports but also in neurorehabilitation to enhance performance or facilitate recovery. However, the effectiveness of mental training can widely vary between individuals, potentially because some mental

strategies do not optimally tap into the neurophysiological mechanisms that critically underpin performance or recovery. Here we can show that the neural specificity and effectiveness of mental training can be significantly enhanced by neurofeedback methods. Using the motor system and noradrenergic arousal control as examples, this presentation will show how neurofeedback can facilitate mental training and the acquisition of effective self-regulation strategies.

Invited symposia

IS-AP03 A.I. IN SPORT AND EXERCISE SCIENCE: WE WERE SO PREOCCUPIED WITH WHETHER WE COULD, WE DIDN'T STOP TO THINK IF WE SHOULD

ARE WE DOOMED? THE FUTURE OF SPORT AND EXERCISE SCIENTISTS IN THE FOURTH INDUSTRIAL REVOLUTION

ABT, G.

THE UNIVERSITY OF HULL

Since the development of the personal computer in the 1970s, digital technology has largely played a complimentary role in our working lives. Yet Susskind and Susskind [1] argue that technology is increasingly substituting for professionals, such that tasks undertaken by robots or algorithms will eventually dominate. At the dawn of the fourth industrial revolution [2], it is appropriate that sport and exercise scientists consider how they adapt to this technological challenge. Although we may think our work is too complex or uncertain to be automated [1], tasks in other professions, like diagnosing skin cancers, are now being performed equally well by algorithms [3]. Likewise, in our profession, tasks once requiring specialised laboratory equipment and expertise are now performed with smartphones [4]. Although there is little evidence that technological change leads to net unemployment [5], our challenge is to consider which tasks will (or can) be automated, whether people will accept or want this automation [6], how we adapt [5], and how we create the optimal balance between human and machine [7]. We must also consider the ethical implications of devolving professional responsibility to decision algorithms [8], and by extension, to where liability rests following a negative outcome [9]. While we are all exposed to the implications of technological change, it is the next generation of sport and exercise scientists who will be most challenged by the exponential growth, capability, and scale of the fourth industrial revolution. As educators, we must help the next generation to develop the knowledge, skills, and resilience, to prepare, adapt, and rise to the technological challenge that confronts them [10].

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MACHINE LEARNING FOR DUMMIES: SIMPLE METHODS TO IMPLEMENT ARTIFICIAL INTELLIGENCE ALGORITHMS INTO CONSUMER-BASED APPS

BALSALOBRE-FERNÁNDEZ, C.

AUTONOMOUS UNIVERSITY OF MADRID

Machine learning is often defined as a subfield of artificial intelligence (AI) devoted to methods that allow programs to 'learn' from data to automate and improve different types of tasks [1]. In sports and exercise research, some of the most frequent tasks that have been investigated are exercise recognition and training load analysis [2,3]: the former, to elaborate algorithms that could measure exercise performance or technique, the latter, to improve injury prevention strategies or even (try to) predict when/if they are going to occur [2]. Traditionally, creating AI to perform such tasks required advanced computing, coding, and data science skills, as well as computers with enough processing power to train the machine learning models that would perform those tasks. However, advances in smartphone and wearable technologies have not only improved the variables these devices can collect in a valid and reliable way [4]; some companies have also developed Software Development Kits (SDK), frameworks and apps for developers so they can train their own machine learning models in a simple, code-less way using personal computers. In this presentation, the free CreateML software (Apple Inc., USA) will be introduced, with an example of how to create an object-recognition model that automatically detects a weightlifting plate from a live video feed to measure barbell kinematics. This type of novel software simplifies the skills required to successfully implement AI in consumer-based products and can benefit the next generation of sport and

exercise scientists. Furthermore, it could help fight the 'black box' problem when dealing with sports technology, so rather than trusting undisclosed proprietary algorithms, sports scientists can have the power to build their own.

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HUMAN VS MACHINE: WHO MAKES THE DECISION WHEN IT COMES TO ATHLETE MANAGEMENT?

CLUBB, J.

CHELSEA FOOTBALL CLUB

In the pursuit of high performance, there has been dramatic growth in the volume of data that sports science practitioners are expected to collect, manage, and disseminate [1]. Such data is thought to be a key enabler of decision making in elite athlete management [2]. It is unsurprising that the search for a competitive advantage has led teams and practitioners to seek out innovative approaches. Yet, such innovation is not without trepidation. Both athletes [3] and scientists [4] have expressed concerns that athlete monitoring has already gone too far, and that athletes are 'people, not just numbers' [3]. Despite this apprehension, complex data science methodologies continue to emerge. Solutions driven by artificial intelligence (AI) are now being employed across a multitude of applications in sports, including forecasting injury risk [5], providing individualised, 'precision strength training' [6], and developing sports technology solutions such as indoor navigation [7]. While practitioners have historically been encouraged to 'unpack the black box' with sports technology [8], this is becoming increasingly difficult in the face of unexplainable methodologies and proprietary algorithms. This landscape requires an urgent discussion of AI integration in the scientific management of athletes. How can practitioners critically appraise vendors, especially when the algorithm cannot be evaluated? How should system outputs be integrated into decision support systems? Who takes the blame if the system is wrong, or if the system was right but was not heeded by the human practitioner? How can academics and applied practitioners collaborate to produce evidence-based research in this area? Both ethically and operationally, the implication of devolving professional responsibility to a decision algorithm [9] is the foremost issue sport and exercise scientists face today.

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Oral presentations

OP-PN28 Ketogenic

KETO-ADAPTATION FOR TEAM SPORT ENERGETICS?

PRETORIUS, J., ENGELBRECHT, L., TERBLANCHE, E.

STELLENBOSCH UNIVERSITY

INTRODUCTION: Many believe that anaerobic carbohydrate metabolism is the main energy source for all high-intensity exercise. Yet, during intermittent sprints, typical of many team sports, ATP is in fact mainly derived from ATP-PCr and aerobic pathways (MacLarren & Morton, 2012). It is well documented that aerobic fat oxidation rates are enhanced on a ketogenic diet (KD). Yet, keto-adaptation in the ATP-PCr pathway has not been investigated.

METHODS: 15 Recreationally active participants (n=7 men, n=8 women; aged 25.1 ± 6.4 years) performed intermittent sprints (6 x 10 s with 2 min rest) and a graded maximal aerobic capacity test, both on a cycle ergometer, first at baseline

while they maintained their habitual diet (HD: 35% CHO, 45% fat, 20% protein) and at the end of a 6-week KD intervention (7% CHO, 66% fat, 28% protein). We used the fast component of VO2 off-kinetics to calculate ATP-PCr derived energy for the intermittent sprint test. During graded exercise tests, gas exchange- and blood lactate measures were obtained to determine various metabolic thresholds.

RESULTS: Both intermittent sprint mean power output (627,6 ± 167,83 to 629,1 ± 155,39 W; p = 0.858) and graded exercise peak power performance were preserved on KD (271.6 ± 60.19 to 272.7 ± 54.48 W; p = 0.772). ATP-PCr derived energy during intermittent sprints increased significantly on KD (+22.0 ± 43.15 Joule; p = 0.003). In the graded exercise test, absolute VO2max was maintained on KD (3133.5 ± 641.55 to 3179.6 ± 657.32 mL/min; p = 0.302) with significant increases in relative VO2max (+5.3 ± 5.66%; 40.5 ± 6.34 to 42.7 ± 7.14 mL/min/kg; p = 0.005) and power at aerobic threshold (+12.1 ± 12.77%; 190.5 ± 47.64 to 211.8 ± 51.86 W; p = 0.002) while peak blood lactate lowered significantly after KD (14.3 ± 3.14 to 8.1 ± 4.45 mmol/L; p = 0.005).

CONCLUSION: The most noteworthy finding of this study was the increase in ATP-PCr derived energy during intermittent sprints after the 6-week KD, presenting this energy pathway as a potentially novel site of keto-adaptation. Herewith, future research may investigate KD as a potential endogenous alternative or -addition to exogenous creatine supplementation, currently used as an ergogenic aid by many team sport players. Furthermore, higher power at aerobic threshold and lowered peak blood lactate with maintained peak power on KD during the graded exercise test, suggests that the 6-week keto-adaptation enhanced aerobic energy metabolism to reduce blood lactate accumulation during exercise. So, the maintained power output on KD in both the intermittent sprint- and maximal aerobic exercise tests, was underpinned by desirable metabolic keto-adaptations in the two key energy systems utilized during intermittent sprints (i.e., ATP-PCr and aerobic metabolism). These metabolic adaptations may suggest potential for keto-adaptation in team sport contexts.

EXOGENOUS KETONE SUPPLEMENTATION IMPAIRS 20-MINUTE TIME TRIAL PERFORMANCE IN TRAINED CYCLISTS

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INTRODUCTION: The effect of ketone monoester (KE) ingestion on exercise performance is equivocal. A KE supplementation strategy that increases blood [β-hydroxybutyrate] ([β-HB]) to ~1-3 mM has been suggested to be optimal for a potential performance benefit (doi:10.1113/JP273185). This can be achieved by ingesting ~0.3-0.4 g/kg body mass of KE, which reduces the potential for blood acidosis and gastrointestinal distress associated with higher doses. We examined the effect of acute ingestion of 0.35 g/kg KE on 20-min time trial (TT) performance in trained cyclists. We hypothesized that mean power output would be different after KE ingestion vs a flavour-matched placebo (PL). This TT test is strongly correlated with functional threshold power and has a day-to-day variability of ~1.4% using the same equipment and procedures in trained cyclists (doi:10.1123/ijspp.2018-0100).

METHODS: An a priori sample size estimation (G*Power) determined n=22 provided 80% power to detect a 2.0% difference (dz=0.63) in TT power output at alpha=0.05 with a 2-tailed paired t-test. A total of 23 trained cyclists (21 males, 2 females; peak oxygen uptake: 65±12 mL/kg/min; mean±SD, >5 h/wk cycling training) completed a familiarization session followed by two experimental trials. Diet was self-selected and replicated for 24 h before participants ingested either 0.35 g/kg body mass (27±4 g) of (R)-3-hydroxybutyl (R)-β-HB KE or a ketone-free PL 30 min before exercise in a randomized, triple-blind, crossover manner. Exercise involved a 15 min warm-up and 20-min TT on a cycle ergometer. Participants adjusted workload by changing cadence and/or simulated gear. The only feedback provided was elapsed time.

RESULTS: Mean TT power output was 2.4 [0.6 to 4.1]% (mean[95% CI]) lower after KE vs PL (255±54 vs 261±54 W; p<0.01; dz=0.60). There was no effect of trial order (p=0.44). An exploratory 2-way repeated-measures analysis of variance [(KE vs PL) * (power output each quarter of the TT)] indicated power output was lower after KE vs PL ingestion (main effect p<0.01) but no interaction effect (p=0.93). KE vs PL ingestion increased pre-exercise blood [β-HB] (2.0±0.6 vs 0.2±0.1 mM, p<0.0001). Blood pH was not different but [bicarbonate] was lower in KE vs PL (28.2±1.8 vs 29.9±1.9 mM, p<0.001), as was total CO2 (28.9±2.0 vs 30.5±2.0 mmHg, p=0.001). Median gastrointestinal symptom severity did not exceed 1 out of 10 in either trial. Continuous glucose monitoring revealed that blood [glucose] was lower after KE vs PL ingestion before exercise (4.1±0.7 vs 4.6±0.9 mM; p=0.048) but not different during the TT (KE: 4.5±0.7, PL: 4.9±0.9; p=0.12). Rating of perceived exertion on a 6-20 scale was not different between trials (17[16-18] for both; p=0.11).

CONCLUSION: Acute KE ingestion, which increased blood [β-HB] to within the range purported to be ergogenic, impaired 20-min TT performance in trained cyclists. The mechanistic basis for this effect remains to be elucidated.

ClinicalTrials.org registration: NCT05226962. Funding: NSERC, Canada.

A KETONE MONOESTER DRINK REDUCES POSTPRANDIAL GLYCAEMIA IN INDIVIDUALS WITH TYPE 2 DIABETES.

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INTRODUCTION: Ketone monoester (KES) ingestion has been shown to reduce postprandial glycaemia in lean individuals and those with obesity. We sought to determine whether ingestion of KES would reduce postprandial glycaemia in individuals with Type II diabetes (T2D); a condition characterised by dysregulated glucose control.

METHODS: Ten individuals with T2D (m=5, f=5; age 59±5 y; BMI 32±3 kg·m-2; diagnosed 6±5 y; Hb1Ac 54±8 mM; not prescribed exogenous insulin or SGLT2 inhibitors) completed two trials, in a randomised, double-blind, placebo-controlled, crossover design. Participants consumed a KES drink [(R)-3-hydroxybutyl (R)-3-hydroxybutyrate; 0.5 g·kg-1 body weight] or a noncaloric taste-matched placebo (CON), 30 min before consuming a 475 kcal mixed meal tolerance test (MTT; 75 g carbohydrate, 18 g protein, 12 g fat) at t=0 min. Circulating ß-Hydroxybutyrate (ß-OHB), glucose, and insulin concentrations were subsequently measured over 4 hours. Data were analysed with two-way ANOVA and presented as means ± SD.

RESULTS: Plasma ß-OHB concentration remained at baseline during CON (0.3±0.0 mM), whereas it was increased to a steady-state of 3.0±1.0 mM (peak 4.3±1.2 mM at t=30) in KES (P<0.05). From values of 6.0±1.0 mM in CON, and 5.8±1.2 mM in KES at t=0 min, blood glucose concentration increased following MTT to a peak of 11.0±2.3 mM at t=75 min in CON, which was supressed in KES to a peak of 8.7±1.4 mM at t=60 min (P=0.0015), before decreasing to values of 5.9±1.6 mM and 6.5±1.9 mM in CON and KES, respectively, at t=240 min. Compared with CON, KES ingestion reduced glucose area under the curve by 31% (P=0.0286). From values of 29±17 mU/l in CON, and 45±21 mU/l in KES at t=0 min, serum insulin concentration increased following MTT to a similar extent in CON and KES, peaking at 108±46 and 108±63 mU at t=90 min, respectively, before decreasing to values of 50±25 and 68±30 mU/l, respectively, at t=240 min.

CONCLUSION: KES ingestion reduces postprandial glycaemia in T2D. The postprandial glucose excursion was lowered to near normoglycaemic values despite no apparent differences in insulin secretion, suggesting an improvement in peripheral insulin sensitivity, a reduction in hepatic glucose production and/or reduced gastric emptying.

EXOGENOUS KETOSIS ELEVATES CIRCULATING ERYTHROPOIETIN AND STIMULATES MUSCULAR ANGIOGENESIS DURING ENDURANCE TRAINING OVERLOAD

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KU LEUVEN

INTRODUCTION: De novo capillarization is a primary muscular adaptation to endurance exercise training and is crucial to improve performance (1,2). Excess training load, however, impedes such beneficial adaptations, yet we recently demonstrated that such downregulation may be counteracted by ketone ester ingestion (KE) post-exercise (3). From this perspective, we hypothesized that KE could increase pro-angiogenic factors and thereby stimulate muscular angiogenesis during a training-overload period.

METHODS: A randomized, double-blind trial was performed using eighteen young, fit males. Subjects performed a three-week endurance training-overload period involving 10 training sessions/week. Immediately after each training session and before sleep, subjects received either 25g of a ketone ester (KE, n = 9) or a control drink (CON, n = 9). Biopsies of m. vastus lateralis and venous blood samples were collected before and after the training-overload period to characterize the effect of KE on muscular angiogenesis. A two-way repeated measures analysis of variance (ANOVA) was performed to evaluate differences between both groups and over time.

RESULTS: The training period altered neither capillary contacts (CC, $p > 0.999$) nor capillary-to-fiber perimeter exchange index (CFPE, $p = 0.333$) in CON. In contrast, in KE, the training period increased CC and CFPE on average by 44% ($p = 0.005$) and 42% ($p < 0.001$), respectively. Furthermore, in KE, VEGF increased by 33% at the protein level ($p = 0.028$) and increased 2-fold at the mRNA level ($p = 0.007$). In contrast, VEGF mRNA and protein expression were unchanged in CON (both $p > 0.999$). eNOS mRNA expression increased twofold in response to training in KE ($p < 0.001$), but remained unaffected in CON ($p > 0.999$). Conversely, at the protein level, eNOS increased in both KE and CON by ~125% (main effect of time, $p = 0.001$). Serum erythropoietin concentration increased by 26% in KE ($p = 0.027$), but remained stable in CON ($p > 0.999$).

CONCLUSION: These data indicate that intermittent exogenous ketosis during endurance overload training stimulates muscular angiogenesis. This resulted from a direct stimulation of muscle angiogenesis, which may be at least partly due to stimulation of erythropoietin secretion and elevated VEGF activity, and/or an inhibition of the suppressive effect of overload training on the normal angiogenic response to training. This study provides novel evidence to support the potential of exogenous ketosis to benefit endurance training-induced muscular adaptation.

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THE IMPACT OF DIET ON HUMAN VASCULAR RESPONSES TO MENTAL STRESS

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INTRODUCTION: Mental stress has been shown to induce cardiovascular events, likely due to the negative effect of stress on endothelial function. During stressful periods, individuals often change their behavior to be less physically active and worsen their diet, which can influence endothelial function. For example, fat consumption can impair endothelial function, whereas flavonoid-rich foods, have been shown to improve endothelial function. Yet, the impact of diet (fat or flavanol consumption) on endothelial function in the context of mental stress is unknown. Thus, we investigated the impact of a high-fat meal (Study 1) and cocoa flavanols (Study 2) on vascular responses to mental stress.

METHODS: A randomised, within-subject design was used in both studies.

Study 1: 21 healthy participants (11M) completed two sessions (order counterbalanced) and consumed either a high-fat meal (56.5g fat) or a low-fat meal (11.4g fat) 1.5 h prior to mental stress (8-min mental arithmetic task). Vasodilatory responses (forearm blood flow, FBF), blood pressure (BP) and cardiovascular activity (CV) were assessed pre-meal and post-meal during a pre-stress resting baseline and the stress task. Endothelial function (brachial artery flow-mediated dilatation, FMD) was assessed pre-meal and 30 and 90 min post-stress.

Study 2: 30 healthy males completed two sessions (order counterbalanced) and consumed either high-flavanol cocoa (150mg (-)-epicatechin) or low-flavanol cocoa (< 4mg (-)-epicatechin) 1.5 h prior to mental stress. FBF, BP and CV were assessed pre-cocoa and post-cocoa during a pre-stress resting baseline and the stress task. FMD was assessed pre-cocoa and 30 and 90 min post-stress.

RESULTS: In both studies, mental stress increased FBF, BP, and CV, and impaired FMD 30 min post-stress. Study 1 showed that FMD remained significantly impaired 90 min post-stress in the high-fat condition only, suggesting that fat intake attenuates the recovery of endothelial function following stress. Conversely, Study 2 showed that high-flavanol cocoa attenuated the decline in FMD 30 min post-stress and, improved vasodilatory responses at rest and during stress. No differences in stress task perceptions and performance were observed between interventions in both studies.

CONCLUSION: Fat consumption impaired the recovery of endothelial function following stress. Given the prevalence of maladaptive coping mechanisms, such as reduced physical activity and increased fat intake, during stress, these findings suggest that fat consumption during stressful periods can aggravate the impact of stress on the vasculature. Importantly, cocoa flavanols are effective at counteracting stress-induced endothelial dysfunction and improving blood flow during stress. Therefore, these findings have important implications for future dietary choices and, selecting flavanol-rich foods over high-fat foods, may be an important strategy to protect the vasculature during periods of stress.

Oral presentations

OP-AP25 Team Sports: Load Monitoring

RELATIONSHIP BETWEEN INTERNAL AND EXTERNAL LOAD IN YOUNG ITALIAN HIGH-LEVEL SOCCER PLAYERS

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INTRODUCTION: In top-level soccer, monitoring training loads has become a fundamental method for achieving top performance (1). In the present study, the relationships between external and internal training loads variables were investigated in high-level Italian youth soccer.

METHODS: 25 players from a soccer team participating in the Primavera 1 league, the most important youth soccer competition in Italy, were monitored via GPS during all training sessions held between November 2021 and May 2022 of the 2021/2022 competitive season. Total distance, distance at different speed, number of accelerations and decelerations, distance traveled in acceleration and in deceleration, distance at high metabolic effort, average metabolic power, energy cost, and session duration were collected as external load variables, while the perception of effort assessed by Fosters RPE scale method was used as internal load variable (2). For each repeated measure, a linear regression analysis was performed using the within-subjects correlation method (3). The statistical significance was set at an alpha level of 0.05.

RESULTS: Positive correlations were found for all the variables included, in a range between rho = 0,112 and rho =0,822. There were close to strong correlations for total distance and energy cost (rho = 0.691, rho = 0.698, respectively). There were moderate to strong correlation for distance traveled in acceleration and deceleration and distance at high metabolic effort (rho = 0.621, rho = 0.611, rho = 0.599, respectively), and moderate correlations for number of accelerations and decelerations, high speed distance and very high speed distance (rho = 0.437, rho = 0.505, rho = 0.426, rho = 0.300, respectively). Weak correlations were found for average metabolic power and distance covered in sprint (rho = 0.112, rho = 0.180, respectively).

CONCLUSION: According to the model presented by Jeffries et al. in 2021 (4), the manipulation of the training prescription based on the modulation of the external load variables is an effective method to obtain different responses in the internal load perceived by the athletes. Internal load can be better controlled by focusing on the training variables most correlated with the perception of effort. The results of this study show that total distance, energy cost, acceleration and deceleration distance, and high metabolic effort distance have the greatest effect on changing the perception of effort in high-level young Italian soccer players.

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DIRECTION MATTERS WHEN DESIGNING FOOTBALL PRACTICE – INVESTIGATING THE REPRESENTATIVENESS OF POSSESSION GAMES VIA POSITIONAL DATA

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INTRODUCTION: In football, practitioners and sports scientists observe a growing involvement in possession games (PG) to encourage passing skills, interpersonal space exploration, and occupation tendencies (Menuchi et al., 2018). These training tasks are designed without goals so that goal-setting shifts from goal-scoring towards maintaining possession for as long as possible. Informed by the Ecological Dynamics framework, collective cooperative behaviour is shaped by the layout of the available affordance landscape (Pinder et al.,2011). So, to facilitate skill transfer from training to the actual game, the present study investigates the representativeness of interpersonal relations in PG practice in football (O Sullivan et al., 2021).

METHODS: 22 male football players (age: 23 ± 2.5 years, body height: 183 ± 8 cm, mass:77.2 ± 7.8 kg) participated in one formal game (FG) condition (FG11VS11), two on-goal (OG) practice games: 6 vs. 6 (OG6VS6) and 7 vs. 5 (OG7VS5) and two PG conditions, 6 vs. 6 (PG6VS6) and 7 vs. 5 (PG7VS5), which aimed players to maintain possession as long as possible. The teams performed 60 trials in a crossover study design. Players' positional data were computed using a global positioning system (10 Hz, Catapult ®) and processed to calculate measures of inter-team distance, dyadic distance, and distance to the nearest opponent. The resulting values were analysed via repeated-measures ANOVA using the statistical software R (version 4.2.2). Tukey test for pairwise comparison was used when the repeated-measures ANOVA was $\alpha \leq 0.05$.

RESULTS: Results from the repeated-measures ANOVA revealed significant differences between the played conditions for distance to the nearest opponent, $F(4, 50) = 48.14$, $p < 0.001$, $\eta 2 = 0.76$, dyadic distance, $F(4, 50) = 72.13$, $p < 0.001$, $\eta 2 = 0.85$, and inter-team distance, $F(4, 50) = 9.64$, $p < 0.001$, $\eta 2 = 0.44$. The pairwise comparisons between FG11VS11 and the other conditions reveal that FG11VS11 resulted in a significant higher distance to the nearest opponent compared to PG6VS6 ($p = 0.0116$) and significantly lower values compared to PG7VS5 ($p < 0.0001$). The inter-team distance also differed in the two PG conditions compared to the formal game condition: (PG6VS6 ($p = 0.0084$) and PG7VS5 ($p = 0.0004$). Furthermore, Dyadic distance in FG11VS11 was significantly higher across all practice conditions ($p < 0.01$).

CONCLUSION: The major findings indicate that concerning the spatiotemporal relation, the applied possession games differed significantly from the FG, while the OG conditions showed representativeness. Consequently, when simulating the interpersonal properties of football, the direction of play is crucial to facilitate kinematic representativeness. Future studies should extend the kinematic comparison between the formal game and practice tasks in football to facilitate skill transfer into the performance environment (Farrow et al., 2016).

1. Menuchi et al. (2018) 2. Pinder et al. (2011) 3. O Sullivan et al. (2021) 4. Farrow et al. (2016)

EXTERNAL MATCH-PLAY LOADS IN ELITE FEMALE ASSISTANT SOCCER OFFICIALS

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INTRODUCTION: In soccer, little research has examined the general physical demands of match-play in the contemporary elite female central referee [1] and to our knowledge, none exists in assistant referees (AR). Recent research [2] has shown that female central referees experience temporal deteriorations in physical performance across match-play. Once again however, no study has attempted to confirm whether similar declines occur in AR. This study aimed to 1) describe the overall external match loads in elite female AR during official matches, 2) compare performance across halves and whether decrements occur during the final 15-minute intervals of each match half.

METHODS: Altogether, 6 elite French AR (age 28.9±5.1) participated. Data were collected in 229 competitive matches over 3 consecutive seasons (2020/21-2022/23). The sample included domestic French female and male league (female D1, D2 and male D4) and cup matches and female international youth & senior matches. Global Positioning Systems (Catapult One, Catapult, Australia) were used to collect the data. Each participant wore the same device during the entire duration of the study. External load variables analysed for the match overall included: total distance covered (TD), distance >13km/h (D>13km/h) and >19km/h (D>19km/h), frequency of accelerations & decelerations (>3m/s/s) and maximal speed attained (MS, km/h). Percentage changes in TD & D>13km/h and D>19km/h were analysed across match halves and for the first 15-minute match interval versus the final 15-minute interval in each half (data analysed per minute of play to account for end-half injury time). Effect sizes (ES) are reported for differences in mean values (classified as small [0.2], moderate [0.6], large [1.2], very large [2.0] and extremely large [4.0]).

RESULTS: Overall match data were TD=5112.7±827.1m, D>13km/h1=732.0±334.8m, D>19km/h=104.0±80.9m, accelerations=36.0±21.8m, decelerations=52.1±31.5m and MS: 22.4±1.9km/h. 1st versus 2nd half changes for TD, D>13km/h1 and D>19km/h respectively were: -3.9%, +2.7% and -8.1% (ES: -0.3, +0.2 and -0.2 [all small]). Changes in TD, D>13km/h and D>19km/h for the first 15-minute match interval compared to the final 15-minute interval both in the 1st half and 2nd half respectively were: -8.7% (ES =-0.6, moderate], -25.6% (ES =-0.7, moderate] and -29.4 (ES= -0.5, small]) and -10.4% (ES =-0.9, moderate], -18.1% (ES =-0.5, small] and -27.0% (ES: -0.6 [moderate]).

CONCLUSION: This study has established the general physical match demands for elite French female assistant referees in national and international soccer match-play (total distance covered=~5KM of which ~14% run at speeds >13km/h and

~2% >19km/h). It also shows that small to moderate temporal declines in running performance occur across competition. While this result suggests a need for specific physical conditioning practices to counter fatigue, additional research is necessary to account for the effects of contextual factors.

MOVEMENT AND SUBJECTIVE TASK LOAD CHARACTERISTICS OF MATCH OFFICIALS DURING THE MEN'S AND WOMEN'S RUGBY LEAGUE WORLD CUP

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INTRODUCTION: Rugby league match officials (i.e., a referee and two touch judges) must position themselves relative to the players' actions during a match to make appropriate decisions that enable regulation of the players' behaviour by administering the laws of the game. Influence of the official's role during matches (i.e., referee vs. touch judge) on the physical and subjective task loads remains to be elucidated. Likewise, whether an official's load is influenced when controlling men's or women's competition requires investigation. Therefore, the aims of this study were to examine the influence of the match official's role and whether they were officiating male or female players on their movement and subjective task loads during international match play.

METHODS: A total of 123 performances (referees: n = 39; touch judge: n = 84) from 28 match officials (male n = 25; female n = 3) were assessed during the Men's and Women's Rugby League World Cup. Movement and heart rate data were collected during matches using a 10 Hz global positioning system device and heart rate monitor, respectively. Individual subjective task load was quantified by each official after every match for six sub-scales (Mental, Physical, Temporal, Performance, Effort, Frustration) using the National Aeronautics and Space Administration Task Load Index (NASA-TLX).

RESULTS: Despite similar relative distances (78.7 ± 12.2 cf. 74.3 ± 12.2 m/min; P = 0.061), peak speeds (7.6 ± 1.6 cf. 7.6 ± 1.2 m/s; P = 0.904) and mean heart rate (146 ± 28 cf. 140 ± 21 bpm; P = 0.292), referees performed more accelerations (49 ± 14 cf. 42 ± 18; P = 0.032), decelerations (52 ± 18 cf. 41 ± 21; P = 0.009) and had higher perceived Mental (6.2 ± 2.2 cf. 5.4 ± 1.9, P = 0.03) and Physical (6.2 ± 1.6 cf. 5.1 ± 1.7; P < 0.001) loads during a match than touch judges. Conversely, touch judges (6.3 ± 3.4 m/min) performed more high-speed running in a match than referees (3.8 ± 2.1 m/min) (P < 0.001). High-speed running (6.4 ± 3.2 cf. 3.4 ± 2.3 m/min; P < 0.001), accelerations (49 ± 16 cf. 32 ± 14; P < 0.001), decelerations (50 ± 16 cf. 34 ± 19; P < 0.001), peak speed (7.8 ± 1.4 cf. 7.1 ± 1.0 m/s; P = 0.01), Mental (6.2 ± 1.8 cf. 4.5 ± 2.1; P < 0.001), Physical (6.2 ± 1.4 cf. 4.0 ± 1.5; P < 0.001) and Temporal (5.4 ± 1.8 cf. 3.7 ± 1.8; P < 0.001) perceived loads were higher in those officiating men's compared to women's matches.

CONCLUSION: An official's role during a rugby league match will influence the physical and perceived load that has implications for conditioning practices. Referees need to perform repeated multidirectional movements under high perceived mental and physical load, whereas touch judges require more high-speed running capability. Those officiating men's international rugby league matches also require greater high-speed running and sprint capability, the ability to perform repeated changes of direction and greater tolerance of perceived mental, physical and time pressure loads compared to those controlling the women's game.

Invited symposia

IS-SH02 Swimming education in Europe: State of research towards aquatic literacy

LEN LEARN TO SWIM SUB-COMMISSION REPORT: ENSURING A SAFE GATEWAY TO THE AQUATIC WORLD

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The most recent scientific evidence supports the importance of aquatic competence in reducing the risk of drowning, particularly in children (Campaniço, 2019). LEN has recently established the "Learning2Swim" sub-commission (L2TS) for the purpose of technical and scientific advice on the development of good practices for the massification of aquatic competence across all European member federations.

Data collection and dissemination actions is one important L2TS' strategic vector. This can allow the assessment of the impact of the measures carried out over time and promote the exchange of good practices. Thus, a comprehensive survey was developed to understand the general characteristics of governmental and/or federative swimming education programs, as well as the current qualification and professional license requirements for swimming teachers in Europe. 49 of the 52 member federations responded to the survey.

The results show evident asymmetries in the sports policy to promote the aquatic competence of populations. For example, in 61.2% of the countries there are government programs for learning to swim, generally aimed at basic education (ISCED 1; 87.2%). However, teaching swimming at school is mandatory in only 38.8% of countries (40.8% of which is optional), under different funding models. It was also found that the teaching of swimming varies greatly in terms of duration, frequency, student/teacher ratio and even average costs per class. In about half of European countries (51.1%) swimming

teachers are required to have a professional license, although prior professional training is very variable and does not always include continuing professional training (38.2%).

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RESEARCH APPROACHES TO UNDERSTAND THE CORE DIMENSIONS OF AQUATIC LITERACY

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Starting from the definition of physical literacy being the "integration of physical, psychological, social, and cognitive capabilities that help us live active, healthy, and fulfilling lifestyles", the translation into aquatic literacy (AL) is made. In the Aquatic Literacy for All Children (ALFAC) research project, three core dimensions will be integrated to analyze, compare, and stimulate the concept of AL among European elementary school children: (a) aquatic skills (both actual and perceived), (b) psycho-social features (autonomous motivation, enjoyment & engagement, confidence) and (c) a knowledge aspect (risk perception).

The present contribution provides an overview of the research approaches in the literature on swimming, water competence and AL, taking into account the three dimensions of this latter "new" concept. Specific attention will be given to those preparatory studies conducted at the Vrije Universiteit Brussel (VUB) during the last five years. Concerning the assessment of actual aquatic skills, an inter- and intra-rater reliability study of the Actual Aquatic Skills Test (AAST) will be presented (Mertens et al., 2022). Linking this to perceived aquatic skills, a study identifying the differences between young children's actual, self-perceived and parent-perceived aquatic skills (D'Hondt et al., 2021) is a nice illustration. In terms of the psychosocial dimension, we have some preliminary master thesis' data using a questionnaire to explore fun and fear aspects in relation to aquatic recreation. Finally, the knowledge dimension is covered by a study on the development and validation of tool for individual aquatic risk management among children aged 6 to 12 years (De Martelaer et al., 2022). This research overview offers a retrospective viewpoint and illustrates the challenges the recent ALFAC program has in the three dimensions of aquatic literacy.

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PEDAGOGICAL DIAGNOSTICS IN SWIMMING: A NEED FOR COMPREHENSIVE EDUCATION

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Researchers have been attempting to quantify learners aquatic skills since the 1970s (Erbaugh, 1978). The objectives were (i) the investigation of effects on different aquatic training methods, (ii) the evaluation of human physical adequacy in the water in general or (iii) the assessment of swimming and water safety competencies more specifically. More recently, the focus has been set on the comparison of perceived and actual water competence (i.e., Costa et al., 2020). Most of these assessments are, at least in part, based on diagnostics of basic aquatic skills, which form the foundation of a comprehensive aquatic education. Scientists require diagnostic procedures to be transferable into practical situations. Other than applying scientific diagnostics benefiting research, there is a need for an applicable every-day-approach supporting practitioners in their planning of swimming lessons. In that sense, particularly qualitative diagnostic procedures have been suggested to also match inclusive settings (Mertens et al., 2021).

The Assessment of Basic Aquatic Skills (ABAS; Vogt & Staub, 2020) has been designed as an easy-to-apply tool for the assessment of physical capabilities of learners in swimming. However, actual planning of individualised (swimming) lessons and adaptive teaching needs a pedagogical diagnostic of learners' prerequisites to begin with. For this purpose, the 19 ABAS tasks have been transferred to a diagnostic procedure in swimming to determine the learners' prerequisites. This procedure is structured in two stages: at first, an initial assessment dividing a group of learners up to four consecutive levels of swimming ability. Secondly, the learners' prerequisites are analysed by means of specific ABAS tasks according to the respective level. Based on the results of such pedagogical diagnostics, it will be possible to structure learning opportunities focussing different prerequisites and, thus, designing comprehensive swimming lessons that provide aquatic literacy for all children.

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Oral presentations

OP-BM13 Running II

HOW RUNNING SPEEDS AFFECT ANKLE AND KNEE MUSCLE FORCES AND THE METABOLIC COST?

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INTRODUCTION: Running economy plays a significant role in endurance running performance [1], depending on running speed and is influenced by several physiological, biomechanical and neuromuscular factors. The muscles are essential for supporting body weight, propelling the body forward, absorbing impact from the ground and contributing to the energy consumption during running. Running speed affects muscle forces through a combination of factors, including muscle activation, muscle length, and muscle contraction velocity. As running speed increases, the muscles must produce more force to maintain balance and propel the body forward. This study aimed to examine the effects of running speed on knee and ankle muscle forces and metabolic cost.

METHODS: Nine recreative athletes (5 females, 25±3yrs, 171.2±4.7 and 63.1±6.1kg) performed a series of five running trials during 6 min on a motorized instrumented treadmill (Bertec) at speeds of 1.75, 2, 2.5, 3 and 3.25 m/s. EMG data from 8 lower limb muscles, kinematic of the hip, knee and ankle joint and kinetic data were used into a two-joints EMG-driven model [2] to estimate the ankle and knee muscle forces. The metabolic cost was estimated by indirect calorimetry based on the expired gas. A one-way (speed) repeated measures ANOVA was performed to identify significant changes ($p<0.05$) for individual maximal muscle forces over the range of running speed. Simple and multiple linear regression models were used to analyze the relation between muscle forces and the metabolic cost of running (MCR).

RESULTS: The preferred running speed, at which the MCR was lower, ranged from 1.75 to 3 m/s. The averaged MCR was ranged from 4.0 to 4.5 J/kg/m. Among all the knee and ankle muscle forces, the maximal force is lower at speed of 1.75 m/s compared to 3 and 3.25 m/s except for the semi-membranous (SM), semi-tendinous (ST), vastus lateralis and vastus intermedius muscles. The maximal forces of plantarflexor muscles showed difference for intermediate running speed 2 and 2.5 m/s compared to 3.25 m/s. The simple and multiple linear regression models showed a positive correlation between MCR and the biceps femoris ($R^2=0.292$), rectus femoris (RF) and the tibialis anterior (TA) and negative correlation with the SM and ST. The combination of BF, RF and TA predicted over 51% of the variance in MCR.

CONCLUSION: As running speed increases, the ankle muscles and some knee muscles produced more force probably for the forward body propulsion. However, not all muscles were significantly affected by the running speed. The BF, RF and TA were the main contributor to MCR. In comparison, a previous modeling approach has shown that the quadriceps and plantarflexors are the major contributors to the acceleration of the body mass center during running [3]. Further analysis will be required to better understand the relation between muscle forces and MCR.

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KNEE JOINT FORCES DURING SPORT LOCOMOTION: A COMPARISON OF LINEAR, TURNING AND CUTTING MOVEMENTS

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INTRODUCTION: Precise information about forces acting on the knee joint during sport activities is substantial for understanding injury mechanisms and developing training programs to reduce sports injuries or improve rehabilitation after injury [1]. Due to the difficulty of direct joint force measurement in living persons, musculoskeletal modeling approaches have been used to predict internal knee joint forces (KJF). Previous studies in this field have primarily focused on individual movements and no systematic comparison across multiple sport locomotion tasks has been realized. The purpose of this study was to investigate differences in three-dimensional (3D) KJF for typical linear, turning and cutting movements in sports.

METHODS: The OpenSim simulation software (Gait2392 model with 76 muscles in the lower extremities and torso) was used to determine 3D KJF of the right leg for 13 young (26.1 ± 2.9 years) and healthy male sports students for a variety of sport-specific movements, including walking, moderate running, fast running, sprint start and full-stop after sprinting as linear movements, walking 90° step turn, walking 90° spin turn, running 90° step turn and running 90° spin turn as turning movements, and 45° left-sided v-cut and 45° right-sided v-cut as cutting movements. Differences across movements were assessed using repeated measures ANOVAs for the body weight-normalized (BW) peak KJF and the area under the KJF curve during the stance phase.

RESULTS: Across all movements the peak vertical KJF and the area under the vertical KJF curve increased primary with movement velocity (e.g. peak vertical KJF walking = 3.71 ± 0.96 N/BW vs. peak vertical KJF fast running = 9.93 ± 1.51 N/BW). An increased anterior KJF (i.e. peak anterior KJF > 2.44 N/BW) was identified for sprint start and left-sided v-cut. In contrast, an increased posterior KJF (i.e. peak posterior KJF > 4.48 N/BW) was shown for full stop, running turns and right-sided v-cut. The medial KJF was significantly higher for the left-sided v-cut (e.g. area medial KJF left-sided v-cut = 163.30 ± 51.91 N/BW vs. area medial KJF sprint start = 6.36 ± 16.85 N/BW) than for all other movements.

CONCLUSION: The comprehensive comparison of KJF in this study helps to improve our understanding of biomechanical knee loads during sport-specific movements. The observed KJF are of similar magnitude as presented in earlier studies that focused on a limited number of movements (e.g. 12 N/BW peak vertical KJF during running at 5 m/s [2]). The findings of this study underline the diverse 3D loading characteristics of sport-specific movements. This should be taken into consideration when developing training programs in order to achieve optimal sports performance with minimal injury risk.

NO DIFFERENCE IN BASELINE RUNNING HIP ADDUCTION-ABDUCTION JOINT ANGLES BETWEEN RUNNERS WHO DEVELOPED ILIOTIBIAL BAND SYNDROME AND MATCHED NON-INJURED CONTROLS OVER A 1-YEAR PROSPECTIVE STUDY (SIP)

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INTRODUCTION: The iliotibial band syndrome (ITBS) is accounted to be the second most common injury at the knee among runners [1]. Moreover, the individual running style is considered a biomechanical risk factor for running-related injuries (RRI), and the literature suggests conflicting evidence regarding the hip adduction angle as a risk factor for ITBS [2].

Still, most of the studies evaluate the differences at discrete time points (peak hip adduction angle) during the stance phase [2], limiting their interpretability throughout the continuous waveform of the kinematic data. Therefore, this study aimed to compare the continuous kinematic curves of the hip adduction-abduction joint angle of runners who later developed ITBS against matched control participants through Statistical Parametric Mapping (SPM).

METHODS: A total of 120 competitive runners and triathletes were followed up for one season (12 months). The RRIs were surveyed weekly via a smartphone app (athletemonitoring.com; FITSTATS Technologies, Inc., Canada). Participants were contacted if they reported an injury and then examined by experienced sports medicine physicians who made a precise diagnosis. Three-dimensional kinematic data were collected with 14 color cameras at 150 Hz (Qualisys AB, Sweden) and analyzed with markerless software (Theia Markerless, Canada), during baseline measurements, at the beginning of the season [3]. All athletes were free from any lower limb injury at least three months before the study's start. The current analysis is focused on those runners who later developed ITBS, compared to matched asymptomatic controls (no RRI reported, similar height, weight, and age). A set of 2-way ANOVA was used with the SPM1D package (version 0.4.18) on Python (Jupyter Notebook version 3.9.7) to compare the injured side against the ipsilateral leg of the matched controls.

RESULTS: Seven runners developed ITBS (37.1±8.3 years old, 172.4±5.8 cm height, 66.2±5.8 kg weight, 5 females/2 males, 4 on the right side) within the study period. They were matched with 7 asymptomatic runners (40.7±7.6 years old, 171.7±5.9 cm height, 67.6±6.7 kg weight, 5 females/2 males). Despite qualitative differences in the peak adduction angle during stance, the SPM1D ANOVA results showed no statistically significant differences (p>.05) between both groups at baseline measurement.

CONCLUSION: There were no statistically significant differences at baseline in the hip adduction-abduction angle while running between the runners who subsequently developed ITBS and their matched controls.

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OLDER AND LESS ECONOMIC RUNNERS BENEFIT FROM A SOFTER MIDSOLE.

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INTRODUCTION: Running performance continues to increase thanks to better training programs and footwear. A key parameter of level and long-distance performance is running economy - the energy spent by a runner to move 1kg of their mass over 1km. With continuous improvements in footwear technology, the impact on average running economy is becoming smaller. However, opportunities may exist to continue to improve performance by better understanding runner

specificities as depicted by inter-individual responses (1). For instance, shoe cushioning can improve running economy on average (2); however, it is still unclear what population can benefit most from it. Thus, creating functional groups becomes necessary to better understand individual and group response to an intervention (1). The purpose of this study was to identify characteristics of the population based on their adaptation to a softer midsole, with a focus on how they compress the midsole while running, their running pattern, kinematics and kinetics.

METHODS: Twenty runners of various levels participated in the study and ran on an instrumented treadmill for two times 5 minutes at 85% of their speed at anaerobic threshold (determined before the study). They wore two prototype pairs of Adidas running shoes. The control shoe was composed of a full EVA midsole (HARD, 75.2 N·mm-1), while the second one was composed of a hollowed-out EVA midsole (SOFT, 56.4 N·mm-1). Six reflective markers were pinned to the lateral midsole of the left shoe to track midsole compression (3). Additional markers were placed at different locations on the participant's body and were tracked with a system of eight optoelectronic cameras to assess running kinematics. Ground reaction force data were collected with force plates embedded in the treadmill to assess running kinetics. A breath-by-breath metabolic analysis system was used to quantified gas exchanges and running economy. Two functional groups were formed, one group having better running economy with the SOFT footwear (IMPROVE, 11 runners), and one group having worse running economy (IMPAIR, 9 runners). One-way and two-way ANOVAs were used to assess differences between the two groups and interactions with the shoes.

RESULTS: The IMPROVE group was older (+5.5 years, $p=0.019$) and had a greater braking ratio (+0.37, $p=0.037$) than the IMPAIR group. The IMPROVE group had a worse running economy with the HARD shoe (+0.157 kcal·kg-1·km-1, $p=0.006$), and a greater midsole vertical compression with the SOFT shoe (+2.89 mm, $p<0.001$). No differences were found in running pattern, kinematic, or kinetic data.

CONCLUSION: Older participants with decreased running economy are more likely to benefit from softer shoes. This population was able to better compress the softer midsole and benefit from a reduced braking ratio to improve their running economy.

INFLUENCE OF DIFFERENT LONGITUDINAL BENDING STIFFNESS OF RUNNING "SUPER SHOES" ON BIOMECHANICS AND RUNNING ECONOMY.

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INTRODUCTION: Running performance, particularly in long distance events such as the marathon, depends on an interplay of several physiological factors, including the metabolic cost of running (RE). Increasing shoe longitudinal bending stiffness (LBS) influenced RE and performance[1], being one of the main features of the new "Super Shoes". However, results on the effects of increasing LBS using flat carbon fiber plates or insoles are mixed. The main difference of the shoes conditions in these studies compared to "Super Shoes" is that "Super Shoes" have a curved plate instead of a flat plate and new more resilient and compliant foams. The purpose of this study was to evaluate the isolated effects of increased LBS by embedding a curved carbon fiber plate within a PEBA midsole of a "Super Shoe" on RE and biomechanics.

METHODS: Twenty-one male trained runners participated in this study. Subjects ran 4 x 4 min at 13 km·hr-1 with two experimental condition shoes models with curved carbon fiber plate in a "Super shoe" model with different LBS increments (Stiff: 35.5 N·mm -1 and Stiffest: 43.1 N·mm -1) and a control condition (without carbon fiber plate: 20.1 N·mm-1). We measured energy cost of running (W·kg-1), spatiotemporal and neuromuscular parameters in one visit.

RESULTS: There were significant differences between shoe conditions in RE measured as energy cost ($p<0.001$; $n2 = 0.374$). RE improved for the Stiff shoe condition (15.71 ± 0.95 W·kg-1; $p<0.001$; $n2=0.374$) compared to the control condition (16.13 ± 1.08 W·kg-1) and stiffest condition (16.03 ± 1.19 W·kg-1), without differences between stiffest and control conditions. Moreover, there were an increase of step length and flight time for both experimental conditions in comparison to control condition and an increase of leg stiffness in the Stiff condition in comparison to control condition, but without differences between Stiffest and control conditions.

CONCLUSION: Changes in LBS on "super shoes" influence RE in a "U-shaped" relationship, decreasing 2.56% energy cost of running (better RE) in the Stiff condition in comparison with the control, and 1.98% when comparing the Stiff condition with the Stiffest, similar to a previous study with flat plates[2]. However, the Stiff and Stiffest condition experienced similar spatiotemporal changes compared to the control condition (increases in step length and flight time) except for leg stiffness. Higher leg stiffness has been related to a better RE [3], thus, it seems that the "optimal" LBS condition caused changes in leg stiffness whereas when the increase in LBS is excessive (Stiffest condition) it did not.

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Oral presentations

OP-PN13 Hypoxia II

DIFFERENTIAL EFFECTS OF HYPOXIA AND HEAT ON RESTING AND EXERCISE-RELATED BLOOD OXIDATIVE STRESS

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INTRODUCTION: While exercise is known to augment oxidative stress and alter antioxidant status, environmental stressors such as hypoxia (1) and/or heat (2) can also modulate redox balance. The present work sought to compare resting and exercise-related pro-antioxidant balance following acute exposure to both heat and hypoxia as well as after prolonged acclimatization protocols to both environmental factors.

METHODS: Within the framework of the X-Adapt project (3, 4), twenty-four healthy males underwent acute exercise testing under normoxic (NOR), hypoxic (13.5% FiO2; HYP), and hot (35 °C, 50% RH; HEAT) conditions in a randomized manner. Thereafter they underwent a 10-day acclimation protocol consisting of either 1) continuous normobaric hypoxic exposure combined with exercise training (N=12; FiO2=13.65±0.35%) or 2) daily 90-min controlled-hyperthermia exercise sessions (N=12; Tre=38.5°C). Venous blood plasma samples were obtained before and immediately after the acute exercise tests with further resting samples obtained following the prolonged acclimatization protocols. Several oxidative stress [advanced oxidation protein products (AOPP), malondialdehyde] and antioxidant status markers [ferric-reducing antioxidant power, superoxide dismutase (SOD), glutathione peroxidase, and catalase] along with uric acid (UA) and total nitrite and nitrate (NOx) were determined.

RESULTS: While acute exercise in HYP and HEAT increased AOPP ($P< 0.01$) and UA ($P< 0.05$), SOD was only reduced following HYP ($P< 0.05$). NOx ($P< 0.05$) and Catalase ($P< 0.05$) only increased following HYP and HEAT, respectively. Following prolonged acclimatization protocols, no significant between or Pre-Post differences were observed at rest in any of the measured markers.

CONCLUSION: These data suggest that hypoxia and heat differentially affect acute exercise-related oxidative stress modulation in healthy young males.

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THE ISOLATED AND COMBINED EFFECTS OF ACUTE HYPOXIA, OVERNIGHT SLEEP DEPRIVATION, AND EXERCISE ON COGNITIVE AND PHYSIOLOGICAL FUNCTION

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INTRODUCTION: It is well established that both acute hypoxia and total sleep deprivation may impair cognitive performance. However, few have considered whether there is a cumulative effect when both stressors are experienced in combination. In contrast, moderate intensity exercise has been shown to improve cognitive performance. Whilst a growing number of studies have examined the interaction between hypoxia, exercise and cognition, this relationship remains poorly understood. Furthermore, whether exercise improves cognitive performance after a period of sleep deprivation, or when hypoxia and sleep deprivation are experienced in combination, is currently unknown.

METHODS: Using a randomised, controlled, crossover design, this study examined the isolated and combined effects of acute hypoxia (60 mins at FIO2 0.12), one night of total sleep deprivation, and 40 minutes of moderate intensity (RPE 12) cycling exercise on cognitive performance. Twelve healthy male participants (mean [SD], age: 26 [4] years; height: 185 [7] cm; weight: 84 [12] kg; VO2max: 46 [9] mL.kg-1.min-1) completed a 7-task cognitive battery (ANAM: simple reaction time, logical relations, mathematical processing, Manikin test, n-back) at rest and during exercise in the following conditions: normoxia and hypoxia with a normal night of sleep; normoxia and hypoxia following one night of total sleep deprivation. Peripheral oxygen saturation (SpO2), cerebral oxygenation (measured via near-infrared spectroscopy at the prefrontal cortex), and breath by breath gas analysis were measured throughout.

RESULTS: As expected, SpO2 and cerebral oxygenation were reduced in hypoxia compared to normoxia, with lower values observed during exercise compared to rest. However, no further reductions were observed for either measurement when hypoxia and sleep deprivation were experienced in combination. Hypoxia experienced in isolation did not result in a reduction in performance for any of the cognitive tasks ($P > 0.05$), however, after one night of total sleep deprivation all tasks were impaired when performed at rest ($P = 0.001 – 0.027$). There was no further impairment when tasks were performed at rest during hypoxia and sleep deprivation in combination, than when completed after sleep deprivation alone.

When compared to rest in the same condition, cognitive performance during exercise was improved after total sleep deprivation in both normoxia and hypoxia (P = 0.001 – 0.047).

CONCLUSION: The principal novel findings of this study are as follows: 1) one night of total sleep deprivation reduces cognitive performance at rest across multiple cognitive domains; 2) there is no further reduction in cognitive performance when hypoxia (FIO2 0.12) and one night of total sleep deprivation are experienced in combination; and 3) sleep deprivation-induced decrements in cognitive performance are ameliorated by an acute bout of moderate intensity cycling exercise in both normoxia and hypoxia.

TIME COURSE OF RESTING AND EXERCISE-RELATED CARDIO-RESPIRATORY RESPONSES THROUGHOUT A THREE-DAY ALTITUDE EXPOSURE AT 3375 M

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INTRODUCTION: Multiple-day recreational trips to altitude are increasing in popularity. The reduced barometric pressure and physical activity requirements associated with these sojourns evoke a combined hypoxic and exercise stimulus, posing a significant physiological challenge. The aim of this work was to elucidate cardio-respiratory acclimatisation patterns at rest and during moderate-intensity exercise across three days at high altitude.

METHODS: Thirty-two healthy male participants (Mean ± SD; age, 21.9±3.2 yr; body mass index, 22.5±2.2 kg/m2; peak oxygen uptake, 49.9±9.4 ml/kg/min) underwent a three-day high-altitude sojourn at 3375 m. Upon arrival (A), and on each day (D1; D2; D3), participants performed a moderate-intensity exercise bout on a cycle ergometer, comprising a three-minute rest period followed by two minutes at 20 W and eight minutes at a moderate exercise intensity (20% below gas exchange threshold, adjusted for hypoxia-induced exercise capacity reductions). Outcome measures included oxygen uptake (VO2), ventilation (VE), capillary oxygen saturation (SpO2), heart rate (HR), stroke volume (SV), cardiac output (CO) and muscle oxygenation (TSI). Resting and exercising values were quantified as 60-s averages from the pre-exercise period, and the end of the moderate-intensity exercise bout, respectively.

RESULTS: At rest, SpO2 increased significantly from A to D3 (90.2±2.6% vs. 94.5±1.5%; p<0.001). VE increased from A to D1 (11.7±2.4 vs. 14.0±2.4 L/min; p<0.001), although no subsequent changes from D1 to D3 were observed. HR also initially increased (A vs. D1; 77±10 vs. 96±13 bpm; p<0.001), although a subsequent decrease from D1 to D3 (91±12 bpm; p=0.002) was apparent. Conversely, SV decreased from A to D1 (101±19 vs. 90±12 ml; p=0.016), after which it remained unchanged from D1 to D3 (90±15 ml; p>0.999). The opposing HR and SV effects largely washed out changes in resting CO.

The average moderate-intensity exercise workload was 88±28 W. VO2 was unchanged throughout the exposure (p=0.133). SpO2 increased significantly on each day from 84±4% at A to 89±3% on D3 (p<0.001). VE increased from A to D2 (46.5±10.7 vs. 54.3±11.3 L/min; p<0.001), and plateaued by D3 (54.2±12.1 L/min; p>0.999). HR increased from A to D1 (130±13 vs. 142±14 bpm; p<0.001), decreased to 137±12 bpm (p=0.007) in D2, then remained elevated relative to A. SV decreased from A to D1 (133±24 vs. 114±19 ml; p<0.001), then remained lower throughout the rest of the exposure. The time course of exercising CO data reflected changes in SV rather than HR. TSI did not significantly change throughout the exposure at rest or during exercise.

CONCLUSION: These data provide evidence of altitude acclimatisation, both at rest and during exercise, in the respiratory and the cardiovascular systems, but not skeletal muscle, during three days at 3375 m. The findings may inform acclimatisation strategies that consider the time course of pathophysiological risk at rest and during moderate exercise at altitude in healthy individuals.

MICRODOSES OF RECOMBINANT HUMAN ERYTHROPOIETIN AT ALTITUDE FURTHER ENHANCES HEMOGLOBIN MASS BUT NOT MAXIMAL OXYGEN CONSUMPTION (VO2MAX) COMPARED TO ALTITUDE OR ERYTHROPOIETIN TREATMENT ALONE.

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INTRODUCTION: Here, we investigated if gradual levels of increased erythropoietic stress manifested in differences in total hemoglobin mass (tHb) by combing altitude exposure (ALT) with rhEpo treatment, thus providing an additional erythropoietic stimuli. From an anti-doping perspective, knowledge of the erythropoietic effect from combining ALT and microdoses of rhEpo is relevant as ALT has been suggested as a masking agent for rhEpo misuse. We hypothesized that microdoses of rhEpo at ALT would further increase tHb compared to ALT alone or rhEpo treatment at sea-level (SL).

METHODS: The study included two experimental arms separated by 2 months, each comprised of a 4-week baseline, a 4-week intervention at SL or ALT (2,320 m), and 4 weeks follow-up. Twenty-eight, healthy, low-altitude subjects (males: n=18, VO2max of 62±7 ml/min/kg; females: n=10, VO2max of 50±3 ml/min/kg) was included in the ALT arm and 14 (males: n=8, VO2max of 60±3 ml/min/kg; females: n=6, VO2max of 49±3 ml/min/kg) was included in the SL arm. Subjects were randomly assigned to intravenous injections of either epoetin β (20 IU/kg; n=10 at SL, n=11 at ALT) or saline (n=4 at SL, n=17 at ALT) every second day for 3 weeks. tHb and blood volumes was measured weekly using the carbon monoxide rebreathing method. VO2max was determined using an online breath-by-breath system and performed on a treadmill biweekly. A mixed linear model for repeated measurements was used with a level of significance of P<0.05.

RESULTS: An interaction effect (P<0.001) was evident in ALT for tHb when comparing the placebo (ALT-PLA) and rhEpo group (ALT-EPO). The peak increase (P<0.001) in tHb in ALT-EPO was 83±35g when compared to baseline, whereas the peak increase (P<0.05) in ALT-PLA was 35±10g two weeks after returning to SL. In the rhEpo group at SL (SL-EPO), tHb

increased (P<0.05) by 35±9g immediately following treatment. Comparing SL-EPO and ALT-EPO revealed an interaction effect (P<0.001) but no pairwise differences. No differences were evident between SL-EPO and ALT-PLA. Changes of red cell volume resembled those described for tHb with corresponding increases of 146±41ml (P<0.001) in SL-EPO, 310±90ml (P<0.001) in ALT-EPO, and 214±26ml (P<0.01) in ALT-PLA, respectively. When comparing VO2max in SL-EPO and ALT-EPO an interaction effect (P<0.001) was found, but only a significant change (+7%; P<0.05) was observed in SL-EPO following treatment despite a numerical increase (+5%; n.s.) in ALT-EPO. When comparing ALT-EPO and ALT-PLA no interaction effect was found

CONCLUSION: In summary, a microdose rhEpo treatment additively increase tHb when combined with ALT compared to ALT alone and the increase in tHb at SL following rhEpo was similar to that of ALT alone. However, no additive effect on VO2max in ALT-EPO was found despite a ~50g change in peak tHb increase compared to ALT. The discrepancy highlights that despite tHb is a main predictor of performance in a heterogenous group this does not translate per se into an increased performance.

ADDING WHOLE-BODY CRYOTHERAPY EXPOSURE TO LIVE HIGH-TRAIN LOW AND HIGH HYPOXIC TRAINING.

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INTRODUCTION: "Live High- Train Low and High" (LHTLH) hypoxic training is described as a method consisting of chronic exposure to hypoxia with training at sea-level, and additional hypoxic training sessions per week [1]. This training model contributes to aerobic and anaerobic performance improvement [1]. Nevertheless, altitude exposure is a strong stressor for athletes associated with exacerbated fatigue [2]. Whole-Body Cryotherapy (WBC) which has been shown to improve recovery factors [3], could be an interesting complementary strategy to this training method. This study aimed to investigate the combined effect of LHTLH and WBC on performance improvement. We hypothesize that WBC would improve acclimation and recovery leading to a greater increase in performance.

METHODS: Thirteen well-trained cyclists (5 men and 8 women, 19.2 ± 4.4 yr, body fat mass 15.7 ± 5.5%) carried out 14 days of LHTLH composed of at least 14h.day-1 exposure to normobaric hypoxia (2800 m) and 6 repeated-sprint training sessions in hypoxia (RSH: 3 sets of 5 × 10-s all-out with 20-s of recovery, 3000 m). Cyclists were randomly assigned to two groups involving 9 recovery sessions (CTRL group: 5-min in sitting position at 20°C, n = 6; WBC group: 30-s at -25°C and 3-min at -55°C, n=7). Before (pre), immediately (post-1) and 3 weeks after (post-2) intervention, specific performance tests were performed: Repeated Sprint Ability (RSA), Wingate test, and maximal aerobic power (MAP). During intervention, physiological parameters were recorded to monitor the participants acclimation and recovery, including nocturnal blood oxygen saturation (SpO2).

RESULTS: Both groups tended to increase mean power output during RSA at post-2 compared to pre (CTRL: +4.6 %; WBC: +3.7%, p = 0.06). WBC group allowed reducing decrement scores at post-1 and post-2 (p < 0.05), while CTRL only at post-1 (p < 0.05). Wingate performance was not different at post-1 and post-2, but the mean heart rate was reduced for both groups at post-2 (CTRL: -5.9%, p < 0.05; WBC: -5.0%, p = 0.06). LHTLH induced an increase in MAP for both groups at post-1 and post-2 (CTRL: +5.9%, p < 0.05 and +5.2%, p < 0.05; WBC: +3.3%, p < 0.05 and +2.8%, p < 0.05), with a decrease in mean heart rate at post-2 during MAP test for WBC group (-8.1%, p < 0.05). Both groups showed a variation over time in SpO2 (p < 0.001), with a significant decrease during the LHTLH intervention. SpO2 was higher for the WBC group compared to the CTRL group during pre (96.7 ± 1.2% and 95.2 ± 0.9%, respectively, p < 0.01) and during LHTLH (92.6 ± 1.0% and 90.8 ± 1.3% respectively, < 0.01).

CONCLUSION: The results confirmed that LHTLH improves the physical capacities of athletes. Performance was not affected by WBC exposure. However, WBC could contribute to the acclimation of the participants and thus could prevent the appearance of excessive fatigue by limiting the decrease in SpO2.

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Oral presentations

OP-BM11 Cycling

APPORT OF THE IA TO IMPROVE BIKE PARAMETERS ON MUSCLE ACTIVITY AND POSITION IN ORDER TO OPTIMISE RIDER PERFORMANCE

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INTRODUCTION: Different bike parameters can influence the position and activity of the muscles. These include saddle height, cadence and handlebar position [2,3]. The objective of this study is to carry out a multi-instrumented experimental design to determine the influence of bike settings on muscle activity. This is in order to optimise the cyclists position to increase performance.

METHODS: 6 non-professional cyclists performed tests on an instrumented test bench. Throughout the tests, the muscle activity of 7 muscles (Rectus Femoris, Vastus Medialis, Tibialis Anterior, Soleus, Biceps Femoris, Gastrocnemius Medialis) on the right leg were recorded using wireless EMG (Cometa MiniWave Inifinity) at a sampling rate of 2000Hz. The electrodes were placed according to SENIAM recommendations after the skin was prepared. The subjects were also fitted with inertial units (Cometa WaveTrack) on the pelvis, femur, tibia and foot [1]. The IMUs were calibrated using standing and lying down acquisition. In order to compare subjects with each other, MVC was measured with three 6s sprints with 3min breaks between each to avoid fatigue [4]. After a 10 min warm-up, 8 trials were performed following the order of the experimental design with adjustable factors: cadence (60 or 80 rpm), saddle position (crotch height*0.883 ±5%) and handlebar position. Each test was separated by a 2-minute break. Finally, a validation test was carried out and a final MVC to assess final fatigue. Heart rate was also recorded throughout the trials. The data collected for the EMGs was then filtered using a 4th order Butterworth filter with a cut-off frequency between 20 and 400Hz, rectification and a low pass frequency of 15Hz and then RMS on each cycle before being normalised using Matlab 2022 [5]. The IMU signals were filtered using a Kallman filter until the Euler angles were obtained [6]. Hexagons Lunar software was used to propose an optimised position to reduce energy consumption and thus increase performance.

RESULTS: The results of the experimental design indicate that some factors have a lot of influence such as saddle position and pedalling rate on the muscle activity recorded and therefore on the energy consumed by the cyclist. Indeed, we can see that between two extreme situations some muscles are more influenced : the biceps femoris goes from 31% activation to 8%. The position of the saddle has a very big influence on the heart rate (unlike the handlebars and the cadence). The heart rate increases from 120bpm to 140bpm in both extreme situations. A parameter configuration allowed us to obtain an optimal position for each rider

CONCLUSION: The results obtained have shown that the rider's position influence muscle activity and heart rate. Finally, an optimization model specific for each rider is propose to improved performance by optimising position for the cyclist and therefore muscle activity and energy consumption.

1 Cordillet 2019 2 Dorel 2009 3 Gamez 2009 4 Jobson 2012 5 Munera Ramirez 2014 6 Nez 2017

DEVELOPMENT OF A FORCE-ENDURANCE MODEL ABLE TO DESCRIBE THE MUSCLE FATIGABILITY IN THE SEVERE DOMAIN AND VALIDATION OF THE RACLET TEST.

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INTRODUCTION: Muscle fatigability corresponds to the decrease in the ability of muscles to generate force. The Critical Power (Pc) concept [1] predicts the point at which fatigue develops, in such a way that the required constant intensity will no longer be sustainable (W' reserve is emptied). During all-out tests the power plateau reached at the end of the test and the work done above this value have been numerically and conceptually related to Pc and W', respectively. These two mathematical models, characterizing similar phenomena but based on very different exercises (steady state versus all-out) have not been directly linked. Thus, the aims of this study were to i) develop an integrative model of exercise fatigability and ii) propose a submaximal test based on this model to determine critical intensity.

METHODS: From Mortons 3-parameters model [2] one can make the assumption that fatigability is proportional to the impulse accumulation above the critical force (Fc) so Fmax(t)=(-1/Tau)integral(F(t)-Fc)dt+Fi. Since the model can be applied to any exercises, a specific Ramp Above CriticaL Exhaustion Test (RACLET) was proposed. The test was designed so that the target intensity starts above the critical intensity and decrease below it, before exhaustion of W', so before exhaustion of the participant. It was tested for a cycling task with a 300s ramp test decreasing from 40% to 5% of initial force (Fi), where maximal capacities (Fmax) were assessed every 30s from 6-pedal-strokes sprints. Twenty participants realized 5 experimental sessions: 2 RACLET and 3 time to exhaustion (TTE). A custom friction regulated instrumented cyclo-ergometer was developed to measure crank torque and velocity. Each Fmax was used to adjust the model's parameters. The model's reliability and validity were tested by determination of individual parameters Fc & Tau by adjusting the model to Fmax and time data from RACLET and TTE tests.

RESULTS: The model's goodness of the fit on RACLET test experimental data was excellent (median adjusted R^2=0.95; RMSE=3.4%Fi). Mean±SD Fc &Tau were 29.6±7.2%Fi and 22.7±13.9s, respectively. Fc parameter in RACLET demonstrated good relative (ICC=0.9) and absolute reliability (SEM=4.5%). The comparison of Fc between RACLET and reference TTE method was acceptable (R^2=0.8, SEM=5.8%).

CONCLUSION: The proposed model fit very well with the experimental data obtained during the RACLET. The latter showed very good test-retest reliability. Moreover, the fitted parameters were very similar to those obtained with the gold standard method TTE. The present results show that it is possible to determine individual model parameters (Fi, Fc, and Tau) from experimental data obtained from the proposed RACLET. As this test does not lead to the participants exhaustion, it could be interesting for athletes monitoring tranings, or patients with pathologies that make it difficult to use traditional methods (TTE and all-out tests).

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MUSCLE FASCICLE BEHAVIOR DURING SPRINT CYCLING: NEW INSIGHTS REGARDING THE GAIN IN MAXIMAL POWER IN STANDING COMPARED TO SEATED POSITION

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INTRODUCTION: The standing position is mainly used during road-cycling sprints to increase the maximal power output capacity compared to the seating position. However, the adjustments in behavior of the lower limb muscles induced by this specific position remain unknown. This study analyzed the fascicle behavior during sprint cycling in elite cyclists in both seating and standing positions. The aims were i) to determine whether joint kinematics and both fascicle and muscle-tendon unit (MTU) lengths and shortening velocities of the vastus lateralis (VL) and the gastrocnemius medialis (GM) were modified between these two positions, ii) to relate their operating fascicle length during cycling to their own torque-length characteristic to investigate whether this would participate to explain the gain of power in standing position.

METHODS: Eleven elite cyclists (23.0 ± 3.7 yr; 178.8 ± 3.8 cm; 67.8 ± 3.0 kg) volunteered to participate in this study. The maximal torque-length relationships and optimal length (Lopt) of ankle plantar flexors and knee extensors were determined using series of single-joint maximal isometric contractions at 6 angles (1). Then, cyclists performed four 5-s sprints at 110 rpm on cycle ergometer: two in standing and two in seating position. Joint kinematic, fascicle-tendon behavior (using ultrasound imaging) and EMG activity of VL and GM were recorded throughout the session.

RESULTS: The maximal power output was higher in the standing position with a large inter-cyclist variability in this gain (mean: +15.8%; min: -0.4%; max: +37.8%). A more extended knee angle over the entire cycle (+5,1°) and a delayed and prolonged EMG activity of VL (up to 103.1±11.2° of crank angle in standing compared to 77.8±11.4°in seating position) were observed (P<0.01). In standing position, the VL MTU and fascicle shortened actively more compared to the seating position with an operating fascicle length shorter and near the plateau for maximal force production (117.4 % vs. 122.7 % of Lopt, respectively). GM fascicle operated close to Lopt (i.e. 95.7 % vs. 91.5 % of Lopt in seating and standing positions, respectively) with no significant difference between both positions.

CONCLUSION: The standing position induced adaptations resulting in changes in the fascicle behavior, particularly useful for the VL because it leads to a longer period of contraction around the optimal operating length configuration. Interestingly, this associated theoretical gain in force-generating capacity of VL seems, at least partially, participate to explain the gain of power in standing position. Despite the absence of clear difference in GM fascicle length between both positions, the slower MTU shortening velocity and greater lengthening of the tendinous tissues in standing position may participate to maintain the fascicle in favorable condition to transmit the power to the pedal when this muscle is maximally activated.

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NO ASSOCIATION BETWEEN RELATIVE CHANGES IN SPRINT CYCLING TORQUE AND ISOMETRIC MID-THIGH PULL FORCE FOLLOWING A SIX-WEEK SPRINT CYCLING AND RESISTANCE TRAINING PROGRAM.

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INTRODUCTION: The magnitude and rate at which a cyclist can apply pedal force to produce crank torque are important factors influencing power production (1). Implementation of appropriate training to improve peak force/torque and rate of force/torque development (RFD/RTD) are therefore critical to improve sprint cycling performance. While gym- and cycling-training have been shown to improve peak torque and peak power (2), little is known around the training-induced changes in cycling RTD. A cyclist's peak force/torque and RFD/RTD can be assessed using isometric protocols such as the isometric mid-thigh pull (IMTP) or during dynamic cycling (3). While research has shown a strong relationship between peak force/torque and RFD/RTD during the IMTP and sprint cycling (3), it is unclear if these measures change at the same rate following training. Therefore, the aims of the present study were to: (i) determine the extent that IMTP and sprint cycling measures change following a six-week resistance and sprint cycling training program; (ii) determine if the relative change in IMTP force and sprint cycling torque measures are associated. This would provide information to practitioners on whether the IMTP can be used to infer cycle-specific changes following a training intervention.

METHODS: Fourteen recreationally active individuals who were strength-trained and non-cyclists volunteered for this study. A single-group, longitudinal (pre-/post-test) study design was employed to determine the effects of a 6-week training program. Training consisted of supervised resistance (n=3) and sprint cycling (n=3) sessions per week. Pre- and post-testing involved IMTP force and sprint cycling power, cadence, and torque measurement.

RESULTS: Cycling results showed significantly higher absolute (10.7%) and relative peak power (10.5%), peak torque (11.7%), and RTD measures (27.9-56.7%) post-training (p<0.01). Significantly higher IMTP peak force (13.1%) and RFD measures (23.7-32.5%) were observed post-training (p<0.05). While strong-to-very strong relationships were observed between IMTP force and cycling torque measures pre- (r=0.57-0.84; p<0.05) and post-training (r=0.63-0.87; p<0.05), no relationship existed between relative changes in sprint cycling torque and IMTP force measures.

CONCLUSION: This study demonstrates the extent to which a six-week resistance and sprint cycling training program improves cycling power, torque, and IMTP force measures in strength-trained, non-cyclists. While there was transferability

between IMTP force and cycling torque pre- and post-training, the rate of change in these measures were not associated following training, and therefore, should not be treated as interchangeable for longitudinal monitoring.

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REAL-WORLD CYCLING CADENCES: EFFECT ON ENERGY COST, JOINT MECHANICS, AND FATIGUE

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INTRODUCTION: Within an individual pursuit event (IP; 3- to 4-km time trial) in track cycling, bicycles operate with a single, fixed gear, and riders are required to sustain high power outputs resulting in significant fatigue. Gearing selection will influence the muscles' shortening speeds, activation rates, and force production, impacting the energy cost and thus performance fatigue. Gear selection is therefore critical for IP performance and may be adjusted by a rider to achieve a small, 2-4 rpm (cadence) manipulation for a given power output. Over a large range (40-180 rpm), higher cadences are associated with a higher energy cost and fatigue, yet the effect of small changes in cadence in experienced cyclists during an IP is unknown. Our purpose was to test whether small changes in cadence (as a proxy for gearing) meaningfully impact a cyclist's oxygen uptake kinetics, joint-specific torque- and- power distributions, and performance fatigability.

METHODS: Thirteen highly trained male (10) and female (3) cyclists performed three 2-min cycling trials at their best IP power output on a stationary ergometer. Cadence was manipulated between the cycling trials, from the average cadence of their best IP (termed "preferred") to cadences 5 rpm above and below their preferred (PREF+5rpm and PREF-5rpm). Physiological stress (VO2 kinetics and blood lactate concentration) was monitored; joint-specific angular velocity, torque, and power were calculated through inverse dynamics; and performance fatigability was estimated as the mean power loss in a maximal 10-s sprint performed without pause after the 2-min cycling trials.

RESULTS: Greater performance fatigue was evoked by PREF+5rpm than both PREF and PREF-5rpm (8.8 vs 8.8 and 8.4 W·kg-1, respectively, $p=0.01$), and a trend towards an increase in peak VO2 and rate of VO2 rise were observed. PREF+5rpm was associated with an increase ($p<0.01$) in peak knee and hip angular velocities (extension and flexion). Changes in the average joint-specific torques and powers occurred mainly during the pedal upstroke where ankle dorsiflexion torque ($p=0.01$), hip flexion torque ($p=0.003$) and knee flexion power ($p=0.01$) increased in PREF+5rpm, possibly suggesting a concerted effort by the cyclists to increase leg flexion during the pedal upstroke phase. No significant relationship was found between level of performance fatigue and joint-specific mechanics.

CONCLUSION: This study demonstrated that a small increase in cadence (i.e., gear) may induce small but significant increases in performance fatigue and alter joint-specific mechanics in highly trained cyclists during the first 2 min of a simulated IP. Importantly, high inter-individual variations were observed, as particularly torque- and- power distributions varied across the joints for different individuals in response to cadence changes. This emphasises that practitioners should take an individualised approach to understand the effects of small (but practically relevant) changes in cadence on IP performance.

Oral presentations

OP-BM20 Neuromuscular function

THE EFFECTS OF INCREASED MUSCLE VS. CORE TEMPERATURE ON NEUROMUSCULAR FUNCTION AFTER A HOT-WATER IMMERSION SESSION

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INTRODUCTION: Passive heating can increase skeletal muscle contractile function in humans (1). However, complexity exists when testing neuromuscular function after a passive heating intervention. While a passive increase in muscle temperature (Tmu) can enhance voluntary and evoked muscle contractile function (2), any parallel increase in core temperature (Tc) may impair neural drive transmission to the working muscles (3), masking the enhancement of muscle contractile responses resulting from increased Tmu. This study investigated the effects of a passive heating session on voluntary and evoked neuromuscular function, firstly with a concomitant increase in Tmu and Tc, and thereafter with increased Tmu but cooled Tc.

METHODS: Fifteen participants (24.9±5.6 yrs) performed neuromuscular assessments before, after, and 15-min after either 90-min of 42°C (hot) or 36°C (control) water immersion to the waist. Maximal voluntary contraction (MVC) torque, voluntary activation (VA), and rate of torque development (during the early phase [0-50 ms: RTDV50] and late phase [0-150 ms: RTDV150]) were assessed by isometric knee extension. The motor unit discharge rate (MUDR) of the vastus lateralis was assessed during submaximal contractions (20% of MVC). Resting evoked twitch was elicited on the femoral nerve for peak

torque, rate of torque development (RTDtwitch), half-relaxation time (HRT) and electromechanical delay (EMD) assessments.

RESULTS: After the hot-water immersion (Tc ↑1°C, Tmu ↑2.4°C), MVC torque and VA decreased (4.2% and 4.3%; P<.05) and RTDV50 increased (26.4%; P<.002). MUDR decreased, showing a time effect, after both water immersion conditions (36ºC and 42ºC) (7.7%; P<.001). Peak twitch torque and RTDtwitch did not change (P>.05) while EMD and HRT decreased (12.3% and 12.4%; P<.03). Fifteen min after the hot-water immersion (Tc at baseline, Tmu ↑1.4°C), MVC torque returned to baseline while VA remained lower (1.2%) and RTDV50 remained higher (27.9%). MUDR remained lower (7.7%). Peak twitch torque and RTDtwitch increased (13.4% and 21.8%; P<.02) and EMD and HRT remained lower (18.7% and 8.3%). No changes were observed for RTDV150 at any moment (P>.05).

CONCLUSION: After 90 min of 42ºC hot-water immersion session, increased Tc impaired MVC torque and VA, but the increased Tmu enhanced RTDV50, and evoked EMD and HRT. Fifteen min after the hot bath, a passive increase in Tmu improved all the evoked contraction assessments (peak twitch torque, RTDtwitch, EMD, and HRT) and the RTDV50, but did not change MVC torque or RTDV150. The MUDR required to attain the same relative torque (20% of MVC) decreased after and 15-min after the hot-water immersion, likely caused by lesser voluntary synaptic input needed due to increased muscle contractile function (4) after a passive increase in Tmu.

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QUANTIFYING THE SPATIAL DISTRIBUTION OF INDIVIDUAL MUSCLE UNITS USING HIGH-DENSITY SURFACE EMG AND ULTRAFAST ULTRASOUND

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INTRODUCTION: Resistance training is a well-known intervention to improve muscle strength (1), with motor unit (MU) adaptation playing an important role (2). Recently, MUs were tracked in humans before and after resistance training using high-density surface electromyography (HDsEMG), showing a correlation between maximal force increase and MUs' average discharge rate (3). Although these results demonstrate the relationship between an increase in strength and MU activity, only MU-level neural adaptation was considered. Indeed, neural and muscular information needs to be studied jointly to understand the exact adaptations of the MUs in response to resistance training (4).

Recently, a method based on ultrafast ultrasound was presented, providing estimates of MU territories in cross-section and the train of twitches evoked by the spinal motoneurons' discharges (5). In this study, as a proof-of-concept, we combined ultrafast ultrasound and HDsEMG to explore the spatial distribution of individual MUs.

METHODS: In a cross-sectional study, four participants performed low-force isometric contractions of the biceps brachii muscle while recording HDsEMG and ultrafast ultrasound signals from the biceps brachii muscle.

The HDsEMG signals were decomposed into individual MU discharge timings (6), and the ultrafast ultrasound signals were decomposed into many components, each having a spatial map and temporal signal (5). We matched each discharge timing of a MU with a component based on spike-triggered averaging of the component's temporal signal. Given a selected component, we applied a threshold to the spatial map and calculated the centroid and an equivalent diameter.

RESULTS: Out of 16 recordings from four subjects, we decomposed 82 MUs from HDsEMG. Given this, we found 32 matches between individual MU discharges and ultrasound components where the triggered twitches had a significant amplitude. The estimated territories were 4.6 ± 1.1 mm (ranging from 2.8 to 8.6 mm), in line with findings from previous research using scanning-EMG (7). Moreover, the components were located 12.7 ± 3.4 mm below the skin (ranging from 6.4 to 19.4 mm).

CONCLUSION: Our results show that using ultrafast ultrasound and HDsEMG in a strength training intervention, we should be able to quantify the relative contribution of the nervous system and skeletal muscle at the MU level. This information may provide the time course of both neural and hypertrophic adaptations to resistance training and elucidate the relative contributions of each to strength gain.

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MUSCLE DESTABILIZATION AFTER A SPECIFIC PROCEDURE OF CONTRACTION AND PASSIVE MOTION QUANTIFIED BY MEASUREMENTS OF THE ADAPTIVE FORCE

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INTRODUCTION: A special procedure whereby a muscle is contracted in a lengthened position and brought back passively in testing (middle) position (procedure CL) is thought to provoke a slack in extra- and intrafusal muscle fibers. This slack might influence sensitivity of muscle spindles to stretch. Thus, the stretch reflex was found to be considerably reduced [1]. The present study questioned if the Adaptive Force (AF) which depends on sensorimotor control is affected by the described procedure, too.

AF reflects the neuromuscular functionality to adapt adequately to external forces as a possible prerequisite of muscle and joint stability. A reduced AF could, therefore, be a risk factor for injuries [2].

METHODS: 19 biceps brachii muscles of 12 healthy subjects were examined. Maximal isometric AF (AFisomax) and maximal AF (AFmax) were measured by a handheld device during an examiner started manual muscle test (MMT) under different scenarios: regular, after CL, after CL with additional contraction in testing position (procedure CL-CT). Contractions were performed at ~25% of maximal voluntary isometric contraction (MVIC). All MMTs were executed twice in a defined order and statistically compared. MVIC was determined by pushing as strong as possible against examiner's resistance.

RESULTS: During regular MMTs, testing position was held isometrically until 99.7 ± 1.0% of the reached maximum force (AFisomax ≈ AFmax) reflecting muscle stability. In contrast, after CL the muscles started to lengthen at 53.0 ±22.5% of AFmax indicating muscle instability. After CL-CT isometric position could be held up to higher forces again (98.3 ± 5.5% of AFmax). The AFmax did not differ significantly between procedures and was similar to the maximal isometric pushing force (MVIC). However, the maximal isometric holding force (AFisomax) was significantly reduced after CL compared to the other scenarios (padjust<.001) .

CONCLUSION: The assumed slack of intrafusal muscle fibers might lead to the found significant reduction of the holding capacity of the biceps brachii muscle after CL. Under this circumstance, the muscle gives way considerably before its maximal strength capacity is reached. A muscle contraction at low intensity in the testing position possibly eliminates the slack and, therefore, the destabilizing effect immediately.

As the isometric AF is thought to rely on muscular tension and length control, the results fit to the explanatory approach of a reduced spindle sensitivity. The mechanical state of intrafusal muscle fibers together with the history of fusimotor activity need to be taken into account during muscle testing.

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INFLUENCE OF MUSCLE LENGTH ON PRESYNAPTIC INHIBITION OF THE SOLEUS MUSCLE DURING PASSIVE LENGTHENING, SHORTENING AND STATIC MUSCLE ACTIONS

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INTRODUCTION: It is well documented that presynaptic inhibition (PSI) mechanisms are modulated by passive muscle actions, particularly during passive lengthening muscle actions. However, it is unknown if these modulations can be influenced by muscle length. This study aimed to determine whether variation in muscle length can affect the involvement of primary afferent depolarisation (PAD) and homosynaptic post-activation depression (HPAD) during passive lengthening, shortening and static muscle actions.

METHODS: Fifteen young healthy individuals participated in two experimental sessions. Percutaneous electrical stimulation of the posterior tibial nerve was used to evoke soleus compound action potential (M wave), and Hoffmann (H) reflex. Maximal H reflex (HMAX) and M wave (MMAX) were obtained from H-M recruitment curves. The efficacy of Ia-afferent-α-motoneuron transmission was analysed with the HMAX/MMAX ratio (%). PAD was evaluated with the D1 inhibition technique, including recordings of submaximal H reflexes with conditioning peroneal nerve stimulations (HCOND) and without conditioned stimulations (HTEST), i.e., HCOND/HTEST ratio reflecting the amplitude of PAD. HPAD was evaluated with stimuli at different time intervals, including recordings of submaximal H reflexes at interstimuli interval of 3 s and 6 s, i.e., 3 s/6 s ratio reflecting the amplitude of HPAD. HMAX/MMAX, HCOND/HTEST, and 3 s/6 s ratio were obtained at long, intermediate and short muscle lengths (which were verified by using ultrasound technique) during all passive muscle actions.

RESULTS: HMAX/MMAX ratio was significantly lower at long compared with intermediate (-10.1%) and short (-23.5%) muscle length regardless of the passive muscle action ($P < 0.001$). For HCOND/HTEST ratio a significant ($P < 0.05$) muscle length x passive muscle action interaction was found. For this parameter, the reduction at long muscle length reached -24.5% and -35.6% ($P < 0.001$) during lengthening, -11.1% and -18.3% during shortening ($P = 0.075$ and $P < 0.001$) and -10.7% and -17.9% ($P = 0.082$ and $P < 0.001$) during static passive muscle action compared with intermediate and short muscle lengths, respectively. This interaction shows that the increase of PAD activity at long muscle length is significantly further enhanced during passive lengthening muscle actions. 3 s/6 s ratio was lower at long compared with intermediate (-5.8%) and short (-12.3%) muscle lengths, regardless of the passive muscle action ($P < 0.01$ and $P < 0.001$).

CONCLUSION: This work highlights for the first time that PAD activity is enhanced when muscle length increases during passive muscle actions especially during passive lengthening muscle actions. These new results suggest that the additional Ia afferent discharge from increased muscle length might enhance PAD and HPAD activities. This increase in PSI activity could be involved in the lower efficacy of Ia-afferent-α-motoneuron transmission observed at long muscle lengths.

Oral presentations

OP-MH24 Metabolic syndrome and diabetes II

AEROBIC EXERCISE, INFLAMMATION, AND GLYCAEMIC CONTROL IN TYPE 2 DIABETES: A RANDOMISED CONTROLLED TRIAL

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INTRODUCTION: Regular exercise improves hyperglycaemia in type 2 diabetes (T2D), however, the mechanism by which such improvements occur are not completely understood. Given the relationship between inflammation and hyperglycaemia, this study aimed to determine whether aerobic exercise-induced improvements in glycaemia are associated with improvements in inflammatory marker profiles.

METHODS: Twenty-eight inactive adults with obesity and T2D were randomised to 12 weeks of supervised moderate-intensity continuous training (MICT) (n=10) at 60% VO2peak for 45 min, 3 days/week; low-volume high-intensity interval training (HIIT) (n=11) at 90% VO2peak for 4 min, 3 days/week; or placebo control (n=7). Pearson correlation analyses were performed to determine the association between changes in circulating cytokines and glycated haemoglobin (HbA1c). Regression analyses were undertaken to determine whether the associations between Δcytokines and ΔHbA1c were independent of changes in adiposity.

RESULTS: There was a strong positive correlation between ΔHbA1c and interleukin 6 (IL-6) (r = 0.553). There were moderate positive associations between change in ΔHbA1c and Δtumour necrosis factor alpha (r = 0.459), Δinterferon gamma (r = 0.398), ΔIL-10 (r = 0.418), Δ interferon gamma-induced protein 10 (r = 0.390), and Δadipsin (r = 0.474). Participant age, sex, T2D duration and Δbody mass index accounted for 14% of the variance in ΔHbA1c. The addition of Δwaist circumference and Δintrahepatic lipid to the model increased the prediction of ΔHbA1c to 18%. Finally, the addition of Δcytokines associated with ΔHbA1c increased the prediction of ΔHbA1c to 54%.

CONCLUSION: Aerobic exercise-induced improvements in glycaemia are positively associated with changes in various inflammatory markers. These associations appear to be independent of changes in central adiposity and ectopic fat, however, further appropriately powered studies are required to confirm these preliminary findings.

THE EFFECT OF AEROBIC EXERCISE TRAINING ON INSULIN-STIMULATED FEMORAL ARTERY BLOOD FLOW IN PATIENTS WITH TYPE 2 DIABETES AND HEALTHY MATCHED CONTROLS

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INTRODUCTION: In healthy people, insulin induces an increase in peripheral blood flow, which has been shown to contribute largely to glucose uptake in skeletal muscle, whereas the vascular effect in patients with type 2 diabetes (T2D) may be blunted(1). The majority of the studies investigating this during a glucose clamp have examined during euglycemic conditions (5 mmol/L). However, most T2D patients have higher habitual plasma glucose levels and may exhibit a normal response at this level(2). Exercise improves glucose homeostasis and insulin-stimulated blood flow, though few studies have investigated this effect in the conduit arteries(3,4).

In this ongoing study, we hypothesized that (1) aerobic exercise training improves insulin-stimulated blood flow in the femoral artery in patients with T2D and (2) there are no differences between T2D and healthy matched controls (CON) during isoglycemic conditions.

METHODS: 4 male patients with T2D (age 48.7±6.2 yrs, BMI 35.0±3.3 kg/m2, HbA1c 61±18 mmol/mol, T2D duration 2.0±1.2 yrs) and 5 controls (age 48.6±6.0 yrs, BMI 37.6±3.0 kg/m2, HbA1c 35±6 mmol/mol) completed a 12-wk aerobic exercise training intervention. We measured femoral artery blood flow (FBF) using ultrasound Doppler technique at baseline and the end of each step of a 2-step hyperinsulinemic (40 and 400 mU/m2/min) isoglycemic clamp. deltaFBF1 and deltaFBF2 represent the insulin-stimulated FBF from baseline to the two clamp steps. Data (mean±SD) were analysed by two-way ANOVA repeated measures.

RESULTS: We found no effect of the presence of T2D (P=0.80) or exercise training (P=0.14) on baseline FBF (391±61 to 535±178 ml/min in CON and 472±177 to 513±304 ml/min in T2D, before and after training, respectively). Neither did the presence of T2D (P=0.85) or exercise training (P=0.10) affect insulin-stimulated blood flow (deltaFBF1: +233±132 to -19±65 ml/min in CON and +45±42 to +147±148 ml/min in T2D; deltaFBF2: +369±127 to +179±149 ml/min in CON and +270±151 to +374±141 ml/min in T2D, before and after training, respectively).

CONCLUSION: Contrary to our hypothesis, insulin-stimulated blood flow did not increase in T2D or CON after 12 weeks of aerobic exercise training, but this may be due to the lack of statistical power at this stage. In accordance with our other hypothesis, there were no differences between the groups either at baseline or after the intervention.

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COMPARISON OF A 12-WEEK EXERCISE PROTOCOL OF HIIT VS. MICT ON CARDIORESPIRATORY FITNESS AND GLYCOSYLATED HEMOGLOBIN IN TYPE 2 DIABETICS

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INTRODUCTION: Cardiorespiratory fitness (CRF) is impaired in type 2 diabetes mellitus (T2DM). Moreover, the glycosylated haemoglobin (Hb1Ac) values have been considered an important marker in glucose control in T2DM (1). Aerobic exercise training improves both the CRF and values of Hb1A in T2DM (2), but it remains unclear if the type and intensity of the exercise may produce different benefits. Hence, the main aim of this study was to compared high intensity interval training (HIIT) vs. moderate intensity continuos training (MICT) on cardiorespiratory fitness and Hb1Ac. Indeed, a second aim was to analyse the relationship between changes with each training in CRF with Hb1A levels in type 2 diabetics.

METHODS: This preliminary analysis includes 46 type 2 diabetes participants (55.70 ± 6.97 years), who were randomized into 12 weeks of HIIT (n=15, 4 women), or MICT (n=20, 8 women) or control group (CG) (n=11, 5 women). Participants were tested on two consecutive days in fasting condition. On day 1, blood sampling was taken to determine the Hb1Ac. On the second day, body composition was evaluated by bioimpedance, and the maximum oxygen consumption (VO2max) was determined through an incremental test on a cycle ergometer (15W/1'). All measurments were performed before and after 12 weeks of intervention. Changes in study variables were tested for time (pre vs. post), group (HIIT, MICT, and CG), and time-by-group interactions using a mixed factorial ANOVA with Bonferroni post hoc comparisons. The significance level was set at a p value < 0.05. Pearsons correlation was used to observe if changes in VO2max correlated with larger changes in Hb1A.

RESULTS: The VO2max significantly increased in both intervention groups after the intervention (HIIT 22.43 to 26.16 ml/kg/min, p<0.001 / MICT 23.15 to 25.67 ml/kg/min, p<0.001), whereas CG remained unchanged (20.12 to 19.02 ml/kg/min). In addition to this, a time-by-group effect was found between HIIT, and MICT with CG (p<0.002). The Hb1Ac improved significantly in both intervention groups (HIIT 7.25% to 6.59%, p=0.003 / MICT 6.70% to 6.42%, p<0.001), but no differences were found in the GC group (7.04% to 6.97%).No significant correlation was found between the changes in relative VO2max and changes in Hb1Ac.

CONCLUSION: Both exercise interventions increases cardiorespiratory fitness and decreases glycosylated hemoglobin levels. The HIIT seems to be an time-efficient intervention compared to MICT that achieve similar results.

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THE EFFECTS OF 10-DAYS OF MODERATE OVERNIGHT NORMOBARIC HYPOXIA ON THE GUT MICROBIOTA IN INDIVIDUALS WITH TYPE 2 DIABETES MELLITUS: A SINGLE-BLIND, RANDOMISED, SHAM-CONTROLLED TRIAL.

GOULD, A., CORBETT, J., JAMES, T., MAYES, H., NEAL, R., SHUTE, J., TIPTON, M., MASSEY, H., SAYNOR, Z., PERISSIOU, M., MONTGOMERY, H., STURGESS, C., MURRAY, A., GROCOTT, M., CUMMINGS, M., MCNARRY, M.

UNIVERISTY OF PORTSMOUTH

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INTRODUCTION: The gut microbiota has been linked to the pathogenesis and progression of insulin resistance and Type 2 diabetes mellitus (T2DM). Anaerobic fermentation of short chain fatty acids (SCFA), such as butyrate within the gut microbiota, can improve insulin sensitivity (Cui et al., 2022). These bacteria appear to be increased in individuals living at high altitude (Sturgess & Montgomery, 2021). Accordingly, we hypothesised that repeated exposure to a simulated hypoxic environment would increase the abundance of anaerobic bacteria responsible for SCFA fermentation in a with T2DM.

METHODS: 13 adults with T2DM completed this single-blind, randomised, balanced, sham-controlled, crossover study. Participants undertook 10 days of home-based overnight moderate normobaric hypoxia (fraction of inspired oxygen (FIO2)=~0.155) and a sham hypoxia intervention (FIO2=0.2093) using hypoxic 'pillow tents' (make) in a randomised order.

Stool samples were collected pre and post each intervention and stored at ≤-20 °C until analysis. Bacterial deoxyribonucleic acid (DNA) was extracted using the QIAamp PowerFecal Pro DNA kit and quantified by spectrophotometry. The 16S rRNA gene was targeted by polymerase chain reaction with primers 27F/1492R (27F = 5'-AGAGTTTGATCMTGGCTCAG-3'and 1492R = 5'-ACGGYTACCTTGTTACGACTT-3'). Sequencing libraries were prepared using the Oxford Nanopore Technologies LSK-114 Ligation Sequencing Kit and Nanopore EXP-NBD196 Native Barcoding Expansion 96 kit. Libraries were sequenced on R10.4.1 flow cells on a GridION X5 platform. Sequenced 16S rDNA sequences were compared against the SILVA database of known 16S rDNA sequences for taxonomic classification using Minimap2 and identification of operational taxonomic units was performed using QIIME2.

RESULTS: Alpha and beta diversity comparing hypoxia and sham control will be presented. Taxa responsible for butyrate production will be compared amongst conditions and functional potential will be assessed using PICRUSt2.

CONCLUSION: Hypoxia may elicit increases in butyrate producing taxa within the gut microbiota. This may improve insulin sensitivity and provide a cost-effective therapeutic intervention for people with T2DM.

THE EFFECTS OF 10 NIGHTS OF NORMOBARIC HYPOXIA ON GLUCOSE HOMEOSTASIS AND INFLAMMATION IN PEOPLE WITH TYPE 2 DIABETES MELLITUS. A SINGLE-BLIND, RANDOMISED, SHAM CONTROLLED TRIAL.

SHEPHERD, A., JAMES, T., GOULD, A., MAYES, H., NEAL, R., SHUTE, J., TIPTON, M., MASSEY, H., SAYNOR, Z., PERISSIOU, M., MONTGOMMERY, H., STURGESS, C., MURRAY, A., GROCOTT, M., CUMMINGS, M.

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INTRODUCTION: Type 2 diabetes mellitus (T2DM) is a metabolic disease where chronic hyperglycaemia leads to life shortening comorbid conditions. Preliminary studies in people with T2DM (Mackenzie et al., 2011) suggest that acute exposure to hypoxia can improve markers of metabolic function. The aim of this study was to examine the effect of repeated overnight hypoxic exposure on glycaemic control and inflammation in people with T2DM and to provide insight into the physiological mechanisms underpinning any beneficial effects.

METHODS: Thirteen people with T2DM completed this single-blind, randomised, balanced, sham-controlled, crossover design study. Participants were assessed pre and post 10-nights of sleeping at home in 'hypoxic tents' (fraction of inspired oxygen (FIO2)=0.155) and a normoxic sham tent: (FIO2=0.209) separated by ≥1 month washout. Outcome measures included fasted plasma [glucose] and peak plasma [glucose] and insulin sensitivity following a 2-h oral glucose tolerance test (OGTT; 75g sugar). [hypoxia-inducible factor 1-alpha] (HIF1α), [interleukin-6] (IL-6), [interleukin-10] (IL-10) and [extracellular heat shock protein 70] (eHSP70) were assessed. During sham and intervention periods overnight transcutaneous O2 saturation (SPO2) was continuously assessed, wrist-worn accelerometers measured sleep indices and continuous glucose monitors (CGMs) measured estimated glycated haemoglobin (HbA1c), glucose management indicator (GMI) and time in target range.

RESULTS: Hypoxia decreased overnight SpO2% compared to sham (p=0.01 r=0.89) but did not affect plasma [glucose] area under the curve (AUC; P=0.21, d=0.39); peak plasma [glucose] (P=0.70, d=0.12); fasting plasma [glucose] (P=0.65, d=0.13) or post-prandial insulin sensitivity (P=0.13, d=0.47) whilst fasting insulin sensitivity (P=0.10, d=0.49) trended towards significance. Hypoxia had no effect on 10-day [glucose] (P=0.42, r=0.24); estimated HbA1c (P=0.48, r=0.24), GMI (P=0.62, r=0.16) or time in target range (P=0.37, d=0.32) or sleep efficiency (P=0.65, r=0.15). Hypoxia had no effect on plasma [HIF1α] (P=0.48, r=0.20); [eHSP70] (P=0.79, d=0.08); [IL-6] (P=0.24, r=0.34); [IL-10] (P=0.48, r=0.20).

CONCLUSION: Repeated overnight exposure to moderate hypoxia does not improve glucose tolerance but small-moderate effect sizes for insulin sensitivity suggests hypoxia may have an effect and has clinically meaningful effects on HbA1c (mean difference 4.3 mmol•mol-1; Lind et al., 2008).

Funding

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Oral presentations

OP-PN20 Thermoregulation II

THE INFLUENCE OF CUP SIZE ON VOLUNTARY DRINKING IN RECREATIONAL RUNNERS.

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INTRODUCTION: Voluntary drinking during exercise has the potential to be moderated by access to, and acceptability of, the drinking environment. This study aimed to determine the impact of cup size on voluntary water consumption during recreational running.

METHODS: Eighty-five healthy individuals (24±5 y, 72±15 kg, 45 females) completed two trials (1-week apart) in mild conditions (~20oC, RH ~70%). Trials consisted of a self-paced 10 km run/walk (athletics track) with randomly-assigned access to either a small (240 mL) or large (375 mL) cup for self-administering water (18-22oC) at the end of each 2 km. Participants were assigned to 1 of 4 treatment groups (week 1/week 2) - small/small, small/large, large/small and large/large cups. Total fluid intake and measures of hydration status were collected before and throughout trials. Within-participant data for small/large and large/small treatments was explored via linear mixed-effects models using RStudio (Version 1.4) with the data transformed (√) as case residuals were non-normally distributed (Shapiro-Wilk test, $p<0.05$).

RESULTS: Pooled average fluid intakes across all treatments were 326±196 mL (small) and 377±215 mL (large). Mean differences (95% CI) between weeks for treatments were 73 (-75 to 221) mL (small/small), 68 (-38 to 173) mL (large/large), -26 (-155 to 102) mL (small/large), 35 (-96 to166) mL (large/small). The retained structure for mixed-effect model included 'cup size', and 'trial order' as fixed effects, and 'participant' as a random effect parameter. Average fluid intakes for these participants were 304±193 mL and 330±242 mL for the small and large cup trials, respectively. While an interaction between trial order and cup size was identified ($p=0.04$), planned comparisons (pairwise) indicated the typically small fluid intake shifts (all <30 mL increase from small to large) were not statistically significant, and well within the variability observed when cup size did not change.

CONCLUSION: Under mild environmental conditions, changing cup size appears to have little impact on voluntary drinking during self-paced running. The extent to which cup size variations may influence voluntary drinking when cups are pre-filled, under more thermoregulatory stressful conditions and/or during more rigorous exercise is yet to be elucidated.

EXERTIONAL HEAT STRESS INCREASES BIOMARKERS OF ACUTE KIDNEY INJURY AND IMMUNE FUNCTION

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INTRODUCTION: Strenuous physical activity in the heat is associated with an increased risk of kidney dysfunction and acute kidney injury (AKI). AKI is also associated with heightened systemic inflammation. However, the relationship between exertional heat stress, inflammation and AKI remains unclear. This study aimed to investigate the effects of prolonged exertional heat stress on AKI biomarkers and the ingress and egress of lymphocytes from peripheral blood. We hypothesised that greater exertional heat stress levels would result in elevations in AKI biomarkers (Neutrophil gelatinase-associated lipocalin, NGAL; Insulin Like Growth Factor Binding Protein 7; IGFBP7) and a higher ingress and egress of lymphocytes.

METHODS: Ten healthy, endurance trained participants (4 females; mean ± SD, age 24 ± 3 years; mass 67.6 ±12.3 kg; height 172 ±10 cm; VO2peak 55 ±8 ml/kg/min) completed 90-min of cycling at 45% Wmax in both hot and temperate ambient conditions (HOT: 40 °C, 20% relative humidity (RH); TEMPERATE: 20 °C, 20% RH) to elicit two distinct levels of exertional heat stress. Rectal temperature (Tre), skin temperature (Tsk) and heart rate (HR) were monitored continuously during exercise. Urine and blood samples were obtained pre, immediately post, 1-h post and 4-h post (urine only) exercise. Urine was analysed for NGAL and IGFBP7. Whole blood was analysed for total lymphocytes (Horiba, Yumizen H500).

RESULTS: At baseline, Tre, Tsk, HR and lymphocyte concentrations did not differ between HOT and TEMPERATE conditions (all $P>0.05$). By design, HOT resulted in higher peak Tre (38.30 ±0.34 vs 37.79 ±0.25 °C, $P<0.01$), Tsk (36.35 ±1.45 vs 26.95 ± 1.27 °C, $P<0.01$) and HR (166 ±8 vs 125 ± 9 b/min, $P<0.01$), as compared to TEMPERATE. Total lymphocyte concentrations were higher in HOT compared to TEMPERATE conditions immediately post exercise (2.20 ±0.42, vs 1.74 ±0.39 cells/µL, $P<0.01$), with no difference 1-hour post exercise (1.60 ±0.32, vs 1.57 ±0.39 cells/µL, $P<0.01$). In HOT, there was a greater ingress at baseline to immediately post exercise (+0.59 ±0.28 vs +0.21 ±0.16 cells/µL, $P<0.01$) and egress at 1-h post exercise to immediately post exercise (-0.60 ±0.22 vs -0.17 ±0.16 cells/µL, $P<0.01$) of lymphocytes from peripheral blood, as compared to TEMPERATE. From baseline to immediately post exercise, there was an increase in NGAL (Δ; 2.65 ±1.47, $P<0.05$) and IGFBP7 (Δ; 18.53± 18.87, $P<0.05$) in HOT, but no difference (NGAL Δ: 2.57 ±1.58; $P>0.05$; IGFBP7 Δ: 7.49 ±6.48; $P>0.05$) in TEMPERATE conditions.

CONCLUSION: These data indicate that the higher level of exertional heat stress in the HOT condition caused a greater immune response, as indicated by a higher total lymphocyte concentration and higher ingress and egress of lymphocytes, which was associated with moderate perturbations in AKI biomarkers. Thus, signs of inflammation with AKI may result from exertional heat-induced kidney injury.

NEGATIVE EFFECT OF SLEEP RESTRICTION ON HEAT TOLERANCE TO EVEN MILD HYPERTHERMIA INDUCED BY PASSIVE EXPOSURE

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INTRODUCTION: In a growing context of global warming, populations, in particular soldiers, are increasingly exposed to hot climate often exacerbated by sleep restriction. Both exposition, when cumulative, can challenge individual heat tolerance capacities. Sleep restriction was in particular shown to be involved in onset of exertional heat stroke. We here proposed to assess the effect of sleep restriction on heat tolerance to passive exposure, in particular through endothelial function, which was shown to be altered by sleep debt.

METHODS: 13 healthy subjects (military and/or sportsmen's) were monitored in a randomized cross-over design, after getting normal nights (NN) (>6h) and sleep restriction (SR) (<3h). In both conditions, the subjects were exposed in a climatic chamber to passive-induced hyperthermia by uncompensable stress (45°C; 70% RH; wind: 1,9 m.s-1) then compensable conditions (42°C; 50% RH; 1,6 m.s-1). Core and skin temperature (Tcore and Tsk), heart rate (HR), blood pressure and cutaneous vascular conductance (CVC) were monitored.

RESULTS: All subjects were kept euhydrated during the experiment. During heat exposure, sleep restriction induced higher elevation of Tcore (heat exposure p=0.001, interaction sleep restriction and heat exposure p=0,01) and Tsk (heat exposure p=0.001, interaction sleep restriction and heat exposure p=0,01). Regarding to cardiovascular function, we observed heat exposure induced higher elevation of HR (heat exposure p=0.001, interaction sleep restriction and heat exposure (p=0,01) after a night of sleep restriction. However, we observed on mean arterial blood pressure heat exposure (p=0.03) and sleep restriction (p=0.01) effect without interaction. This alteration of thermoregulatory response was associated with lower elevation of CVC after sleep restriction (p=0.01).

CONCLUSION: These results showed an alteration in thermoregulation capacities by sleep restriction. This alteration was associated with increased cardiovascular stress. In addition, during heat exposure, we observed a decrease in cutaneous vascular conductance which could havecontributed to less thermoregulatory efficiency. This higher heat strain, induced by sleep restriction may have arisen from impaired endothelial function. These first results highlight the relevance of conditioning known to alter endothelial function, like endurance training, in order to improve heat tolerance, even for mild hyperthermia, in young men with putative healthy endothelium function, .

THE EFFECTS OF HEAT-INDUCED HYPO-HYDRATION AND REHYDRATION ON BLOOD-BRAIN-BARRIER PERMEABILITY, CORTICOSPINAL AND PERIPHERAL EXCITABILITY.

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INTRODUCTION: Thermoregulatory sweating, coupled with inadequate fluid intake, leads to intracellular fluid losses from skeletal muscle and neural tissue. The effects of heat-induced hypo-hydration and rehydration on maximal strength and underlying neurophysiological mechanisms are not well understood. Therefore, this study aimed to investigate the corticospinal and peripheral responses to heat-induced hypo-hydration and rehydration.

METHODS: Twelve participants (29 ± 7 yrs, 86.4 ± 9.5 kg, 185 ± 12 cm) underwent a 3 h light-intensity exercise trial in 40°C, with i) rapid rehydration in 2 h (RHY2), ii) gradual rehydration across 24 h (RHY24) and iii) a euhydrated trial in ambient conditions (25°C; CON). Neuromuscular function and peripheral excitability were assessed by maximal voluntary contractions (MVC), potentiated twitch (QtwPot), maximum motor unit potential (MMax) and voluntary activation (VA). Corticospinal excitability was assessed by single-pulse TMS measures (at 10% MVC); motor evoked potential (MEP) amplitude, MEP/MMax ratio and cortical silent period (cSP). Neuronal and blood-brain-barrier integrity was assessed by serum Ubiquitin Carboxyl-terminal Hydrolase (UCH-L1) concentrations. All measures were obtained immediately pre, post, post-2 h and post-24 h (POST2 and POST24, respectively).

RESULTS: Mean body mass losses in RHY2 and RHY24 were both -4.6%, but 0.2% in CON. VA (91 ± 1% vs. 81 ± 2 %, $p = 0.037$) decreased post-exercise after RHY24 compared to CON, and increased at POST2 during RHY2 compared to CON (92 ± 1% vs. 85 ± 2 %, $p = 0.017$). MVC and MEP amplitude decreased across time for both dehydration trials ($p < 0.05$) and MEP returned to baseline at POST2 during RHY2, but not during RHY24 (2.6 ± 0.3 mV vs. 2.2 ± 0.3 mV, $p = 0.02$). MEP/MMax ratio decreased across time for all trials ($p = 0.009$) and returned to baseline at POST24, except during RHY24 (0.55 ± 0.05 vs. 0.43 ± 0.4, $p < 0.026$). A decrease in QtwPot (205 ± 13 Nm vs. 231 ± 18 Nm, $p = 0.045$), and increase in cSP (0.160 ± 0.006 ms vs. 0.146 ± 0.005 ms, $p = 0.011$) were only observed during CON post-exercise but returned to baseline at POST24. Serum UCH-L1 increased across time for all conditions ($p < 0.01$), but was not significantly different between conditions ($p > 0.05$).

CONCLUSION: Overall, maximal strength was impaired after heat-induced hypo-hydration and the neurophysiological mechanisms differed from that of light-intensity exercise in ambient conditions. Heat-induced hypo-hydration leads to a reduction in corticospinal excitability and VA, while exercise in a euhydrated state increases corticospinal inhibition and skeletal muscle impairment. In addition, low-intensity exercise (irrespective of hydration status) increases blood-brain-barrier permeability, resulting in an increase of UCH-L1 in the peripheral bloodstream.

Oral presentations

OP-MH26 Sports medicine

ELITE ATHLETES WITH EARLY TENDINOPATHY - CLINICAL AND IMAGING FINDINGS

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INTRODUCTION: Tendinopathy poses serious clinical and socio-economic problems, as the prevalence of tendon injuries is high. For affected individuals, the symptoms and reduction in performance often last for years and many never return to their previous performance leading to cessation of their sports career. Knowledge of how to treat chronic tendinopathy has advanced in recent years, but the disease progression and treatment of early tendinopathy is not well understood. The main purpose of this prospective observational study was to investigate possible changes in clinical and imaging (MRI and ultrasonography) outcomes over the course of 3 months in elite athletes presenting with symptoms of Achilles and patellar tendinopathy for <3 months.

METHODS: 65 elite adult athletes (24±5 years) with early Achilles or patellar tendinopathy (symptom duration <3 months) were examined at baseline and after 3 months. Patients were divided into groups based on duration of symptoms at the time of inclusion: 0-1 month (T1), 1-2 months (T2) or 2-3 months (T3). Recommendations on load management was the only intervention. We assessed the following clinical outcomes: Questionnaires (Victorian Institute of Sports Assessment (VISA)) and pain scores (0-10 numeric rating scale (NRS)), as well as ultrasonography (US) outcomes: thickness, echogenicity, and Doppler flow area. Also, dimensions (cross-sectional area (CSA), thickness and length) of the Achilles and patellar tendons were obtained by 3-Tesla MRI. A linear mixed effects model was used to analyze changes from baseline to 3 months in all outcome variables.

RESULTS: Tendinopathic Achilles and patellar tendons revealed no significant differences on clinical scores (VISA and NRS) or any imaging (US and MRI) variables between T1 (n=19), T2 (n=23) and T3 (n=23) at baseline or after 3 months, with one exception: Patellar tendons in T1 were larger than T2 and T3 at baseline ($p<0.05$). Elite athletes had clinically relevant improvements on the VISA (>14 points) and most NRS scores (>2 points) after 3 months. Tendinopathic Achilles and patellar tendons had a greater thickness, CSA and Doppler flow than the contralateral tendons at baseline that remained unchanged after 3 months.

CONCLUSION: These novel data suggest that symptoms of early tendinopathy in elite athletes improved clinically after 3 months, but morphology remained unchanged in both Achilles and patellar tendons. These data also suggest that tendon morphologic changes probably develop a long time before symptoms occur. Finally, based on previous results, recreational and elite athletes do not seem to differ in pain response or tendon dimensions.

ONE YEAR FOLLOW-UP IN ELITE ATHLETES WITH EARLY TENDINOPATHY - CLINICAL AND ULTRASONOGRAPHY FINDINGS

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INTRODUCTION: Knowledge of how to treat chronic tendinopathy has advanced in recent years, but the understanding of the disease progression and treatment of early tendinopathy is limited. The primary aim of this prospective observational study was to investigate possible changes in clinical and ultrasonographic imaging outcomes over the course of 12 months in elite athletes presenting with Achilles and patellar tendinopathy within <3 months after symptom onset. The secondary aim was to assess the prognostic values of the baseline ultrasonography and clinical outcomes on the progression of these outcomes.

METHODS: Sixty-five elite adult athletes (24±5 yrs) with early Achilles or patellar tendinopathy (symptom duration <3 months) were examined at baseline and after 12 months. Recommendations on load management was the only intervention. We assessed the following clinical outcomes: Victorian Institute of Sports Assessment (VISA) questionnaires, pain (numerical rating scale 1-10 (NRS) scores), and ultrasonography outcomes: thickness, echogenicity, and Doppler flow area. A linear mixed effects model was used to analyze changes from baseline to 12 months in all outcome variables and also used to assess any potential association between baseline ultrasound findings and clinical outcomes on the changes in these parameters after 12 months, using a backward elimination process.

RESULTS: Elite athletes with early tendinopathy had clinically relevant improvements on VISA (>14 points) and most NRS (>2 points) pain scores after 1 year. Tendinopathic Achilles and patellar tendons had greater thickness than the contralateral tendon at baseline. Injured Achilles tendons demonstrated a trend towards reduced thickness after 12 months ($p<0.1$) while injured patellar tendons remained enlarged. Lower baseline Doppler flow was associated with greater reduction in thickness after 1 year ($p<0.05$), and longer initial symptom duration was associated with greater reduction in pain over 1 year ($p<0.05$). Higher baseline VISA scores also tended to be associated with greater increases in echo intensity (less hypoechogenic) ($p<0.1$).

CONCLUSION: These novel data suggest that symptoms of both early Achilles and patellar tendinopathy improved clinically in the long-term, but only patients with early Achilles tendinopathy showed trends towards improved morphology after 12 months. Patellar tendon thickness and echogenicity remained unchanged despite clinical improvement. Finally, lower baseline Doppler flow, longer symptom duration and better initial VISA scores tended to represent a better prognosis for tendinopathy morphology and symptoms in elite athletes.

EFFECTS OF PROTEIN SUPPLEMENTATION COMBINED WITH EARLY REHABILITATION ON MUSCLE VOLUME AND FUNCTION AFTER ACUTE MUSCLE STRAIN INJURIES

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INTRODUCTION: Muscle strain injuries constitute a major problem in recreational and professional sports, causing substantial injury absence and greatly increasing the risk of re-injury (1). Despite extensive rehabilitation, muscle strain injuries typically induce a decrease in muscle volume and strength of the injured muscle (2), which might contribute to the high re-injury risk. We hypothesized that protein supplementation during early rehabilitation of acute muscle strain injuries would decrease the loss of muscle volume 3 months post injury.

METHODS: 51 sports active individuals with an acute muscle strain injury in the calf or hamstring musculature were randomized to whey protein supplementation (2x20 g daily, WHEY) or isocaloric placebo (maltodextrin, PLACEBO) during 3 months rehabilitation. Injuries were confirmed using ultrasound, and onset of rehabilitation was 2 days post injury. Total muscle volume was assessed using magnetic resonance imaging (MRi) acute and 3 months post injury. Eccentric muscle strength was measured post rehabilitation using isokinetic dynamometry at 60°/s.

RESULTS: 35 participants completed the intervention (18 PLACEBO, 17 WHEY). 2 participants were excluded, and 13 participants dropped out. The high drop-out rate was related to COVID lockdowns. Median eccentric strength deficit of the injured leg compared to the healthy after the rehabilitation period was -6,9% (Interquartile range (IQR): 9.0%), with no difference between groups (P = 0.51). Preliminary MRi results (n = 5 in each group) indicate larger decreases in muscle volume for PLACEBO compared to WHEY ([Median (IQR)]: -6.9% (-18.3 to +4.5) vs +3.0% (-2.3 to 8.2), P = 0.03). MRi analyses will be completed during spring 2023.

CONCLUSION: Preliminary findings indicate protective effects of protein supplementation on muscle volume after acute strain injuries. These findings will have great clinical relevance in securing optimal muscle mass and function upon return to sport after this type of injury.

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IMPACT OF A 3-WEEKS SPECIFIC SPORT REHABILITATION CYCLE ON NEUROMOTOR CONTROL IN PROFESSIONAL SOCCER PLAYERS WITH LOWER LIMB INJURIES BEFORE RETURN-TO-PLAY.

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INTRODUCTION: During the last decade, professional soccer players (PSP) have been exposed to increased amount of stress on their musculoskeletal apparatus due to the greater volume and intensity of football demands1. Despite prevention strategies, the frequency and severity of injuries hasn't decreased2. As such, evaluating progression during rehabilitation and return-to-play (RTP) programmes3 and specifically neuromotor control is crucial in limiting the risks of re-injury4. This study aimed to investigated the effect of a 3-week specific sport rehabilitation (SSR) program on neuromotor control PSP with lower limb injuries.

METHODS: Altogether, 15-male PSP suffering from various unilateral lower limb injuries (chondropathy, muscle lesions, anterior crucial ligament rupture) and 22 uninjured PSP (UPSP) participated. All performed 3 unilateral countermovement jumps (CMJ) with each leg ; before and after a SSR program3 for injured participants and during a single session for healthy participants. Movement analyses included whole-body kinematics, kinetics and lower limb muscle activation. Main variables were: peaks of trunk flexion and lateroflexion, knee flexion, peak and mean of %maximal voluntary contraction of studied muscles, rate of force development (RFD), peak of vertical ground reaction force , reactive strength index modified, jump height and movement time. A limb symmetry index (LSI, % difference between injured and non-injured leg) and a deficit limb index (DLI, % difference between injured leg and dominant leg of healthy participants) were computed for each variable.

RESULTS: All CMJ variables significantly improved following the SSR program ($p<0.05$). Improvements ranged between +7% (RFD) and +26% (jump height). LSI applied to each CMJ variable almost reached 100% after SSR, indicating a quasi-equivalent performance level between healthy and injured leg. Despite the improvement, CMJ variables except eccentric

and early concentric RFD were lower in injured PSP than in healthy participants ($p<0.05$ to $p<0.001$). DI applied to each CMJ variable showed that CMJ performance remained lower in injured than in healthy participants.

CONCLUSION: The neuromotor control of injured PSP significantly improved following 3-week SSR program. However when CMJ variables were compared post SSR program to normative values in UPSP, it appeared that recovery was incomplete. These results suggest that a longer SSR program is necessary to ensure safe RTP, and that DLI seems to be more relevant than LSI for decision-making during RTP programs.

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PLAYING WITH PAIN-THE EPIDEMIOLOGY OF HIP AND GROIN PAIN IN GAELIC GAMES PLAYERS

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INTRODUCTION: Large injury surveillance studies have suggested that hip and groin pain is prevalent in male Gaelic games players but no study has explored the epidemiology of hip and groin pain across all codes and levels of Gaelic games. The aim of this study was to examine the prevalence of hip and groin pain and Femoroacetabular Impingement Syndrome (FAIS) in male and female Gaelic games and to explore factors (age, gender, code, level, exposure) associated with hip and groin pain and FAIS.

METHODS: During the late 2019 and early 2020 season, a representative national sample of Gaelic games players were invited to complete a questionnaire in which they provided demographic information and reported on hip and groin pain that they have had within the last year, with specific questions pertaining to any FAIS diagnosis within the last year. Seven hundred and seventy-five (22.8±5.2 years) (n=438 males; n=337 females) Gaelic games players from all codes and multiple levels returned completed questionnaires. Logistic regression models were constructed after univariate analysis to identify factors associated with having hip and groin pain

RESULTS: Over half (54.8%) of players had at least one episode of hip and groin pain within the last year (annual prevalence) and 22.8% currently had hip and groin pain (point prevalence). Males were 1.4 (CI 1, 1.8) times more likely to report hip and groin pain than females ($p<0.05$) and players participating in additional sports/physical activity were 1.95 (CI 1.35, 2.79) times more likely to experience hip and groin pain throughout the year ($p<0.05$). Almost half (48.8%) of players with hip and groin pain continued to participate in training and games, 32.5% were sometimes unable to play while 18.7% were unable to participate. Although 40% of episodes lasted no longer than 3 weeks, there was a high rate of recurrent episodes of pain (33.5%). FAIS was reported in 1.8% of players and represented 3.3% of hip and groin pain diagnoses.

CONCLUSION: Hip and groin pain is prevalent in Gaelic Games but a large proportion of episodes appear minor, resolving within 3 weeks. The high proportion of players both continuing to play with pain and experiencing recurrent episodes of pain, needs to be addressed to prevent worsening and eventual time loss injuries. Gender and participation in additional sports/physical activity may be factors to consider in screening and prevention strategies for hip and groin pain. While FAIS has a low prevalence rate, the impact of this condition on players needs to be explored.

Oral presentations

OP-SH15 Mental health

ASSOCIATIONS OF SEDENTARY BEHAVIOURS WITH DEPRESSIVE SYMPTOM AMONG CHINESE COLLEGE STUDENTS

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Background: Mental disorders are the major causes of the global health-related burden, with depression being the primary contributor. Some epidemiological studies have started to recognize sedentary behaviour as an independent risk factor for depression. However, the associations of sedentary behaviours with depression symptom may vary by the type of sedentary behaviours. College students are a population at higher risk of being sedentary. Therefore, the objective of the study was to examine the associations of sedentary behaviours with depressive symptom among Chinese college students.

Methods: A total of 927 Chinese college students participated in this cross-sectional study. Different types of sedentary behaviours on weekdays and weekends were self-reported using questions based on the 24-hour movement behaviours questionnaire (24HMBQ). The participants were required to report the duration of engagement in three types of sedentary behaviors, including time spent on study (including taking courses, self-studying, etc.) and work, time on using electronic screen-based devices for entertainment (including watching TV/movies / short videos, video gaming, and using social media, etc.), and other sedentary behaviours (e.g., having meals, transportation). Depression symptoms were evaluated

using the Center of Epidemiologic Studies Depression Scale, 10-item version (CES-D-10). Linear regression modeling was used to assess the associations of sedentary behaviours with depression symptoms.

Results: After adjusting for potential confounders (i.e., sex, age, height, and weight), the duration of sedentary behaviours in studying or working on weekdays (B=0.158, p=0.006) and weekends (B=0.169, p=0.002) were positively associated with depressive symptom. The duration of sedentary behaviours on electronic screen-based devices for entertainment on weekends (B=0.195, p=0.017), other sedentary weekly behaviours (B=0.515, p=0.008), and other sedentary weekend behaviours (B=0.510, p=0.003) were positively associated with depressive symptom. There was no association between sedentary behaviours on electronic screen-based devices for entertainment on weekdays and depressive symptom.

Conclusions: The present study revealed that prolonged time on sedentary behaviours were positively associated with depressive symptom in college students. Interventions for improving mental health should consider reducing sedentary behaviours in college students.

Keywords: Sedentary behaviours; Depressive symptom; Mental health; College students

ASSOCIATION OF EMOTION REGULATION AND DEPRESSIVE SYMPTOMS AMONG JAPANESE UNIVERSITY ATHLETES

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INTRODUCTION: Depressive symptoms cause not only performance decline, but also the end of an athlete's career. To prevent such problems among athletes, the development of sufficient support systems to enhance their ability to cope with stress and maintain mental health is extremely important. Emotion regulation strategies have been emphasized as effective in coping with stress caused by these problems. "Emotion regulation" is defined as the regulation of thoughts or behaviors that influence emotions [1]. If emotion regulation is effective in preventing depressive symptoms, then emotion regulation can be proposed as a form of stress coping. Therefore, we examined emotion regulation associated with depressive symptoms in Japanese university athletes.

METHOD: Data were collected from 1054 Japanese university athletes (708 males and 346 females). We collected demographic data, emotion regulation (Emotion Regulation Questionnaire, ERQ [1]), and depressive symptoms (Self-Report Depression Scale, SDS [2]). The ERQ assesses two emotion-regulation strategies: reappraisal and suppression. We examined the relationship between demographic variables and SDS scores. Next, we conducted multiple logistic regression analysis by setting emotion regulation (reappraisal and suppression scores) as the independent variable and depressive symptoms (SDS items and total scores) as the dependent variables, including covariates.

RESULTS & DISCUSSION: Result showed that reappraisal had a significant negative effect on SDS total score (Odds Ratio [OR] = 0.25, 95%CI = 0.17–0.38, $p < .001$, Relative risk [RR] = 0.8), following symptoms of "Depressive affect," Crying spells," "Decreased appetite," "Confusion," "Psychomotor retardation," "Hopelessness," "Indecisiveness," "Personal devaluation," "Emptiness," and "Dissatisfaction." However, suppression had a significant positive effect on SDS total score (OR = 1.6, 95%CI = 1.07–2.43, $p < .05$, RR = 0.9), following symptoms of "Depressive affect," "Sleep disturbance," "Decreased libido," "Fatigue," "Hopelessness," and "Emptiness." This indicates that athletes who reappraise themselves to cope with stress have good mental health.

CONCLUSION: Thus, we concluded that emotion regulation associates with depressive symptoms in Japanese university athletes. Reappraisal may contribute to the maintenance of athletes' mental health.

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EFFECTIVENESS OF A SHORT SPRINT TRAINING (SSIT) PROTOCOL IN WOMEN DIAGNOSED WITH MAJOR DEPRESSIVE DISORDER

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Purpose

High-intensity intermittent training has emerged as an option for treating major depressive disorder (MDD). However, short sprint training (sSIT) protocols were not tested yet for this purpose. The sSIT has been proven to induce the same metabolic effects, with the benefit of promoting lower fatigue than other HIIT protocols.

Methods

Eighteen adult (18-58 yrs) women diagnosed with moderate/severe MDD were randomly allocated into a sSIT group (n=9, BMI=28.3 kg/m2) and a control group (n=9, BMI=31 kg/m2). The sSIT group completed, over two weeks, six 10-min sessions in a periodized fashion which consisted of 3-12 "all out" sprints of 5 s interspersed with low-intensity recovery of ≥ 30

s. The week before and after the intervention, both groups were evaluated with the Hamilton Depression Rating Scale of 21-itens (HDRS-21), and for physical fitness (maximum aerobic power, body composition) and incidental physical activity.

Results

The sSIT group exhibited significant improvements for HDRS-21 scores (24.6±8.2 vs. 16.8±10.1, p<0.001), maximum aerobic power (140±15 vs. 155±15 W, p=0.016), % of body fatness (32.4±4.4 vs. 29.3±3.8%, p<0.001), and number of steps (13,626±11,309 vs. 16,643±15,371, p=0.009) after the training protocol when compared to the control group which did not exhibit any changes (p>0.05).

Conclusions

Two weeks of sSIT has demonstrated to reduce depressive symptoms, while improving aerobic fitness and body composition and increasing incidental physical activity.

ASSOCIATION AND CHANGES IN THE PHYSICAL AND MENTAL HEALTH OF ADOLESCENTS AT THE BEGINNING OF THE 21ST CENTURY

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INTRODUCTION: Mental and physical health seems to have declined at the beginning of the 21st century. Therefore, the main aim of the present study was to compare mental and physical health at age 15 in two cohorts, one measured in 2003 and the other in 2015. Secondly, to estimate the association between mental and physical health in the two cohorts, and finally, to examine the association between level of fitness and mental health in each cohort.

METHODS: Data from 2003 (cohort born in 1988. N=443) and 2015 (cohort born in 1999. N=303) were analyzed. Mental health (body image, self-esteem, and symptoms of depression) and magnitude of exercise was assessed with self-reports. Physical health was measured objectively using body mass index and aerobic fitness that was estimated using maximal cycle ergometer test as an indirect measure of VO_2 max. Independent sample t-test was used to evaluate the differences between cohorts, linear regression to assess the relationship between mental health and aerobic fitness and ANOVA to see if level of fitness relates to mental health.

RESULTS: Participants measured in 2003 had lower depression scores (p=0.01, d=0.24), better self-esteem scores (p<0.01, d=0.62), and better fitness (p<0.01, d=0.99) compared to the participants in 2015. No differences were found in body image scores between cohorts. Aerobic fitness was associated with body image, depression, and self-esteem after adjusting for parents' education level, living conditions, sex, and BMI in both cohorts though not between fitness and self-esteem in 2003. Finally, in both cohorts, participants with low fitness level had significantly poorer body image, higher depression, and worse self-esteem than those with high fitness level.

CONCLUSIONS:

This study found that adolescents had poorer mental health and physical health at the beginning of the 21st century compared to a cohort assessed ten years earlier. Interventions to improve fitness specifically could benefit adolescents mental health, but further research is needed to understand the underlying factors and mechanisms.

EXAMINING MENTAL HEALTH OUTCOMES OF STUDENT-ATHLETE MINORITY SUB-POPULATIONS.

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The mental health of university students is a significant concern, with research showing that they have higher levels of anxiety, depression, and psychological distress than the general population (Brown, 2018; Hunt & Eisenberg, 2010). Among university students, varsity athletes, who deal with the stresses of elite athletes as well as those of university students, may have even higher prevalence of mental health issues that non-athlete students (Sullivan et al., 2019; van Slingerland et al., 2018). The current study examined mental health outcomes of marginalized student-athletes relative demographic majorities. Specifically, racial and sexual orientation minorities, which have been linked to lower mental health in university students (Arday, 2018; Lipson et al., 2019) were examined among student-athletes. The database of the 2021 Canadian Campus Well-Being Survey, which includes the Kessler K-10 (Kessler et al., 2003) and Warwick Edinburgh Mental Well Being Scale (WEMWBS; Tennant et al., 2007) were analyzed for this study. The Kessler K-10 is a widely used measure of generalized psychological distress; the WEMWBS was developed as a valid measure of well-being in the general population. The responses of varsity athletes (N = 649) were examined for difference on these outcomes between heterosexual and minority sexual orientations and Caucasian and minority ethnicities. The sample included 1152 Caucasian student-athletes (949 heterosexual, 203 sexual minority) and 637 racial minority student-athletes (484 heterosexual, 153 sexual minority). Results of a factorial MANOVA revealed a significant interaction ($F(2, 624) = 7.25$, $p < .001$, $p\eta 2 = 0.02$) between race and sexual orientation on K10 and WEMWBS scores. Specifically, among Caucasian student athletes, minority sexual orientations showed significantly higher levels of psychological distress than heterosexual athletes whereas among racial minorities, there were no differences between sexual orientations. With respect to well-being, heterosexual Caucasians reported higher scores than sexual minority Caucasian student-athletes, whereas racial minority student-athletes who identified as heterosexual showed significantly lower scores than those who were sexual minority. These results suggest that the pattern of mental health outcome among student-athletes may be more nuanced than previously thought and there may be significant implications for mental health services delivered on campuses.

Oral presentations

OP-MH31 Cardiovascular diseases and aerobic exercise

IMPACT OF SINGLE AND 7-DAY HANDGRIP AND SQUAT EXERCISE IN PREVENTING ENDOTHELIAL ISCHAEMIA-REPERFUSION INJURY IN PARTICIPANTS WITH INCREASED CARDIOVASCULAR RISK

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INTRODUCTION: Exercise may provide immediate protection against endothelial ischaemia-reperfusion (IR) injury in young, healthy individuals (1). Whether these findings translate to older individuals with elevated cardiovascular disease (CVD) risk is unclear, which is especially relevant as exercise-induced protective pathways may be attenuated in the presence of CVD. Furthermore, it is unknown whether a greater volume of exercising muscle and/or short-term exercise provide additional protective effects against IR injury. The aim of this crossover study was to 1) compare two modes of acute exercise involving small (handgrip) and large (squats) muscle mass on vascular responses to IR-injury in older individuals with CVD risk factors, and 2) test whether 7 days of daily exercise modifies these responses.

METHODS: Fifteen participants (9 women, 58 ± 5 years, ≥ 2 CVD risk factors) visited the laboratory on 5 occasions. On visit 1 (control), brachial artery flow-mediated dilation (FMD) was measured before and after a temporary endothelial IR-injury induced in the upper arm (15-minutes ischemia, 15-minutes reperfusion). One week later, participants were randomized to perform dynamic unilateral handgrip (4x5 minutes bouts, 50% maximal voluntary contraction, 25 repetitions per min) or squat (4x5 minutes, bodyweight, 15 repetitions per min) exercises paced by a metronome prior to the IR-injury protocol. The exercises were continued at home for 1 week (daily) before participants returned to the laboratory and the IR-injury protocol was repeated. A two-week washout period took place between exercise modes. Data were analysed using general linear models.

RESULTS: When assessing the acute effect of exercise, there was a significant decline in FMD following IR-injury (P=0.02) and an IR injury*condition interaction effect (P=0.03). There was decline in FMD following IR-injury in the control condition (4.3 ± 2.1% to 2.9 ± 1.8%, P<.001) but not following handgrip (3.8 ± 1.6% to 3.4 ± 1.5%, P=0.33) or squat exercise (3.9 ± 1.8% to 4.0 ± 1.9%, P=0.75). Dose of exercise (1 vs. 7 daily exercise sessions) did not influence FMD responses after IR-injury to handgrip (1-week: 4.3 ± 1.9% to 4.7 ± 3.2%) or squats (1-week: 3.7 ± 2.1% to 4.7 ± 3.0%;(both, P>0.05).

CONCLUSION: We show that dynamic, small and large muscle mass exercise effectively attenuate IR-induced vascular injury in older individuals with CVD risk factors, whilst these effects remain similarly present following 7 days of continued exercise. This highlights the potency of exercise to provide immediate, remote protection against endothelial IR-injury in individuals with elevated CVD risk, which seems largely independent of the volume of exercise.

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SEVEN DAYS OF SMALL OR LARGE MUSCLE MASS EXERCISE TRAINING IS NOT SUFFICIENT TO IMPROVE VASCULAR FUNCTION IN INDIVIDUALS WITH CARDIOVASCULAR RISK FACTORS

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INTRODUCTION: Time course of change in flow-mediated dilation (FMD) in response to exercise training differs according to the individuals' characteristics such as cardiovascular health and age. Moreover, muscle mass seems to have a key role on arterial blood flow and shear stress. Small muscle mass such as handgrip causes minor changes in cardiac output, suggesting that increased blood flow during exercise is mainly attributed to vasodilation. Whist large muscle mass exercise such as squats increase blood pressure and cardiac output, suggesting that the increase in femoral blood flow might be responsible of the vasodilation. In clinical populations, early improvements in vascular function without impacting blood pressure may reveal important new insights into vascular biology. We used a within-subject, cross-over study to determine the impact of short-term large versus small muscle mass exercises on vascular function in older individuals with cardiovascular risk factors.

METHODS: Fifteen inactive participants (Females/males: 9/6, 58 ± 5 years, ≥ 2 cardiovascular risk factors) reported to the laboratory on four occasions to undergo blood pressure and vascular function measurements. Participants completed seven sessions over a one-week period, either handgrip (4x5/25 repetitions per minute/50% maximal voluntary contraction) or squat (4x5 minutes bodyweight, 15 repetitions/min) training in a randomized, balanced cross-over design with a two-week washout period between exercise conditions. Resting vascular function was assessed and analyzed with the expert-consensus guidelines for FMD protocol and statistical analyses were performed with general linear models.

RESULTS: There was no change in resting FMD following either exercise condition (time-effect: p=0.62, interaction-effect: p=0.20). Resting systolic (SBP) and diastolic (DBP) blood pressure did not change after both exercise training interventions (time-effect: p=0.52 and p=0.57, interaction-effect: p=0.95 and p=0.43, for SBP and DBP, respectively). Individual changes in FMD demonstrated a comparable pattern between both exercise modalities where nine and seven participants demonstrated an increase in FMD after seven days of exercise training in handgrip and squat groups, respectively. De-

spite this similarity at the group level, matching the individual changes to both types of training showed large variation between individuals, where no association were found between the two groups (R2=0.05, p=0.42).

CONCLUSION: Our results suggest that one week of exercise training is not enough to improve vascular function in individuals with cardiovascular risk factors. However, intra-individual variation in the adaptation of FMD was found. Since muscle mass involvement has a different impact on blood flow, further studies should focus on the short-term impact of whole-body aerobic exercise (e.g., cycling) on vascular function.

CARDIOVASCULAR PREHABILITATION IN PATIENTS AWAITING HEART TRANSPLANTATION - ADDRESSING CLINICAL NEEDS (PREHAB HTX)

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INTRODUCTION: Heart transplantation (HTx) is a life-saving treatment for patients with advanced heart failure (HF); however, considerable donor organ shortages limit its access. Patients with advanced HF awaiting HTx, in whom advanced age and co-morbid diseases are common, experience substantial declines in functional and exercise capacity, are frail, and suffer from poor mental health and quality of life (QoL). Cardiovascular rehabilitation (CR) programs are integral to managing HF. Such programs include health behaviour change and cardiovascular disease risk factor management (e.g., physical activity programming, nutritional counselling, stress management, and smoking cessation). Few studies have examined the effects of CR for patients with advanced HF awaiting HTx (prehabilitation [PREHAB]). The primary aim was to compare the effects of a 12-week PREHAB program and usual care (UC) in improving functional capacity (6-minute walk test) in adults listed for HTx. Secondary aims included comparing a 12-week PREHAB program and UC in improving exercise capacity (VO2peak), depression (Beck Depression Inventory-II, BDI-II), anxiety (Beck Anxiety Inventory, BAI), and QoL (Minnesota Living with Heart Failure Questionnaire, MLHFQ).

METHODS: An RCT was conducted at the Ottawa Heart Institute and Toronto General Hospital/Toronto Rehabilitation Institute in Canada. Participants were randomized to PREHAB or UC. The 12-week PREHAB program included thrice weekly high-intensity interval training (HIIT) sessions (2 x 8-minute interval training blocks of 30-seconds at 100% of peak power output [PPO] interspersed with 30-seconds active recovery at 50% of PPO, with 4 minutes of passive recovery between the blocks), a stress management course, and a nutrition workshop.

RESULTS: Trial recruitment began in October 2018 and closed, due to the COVID-19 pandemic, in December 2020. The target sample size was n=68. A total of 128 patients were screened for eligibility, 17 were recruited (age: 44±9 years, 71% male), and 4 were randomized (PREHAB=2, UC=2). Both patients completed the PREHAB program and 1 patient completed UC. Reasons for drop-out included: transplanted, medication and device contraindications, commitment and travel constraints, and lack of interest. The PREHAB program showed potential for improvements in functional capacity (baseline (B): 343±120, follow-up (F): 465 m), exercise capacity (B: 14.9±0.1, F: 15.8±0.4 mL/kg/min), depression (B: 11±5, F: 6±3 points), anxiety (B: 11±8, F: 10±0 points), and QoL (B: 41±33, F: 26±1 points).

CONCLUSION: Recruitment for and completion of a PREHAB program for patients listed for HTx proved challenging. Our target sample size was not achieved, and a high attrition rate was observed. Yet, improvements were seen among PREHAB participants across physical and mental health outcomes. Future research is encouraged to examine alternative PREHAB offerings (e.g., virtual based) which may be offered sooner following listing and address reported barriers.

ENHANCING FUNCTIONAL CAPACITY AND QUALITY OF LIFE WITH ECCENTRIC CYCLING IN HEART FAILURE PATIENTS: A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Exercise training is recommended for comprehensive management of patients with heart failure and reduced ejection fraction (HFrEF). However, limited exercise capacity prevents many patients from gaining optimal benefits from training. Given that eccentric cycling is well tolerated in patients with HFrEF, and enables greater power output, we hypothesized that eccentric cycling training would result in superior functional outcomes than concentric cycling training when the interventions were matched for heart rate (HR).

METHODS: Thirty participants (7♀, 57±13 y; BMI 27±4 kg/m2) with HFrEF (ejection fraction 36±7%, New York Heart Association class II) were randomized in a 1:1 superiority clinical trial to undertake either eccentric cycling training (ET, n = 16) or concentric cycling training (CT, n = 14). Each intervention involved 2 weeks of familiarization period followed by 12 weeks of training at matched relative intensity (40-80% of HR reserve), twice weekly. The primary outcome was peak oxygen consumption (VO2peak), secondary outcomes included 6-minute walk, functional lower extremity strength and health-related quality of life (Minnesota Living with Heart Failure, MLHF).

RESULTS: Repeated measures ANOVA revealed a significant time effect for VO2peak (P<0.001) with comparable improvement in each group (ET: 16.5±4.5 to 18.0±5.1 ml/kg/min, P=0.019; CT 18.6±6.1 to 20.6±6.4 ml/kg/min, P=0.008). Similarly, main effects were evident in both groups for 6-min walk (P<0.001) (ET: 465±86 to 521±83 m, P<0.001; CT 495±87 to 523±109 m, P=0.041, 30s sit-to-stand (P<0.001) (ET: 11±2 to 14±3 repetitions, P<0.001; CT 13±3 to 14±2 repetitions, P=0.082) and timed up-and-go (P=0.003) (ET: 7.1±1.3 to 6.1±1.0 s, P=0.008; CT 7.4±1.5 to 7.1±1.4 s, P=0.138). MLHF score improved greater (P=0.045) for ET (29±22 to 21±17) than CT (28±18 to 27±17).

CONCLUSION: When matched for heart rate to control for cardiovascular burden, ET was well tolerated in HFrEF patients and conferred similar benefits in fitness and functional capacity as CT, with a superior effect on health-related quality of life and tolerability. Eccentric cycle training is a novel and efficacious approach for clinical benefit in highly compromised HFrEF patients, who represent a challenge in terms of exercise prescription.

This work was supported by WA Government FHRI Research Excellence Award and the National Health and Medical Research Council (NHMRC, APP1085479).

SEX-RELATED PROTEOMIC DIFFERENCES OF THE ATHLETE'S HEART

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INTRODUCTION: Regular physical activity results in characteristic structural and functional changes in the heart, which are collectively referred to as the athlete's heart. However, the extent of exercise-induced left ventricular (LV) hypertrophy and functional changes show significant differences between men and women, the molecular background of which is not fully elucidated. The aim of this study was to provide a proteomic characterization of long-term, intense exercise-induced LV myocardial hypertrophy in a rat model, with a focus on sex-related differences.

METHODS: Our rats were divided into trained (FEx) and control female (FCo) as well as trained (MEx) and control male (MCo) groups. In the trained groups, athlete's heart was induced by swimming for 12 weeks. Myocardial hypertrophy was confirmed by cardiac ultrasound and functional adaptation by pressure-volume analysis. Proteomic measurements based on liquid chromatography-coupled mass spectrometry were performed on proteins isolated from our left ventricular samples.

RESULTS: Echocardiography and post-mortem myocardial mass showed significant LV hypertrophy in both sexes, which was more pronounced in female animals (tibial length normalized LV muscle mass: + 17.4% MEx vs. MCo, + 31.0% FEx vs. FCo). LV contractility has increased to the same extent in both sexes. Relative expression of 3074 proteins were determined by proteomics. There was a significant change in expression of 229 proteins in males and 599 in females compared to the level of same-sex controls. Based on our gene ontological analysis, physiological LV remodeling in females is characterized by increased expression of proteins in cellular respiration and fatty acid oxidation, whereas in males, proteins that bind to the actin cytoskeleton is primarily increased.

CONCLUSION: Our data suggests that physiological LV hypertrophy resulting from regular, balanced exercise is associated with sex-specific changes in the myocardial proteome. Our results contribute to the understanding of the development of physiological myocardial hypertrophy.

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Oral presentations

OP-PN31 Brain

EFFECTS OF LACTATE PRODUCED DURING EXERCISE ON BDNF ACTIVATION THROUGH MCT2 AND GPR81 IN THE HIPPOCAMPUS

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INTRODUCTION: The possibility that lactate released from muscle during exercise has an effect on the improvement of brain function has been suggested. This study analyzed the effect of lactate produced in muscle by high-intensity exercise through MCT2 and GPR81 to reduce brain function deterioration and protein expression of dementia-related substances in hippocampus.

METHODS: To confirm whether lactate increases the expression of MCT2 and GPR81, 16 rats (Sprague Dawley) were divided into saline injection group (n = 8) and lactate injection group (n = 8) as the first experiment, and saline and lactate were intraperitoneally injected for 2 weeks, respectively. As a secondary experiment, sedentary (n=15), medium-intensity (MIIT) (n=15), and high-intensity interval training (HIIT) (n=15) were performed with C56BL/6 mice for 4 weeks, while saline (n=5), MCT2 blocker (n=5) and GPR81 antagonist (n=5) were divided into groups that were injected intraperitoneally. Measurement items were analyzed for blood concentrations of lactate, BDNF, and β-amyloid by ELISA, and protein expression patterns of molecular biological variables including BDNF, MCT2, and GPR81 in EDL muscle and brain hippocampus were analyzed by western blotting.

RESULTS: Levels of lactate and BDNF in the blood were significantly ($p<0.05$) higher in the lactate-injected group than in the saline-injected group in the first experimental rat. In the mouse of the 2nd experiment, the exercise group was higher than the sedentary group in all conditions, and the HIIT group showed the most significant increase. Rat lactate-injected group showed significantly ($p<0.05$) higher protein expressions of MCT2 in the EDL muscle than the saline injection group, and BDNF and MCT2 protein expressions in the hippocampus were significantly higher than the saline injection group ($p<0.05$). Lactate protein expression in hippocampus and EDL muscles after exercise training in mice was significantly

($p<0.05$) higher in the exercise group than in the sedentary group, and the highest in the HIIT group. The expression of BDNF, MCT2, and GPR81 in hippocampus and EDL muscles was not significantly different between the sedentary, MIIT and HIIT groups under all conditions of saline, MCT-2 blocker, and GPR81 antagonist injection.

CONCLUSION: Activation of BDNF expression in hippocampus by lactate was confirmed, and the role of MCT2 as a messenger was confirmed in this process. However, injection of MCT2 blocker and GPR81 antagonist could not confirm the effect of blocking the effect of lactate produced in muscle on hippocampus BDNF protein expression during exercise. In addition, lactate produced during 4 weeks of exercise including high-intensity interval training could not clearly confirm the activation of BDNF in the hippocampus and the action of MCT2 and GPR81. This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (2020R1F1A1072018)

LACK OF BRAIN GLYCOGEN CAUSES COMPENSATORY LIPID METABOLISM IN MOUSE DURING EXERCISE.

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INTRODUCTION: As the demand for oxygen and energy increases during exercise, it is essential for animals to regulate their metabolism in response. Hence, the central nervous system must monitor not only the heart and skeletal muscle, but also organs involved in energy metabolism, such as the liver and adipose tissue, in an integrated manner to efficiently regulate the supply of energy substrates(organ circle linking). Our previous results implied that lactate broken down from brain glycogen plays a role in metabolic regulation in the hypothalamus during exercise, but the details remain unclear. Transgenic mice that lack brain glycogen (Gys1Nestin-KO mice) exhibit brain dysfunctions, such as reduced cognitive function and long-term potentiation(LTP; Duran et al., 2013). So, we hypothesize that a peripheral metabolic adaptation supported by the brain-liver-adipose tissue axis may be compensating for energy shortages in neurons. Thus, we examined the dynamics of carbohydrate and lipid metabolism during exercise in GysNestin-KO mice.

METHODS: Gys1Nestin-KO (CKO) and littermate control mice(Gys1[cond/rec]Cre[-/-]; CON) (male; 11-13 weeks old) were subjected to incremental treadmill running. Ventilation threshold(VT) was calculated based on respiratory gases using the V-slope method(Beaver et al., 1985), a criterium for moderate-intensity exercise. In a single bout of treadmill running, they performed light(CKO: 6 m/min; CON: 8 m/min) and high intensity(CKO: 15 m/min; CON: 20 m/min) exercise for 30 min. All running speeds were determined based on VT. Carbohydrate and lipid utilization was calculated from respiratory gases. After running, blood and tissue samples(brain, liver and muscle) were collected to measure blood glucose and lactate, plasma BHB, lactate and BHB in the hippocampus and hypothalamus, and other metabolites.

RESULTS: During incremental treadmill running, VT and maximal running speed were significantly lower in CKO than CON. In a single bout of high-intensity treadmill running, the blood lactate of both CKO and CON was higher than for light-intensity exercise and sedentary, indicating reasonable running speeds. Carbohydrate utilization in CKO was lower than in CON during high-intensity exercise, and lipid utilization in CKO tended to be higher. In addition, plasma BHB in CKO was higher than in CON.

CONCLUSION: As in our previous findings(Matsui et al., 2017), the relatively lower VT and maximal running speed found in CKO implies that brain glycogen contributes to exercise capacity, suggesting that a lack of brain glycogen leads not only to cognitive decline but also to reduced endurance. The crux here is that we found lipid-predominant metabolism and high plasma BHB in CKO, suggesting that a decrease in lactate utilization in neurons is compensated for by increased liver-derived lipid utilization. The close regulatory mechanisms among the brain-liver-adipose tissue axis(Uno et al., 2006) appears to be responsible for the coordination of the energetic balance between brain and brawn.

AEROBIC EXERCISE DELAYS ALZHEIMERS DISEASE BY REGULATING MITOCHONDRIAL PROTEOSTASIS IN THE CEREBRAL CORTEX AND HIPPOCAMPUS

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INTRODUCTION: Alzheimers disease (AD), a form of dementia, mostly occurs in elderly individuals. The specific clinical manifestations are progressive cognitive dysfunction and memory decline. The pathological characteristics are the appearance of senile plaques in the brain and the formation of neurofibrillary tangles. An increasing number of studies have shown that mitochondrial dysfunction is closely related to the occurrence and development of AD. In recent years, studies have found that mitochondrial proteostasis is disrupted in the brains of AD patients, leading to mitochondrial dysfunction, which manifests as dysfunction of the mitochondrial unfolded protein response (UPRmt), mitochondrial autophagy, and mitochondrial protein import. Moreover, it has been gradually confirmed that an appropriate amount of exercise can effectively delay and ameliorate neurodegenerative diseases, especially AD. Therefore, in this study, we explored the effect and mechanism of aerobic exercise in improving mitochondrial proteostasis and cognitive function in APP/PS1 mice, to provide a new research direction for studying the ability of exercise to prevent and treat AD.

METHODS: Male APP/PS1 mice were randomly divided into the normal group (NG, n = 20) and activation group (AG, n = 20). The AG was fed nicotinamide ribose (NR), a mitochondrial proteostasis activator, once daily for 13 weeks. The mice in each group were randomly divided into a quiet control group and exercise group (n=10 mice each), yielding the normal control group (CNG), normal exercise group (ENG), active control group (CAG), and active exercise group (EAG). After adaptive training, the mice in the exercise groups were trained on an aerobic treadmill for 12 weeks, and behavioral tests were

conducted in the 13th week. All mice were isolated the cerebral cortex and hippocampus, then Quantitative Real-time PCR and Western blot analysis were performed.

RESULTS: In the Morris water maze test, compared with CNG, the latency was significantly reduced and the number of platform crossings was significantly increased in the CAG and ENG respectively. Compared with ENG, the latency was significantly reduced and the number of platform crossings was significantly increased in the EAG. Compared with CAG, the latency was significantly reduced and the number of platform crossings was significantly increased in the EAG. Compared with CNG, the activity of UPRmt and the level of mitochondrial autophagy were significantly increased, while the level of mitochondrial protein import was significantly reduced in the CAG and ENG. Compared with CAG, the activity of UPRmt and the level of mitochondrial autophagy were significantly increased, while the level of mitochondrial protein import was significantly reduced in the EAG. Compared with ENG, the activity of UPRmt and the level of mitochondrial autophagy were significantly increased, while the level of mitochondrial protein import was significantly reduced in the EAG.

CONCLUSION: Aerobic exercise can enhance the activity of UPRmt and the level of mitochondrial autophagy, inhibit mitochondrial protein import in the cerebral cortex and hippocampus of APP/PS1 mice by regulating mitochondrial proteostasis, thus improve cognitive function and delay AD.

PERIPHERAL BLOOD TNF-ALPHA LEVELS IN CHILDREN WITH ATTENTION DEFICIT/ HYPERACTIVITY DISORDER: EVIDENCE FROM A META-ANALYSIS

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INTRODUCTION: Studies have shown that inflammation is associated with the pathogenesis of attention deficit hyperactivity disorder (ADHD). Abnormal inflammatory cytokine levels have been reported in patients with ADHD, but the results are inconclusive. To assess the relationship between peripheral cytokine levels and ADHD, this systematic review was conducted, followed by a meta-analysis of random controlled trials evaluating peripheral cytokine levels in children with ADHD.

METHODS: This study was reported in strict accordance with the PRISMA guidelines. Through a systematic search of five databases, a total of 3549 potentially eligible articles were identified in the initial search. Finally, 11 studies with 1406 participants (ADHD group: n = 673, healthy group: n = 733) were included in the meta-analysis. The data extraction content is: (a) basic study information: title, author, year; (b) basic participants information: age, gender, sample size, medication; (c) elements of risk of bias assessment; (d) outcome measures: cytokine levels in ADHD and control groups. Publication bias was assessed by inverted funnel plots and statistical bias was assessed using Eggers method. Sensitivity analyses were performed to test the robustness of pooled results by removing trials at risk of assessment bias. Random-effects models were used to synthesize effect sizes for the included studies due to high heterogeneity of participants, participant sampling methods and other factors. The quantitative synthesis of data was performed using Review Manager software and the continuous variables were expressed as weighted mean differences (WMD), with each effect expressed as 95% confidence intervals (95%CI).

RESULTS: The levels of some inflammatory biomarkers in the peripheral blood of children with ADHD are abnormal, and there are statistically significant differences with healthy children. Conducted on 11 studies (totaling n = 1406 children), this meta-analysis on peripheral inflammation biomarker showed that TNF-alpha levels in ADHD children significantly declined 0.69 mg/l (95% CI: 0.36 to 1.02 mg/l, 8 studies, n = 890, effect sizes Z = 1.28, p = 0.02; I2 = 97%; p for heterogeneity < 0.01). However, no differences for IFN-γ (4 studies, n = 486, effect sizes Z = 1.05, p = 0.29; p for heterogeneity < 0.01) were observed.

CONCLUSION: The declined TNF-alpha levels may indicate a specific pattern of biomarkers in ADHD. TNF-alpha may have certain value in the early diagnosis of ADHD, and further large-sample studies and high-quality methodological studies are needed to determine whether the above indicators can be used as biomarkers for the diagnosis of ADHD.

MICROARRAY SCREENING IDENTIFIES DYSREGULATED MICRORNAS LINKED TO PHYSICAL FITNESS IN ANOREXIA NERVOSA.

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INTRODUCTION: Anorexia nervosa (AN) is a mental illness characterized by low recovery rates (50%) and the highest mortality rate (5-7%) among all mental disorders. Scattered research in AN shows a biological imbalance, altered body composition, and poor muscular health [1] coinciding with the period of greatest risk of relapse (six months after hospitalization). In this context, circulating microRNAs (miRs) emerge as ultra-specific biomarkers that regulate multiple signalling pathways linked to different pathologies. However, miRs relevance and connection to physical fitness (PF) recovery in AN are poorly understood. Given the importance of returning to healthy PF as part of the healing process in AN [2], understanding these relationships is key to assist professionals in exercise prescription management. The objective of our study was two-fold, to identify 1) abnormally expressed miRs in AN compared to healthy controls (HC) and 2) their association with PF.

METHODS: Patients were recruited after hospitalization and HC were matched by age and sex. A total of 10 samples were collected (5 AN and 5 HC). After centrifugation, plasma was separated and stored at -80 ºC until later use. Total RNA was extracted using the miRNeasy Serum/Plasma Advanced Kit (Qiagen), and samples were profiled with ThermoFisher GeneChip miRNA 4.0 array. PF was assessed [body composition (anthropometry) and muscular strength (handgrip and half-squat strength test)]. To compare miR expression means, T-student was performed with a FDR correction. Moreover, Principal Component (PC) Analysis (PCA) was performed for miR expression to reduce dimensionality, identify the global relationship of miRs with PF measurements, and to define groups (AN and HC) based on it.

RESULTS: The expression levels of 7 miRs were significantly overexpressed in AN compared to HC (PDR<0.05, log2 FC≥9.35): miR-629-5p, miR-500a-3p, miR-502-3p, miR-505-5p, miR-18b-5p, and two 199 family members (miR-199a-3p and miR-199b-3p). PCA explained the 57% of the differences between groups. Moreover, PCA logistic regression showed a significant negative correlation of the model and waist circumference (WC) and waist-to-height ratio (WtHR) (p = 0.034). Regardless of the differences in muscle strength between groups, no significant associations were found regarding handgrip and half-squat strength with PCs. Uncovering, therefore, a relationship between body composition and miR expression in AN.

CONCLUSION: We have identified for the first time the miR profile in AN. Negative correlations of overexpressed miRs with WC and WtHR, highlight the importance of a combined assessment for disease staging. Future studies on miR profile validation and exploring its association with PF and mental health (with larger samples) are essential to uncover the clinical value of miRs as biomarkers in AN.

1. Watson et al. Nat Genet.

2. Alberti et al. J Sports Med Phys Fitness

Oral presentations

OP-SH14 Psychology and coaching in football

INFLUENCE OF AN EVALUATIVE AUDIENCE ON CONSCIOUS MOTOR PROCESSING AND PERFORMANCE DURING A STOP-SIGNAL SOCCER PENALTY SHOOTING TASK

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Introduction

The Theory of Reinvestment predicts that pressure can negatively impact performance of perceptual-motor skills by experts, due to conscious reinvestment of explicit knowledge about how to perform the skills (i.e., 'conscious motor processing'). A recent systematic review confirmed that performance pressure generally leads to an increase in conscious motor processing, however, there was insufficient evidence to conclude that pressure-induced increases in conscious-motor processing are associated with negative impacts on performance.

Methods

The current study directly addressed this issue by investigating effects of pressure on conscious motor processing and performance in a soccer penalty shooting task. Fifteen experienced soccer players performed two different versions of the task ('Go-only' vs. 'Stop-and-Go'), which allowed for more, or less, conscious motor processing to occur. In both cases, pressure was manipulated by means of an evaluative audience (audience vs. no audience). Conscious motor processing was assessed with the Movement Specific Reinvestment Scale (MSRS) and by means of a skill-focused dual-task. Measures of performance included movement times and penalty shooting accuracy.

Results

Analyses indicate that penalty shooting accuracy was lower in the Stop-and-Go than in the Go-only task context (p = .01). Presence of an audience did not cause participants to experience an increase in competitive anxiety, nor did it result in significant effects on conscious motor processing or penalty shooting performance. Post-hoc exploratory analyses identified trait reinvestment as a significant covariate. High reinvestors had significantly higher state MSRS scores than low reinvestors (p = .01), they were more accurate in their skill-focused dual-task responses in the go-only compared to the stop-and-go task (p = .04) and, unlike low reinvestors, they showed faster reaction times (p = .01) and greater stopping success (i.e., improved response inhibition) in the presence of an audience compared to no audience (p = .04).

Discussion

Findings indicate that in general, presence of an audience had no significant effects on conscious motor processing or penalty shooting performance. Players who scored high on trait reinvestment, however, exhibited faster reaction times and greater stopping success in the presence of an audience, suggesting that increased monitoring pressure – while not causing significant increases in state anxiety – may facilitate inhibitory performance in those players who tend to go about their skill execution in a deliberate and self-conscious manner. Future studies are required to consider the influence of trait reinvestment in examining the effects of pressure on conscious motor processing and performance.

COMPARISON OF EXTERNAL LOAD AND LOAD DISTRIBUTION BETWEEN A RESERVE TEAM IN A ONE-GAME WEEK MICROCYCLE AND ITS FIRST TEAM IN A TWO-GAME WEEK MICROCYCLE WITHIN AN ELITE PROFESSIONAL SOCCER CLUB

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INTRODUCTION: To successfully transition from the academy to the first team, academy soccer players need to be prepared optimally to deal with superior demands on the senior level. While academy teams commonly carry out one-game week microcycles, competitive senior teams regularly carry out two-game week microcycles during congested fixture periods with games every 3-4 days. This study aimed to be the first one to quantify and compare weekly external load and load distribution between a reserve team (RES) in a one-game week microcycle and a first team (FT) in a two-game week microcycle within the same professional soccer club.

METHODS: Between 2017 and 2020, 36 one-game week microcycles of RES players and 64 two-game week microcycles of FT players were analyzed from the same professional soccer club that competed in the Scottish Premier League and the Union of European Football Associations (UEFA) Europa League. FT players were subcategorized into starters (FTS; ≥90 minutes game time) and non-starters (FTNS; ≤45 minutes game time). Data was collected using global positioning measurements for the following variables: duration (min), total distance (TD; m), total high-speed distance (THSD; >19.8 km/h; m), high-speed distance (HSD; 19.8-25.2 km/h; m), sprint distance (SD; >25.2 km/h; m), number of sprints (number of efforts >25 km/h, ≥0.1 s), number of high-speed efforts (HS efforts, number of efforts >20 km/h, ≥0.1s), meters per minute (m/min) and high-speed meters per minute (HS m/min). For each group (RES, FTS and FTNS), external load was quantified for each day of their typical microcycle, and as a cumulative weekly load. Inter-group differences in cumulative weekly load, weekly load patterns and intra-group day-to-day load variability were statistically analyzed. Training monotony (TM) was quantified to assess intra-group within-week load variation.

RESULTS: Overall, weekly loads between RES players in a one-game week microcycle and FTS in a two-game week microcycle were similar, apart from significant differences in duration (8%, $p<0.0001$), TD (21%, $p<0.0001$) and HS efforts (16%, $p<0.005$). FTNS had the lowest cumulative weekly load for all parameters observed. Weekly load patterns of RES players were significantly different from FTS and from FTNS ($p<0.05$). TM was highest for FTNS for all parameters observed, apart from number of sprints.

CONCLUSION: Academy graduates, progressing from a one-game-week microcycle to a two-game week microcycle, need to be prepared optimally to cope with the overall weekly loads and the lack of complete recovery between games FTS face. However, when young players become part of the FTNS group where weekly loads are consistently lower (impeding aerobic and neuromuscular performance capacity) and TM is higher (indicating a limited training load variation with no progressive overloads), coaches are urged to exploit all opportunities to adopt effective loading strategies within the limits of two-game week microcycles to ensure their continuous development.

THE PHYSICAL DEMANDS DURING TRANSITIONS IN ELITE SOCCER: ANALYSIS OF POSITIONAL DIFFERENCES, THE NOVEL CONCEPT OF CLUSTERS, AND IMPLICATIONS FOR TRAINING DESIGN.

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INTRODUCTION: Transitional activities (TA's) and high-pressure actions in soccer match play represent specific high-intensity blocks and include a high technical-tactical context within. Given that limited number of studies exist on the physical demands during transitions, gaining more knowledge in this area, might equip practitioners with additional tools to effectively replicate high-intensity periods in training. Hence, this study investigated physical match demands across different playing positions during transitional activities and analysed repeated activities during transitions.

METHODS: Data was collected using 10 Hz GPS units from 10 official matches including 23 elite soccer players of the 1st Polish Division (Ekstraklasa) in season 2020-21. The following positions were investigated: center backs (n = 4), fullbacks (n = 5), central defensive midfielders (n = 2), central attacking midfielders (n = 2), central midfielders (n = 2), wingers (n = 5), and attackers (n = 3). Match data reflected distances covered per minute (m·min-1): total distance (TD), high-speed running distance (HSRD, > 19.8 km·h-1), sprint distance (SD, > 25.2 km·h-1), as well as the number of high-intensity accelerations and decelerations (A+D, > 3 m·s-2; n·min-1). Total absolute and relative high-speed running and sprint distances were also quantified. Metrics were observed in relation to 4 TAs commonly observed in football matches. Positive Transitions (PT), Negative Transitions (NT), Fast Attacks (FA) and High-Pressure Activities (HP). Clusters of transitional activities (CTA) included two or more transitional activities that occurred within a period shorter than 61 secs.

RESULTS: A univariate analysis of variance revealed position-specific differences and elevated physical outputs across all variables. Significant effects of position were found for all metrics during transitional play (large ESs; $p < .001$). Central attacking midfielders showed higher TD (m·min-1), fullbacks covered highest SD (m·min-1) and wingers had the highest A+D (n·min-1) ($p \leq 0.05$). Center backs showed lower physical outputs compared to other positions but achieved highest A+D (n·min-1) during defensive transitions ($p \leq 0.05$). Attackers reached higher physical metrics during high pressure activities ($p \leq 0.05$). Transitional activities recovery period was found to be 108.5 ± 26.2 s, CTA recovery period was 25.7 ± 3.6 s, while CTA peak duration reached 53.3 ± 18.2 s.

CONCLUSION: Physical metrics are increased when observing transitional play. This study shows that players are exposed to repeated short, intermittent high-velocity actions together during contextualized peak intensity periods (transitions) in football, emphasizing the need to move away from 90min averages. Findings could inform coaching practices

and training programme design in elite soccer to prepare players for their position-specific role during peak intensity periods and reduce their risk of injury.

YOGA DOES NOT ATTENUATE SPEED, AGILITY AND CHANGE OF DIRECTION DEFICIT IN PROFESSIONAL SOCCER PLAYERS

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INTRODUCTION: Yoga is an alternative athletic training methodology that may have a positive impact on the recovery of football players due to the physical and psychological impact on restoration processes [1,2,3,4]. However, there is concern that Yoga may reduce football performance due to decreases in rate of force production and agility due to extensive static stretching aspects of Yoga [5]. Indeed, acceleration, deceleration, and change of direction (COD) are critical skills in football performance [6,7]. However, there is limited research evaluating the impact of Yoga on football skill-related performance. Therefore, the purpose of this study was to evaluate the effect of Yoga on football related skills. We hypothesized is that football players undergoing additional Yoga training would not impact speed, agility and change of direction abilities, and therefore may provide a viable strategy to facilitate recovery.

METHODS: A convenience sample of professional football players (N=21; senior levels under-23 and B; Age: 19±1.89 yr; Height: 182.5±6.02 cm; Body mass: 75.55±5.69 kg from the 1st Portuguese Football League voluntarily participated and were randomly placed into either the Experimental (EG; n=11) or Control (CG; n=12)) group. Participants completed a running velocity (5, 10 & 20 m distances) test and agility (Zigzag test) test using photoelectric cells, before and after 12 weeks of Yoga training. The EG performed (2) 60 min sessions of Yoga per week following football training that were guided by an experienced certified Yoga instructor. Yoga techniques were selected and ordered according to the objectives of the study: pránáyáma (breathing techniques), ásana (psychophysical techniques), yoganidrá (relaxation), samyama (concentration, meditation, etc.). The CG completed the standard football training program only. Mixed factor ANOVA were used to evaluate main and interaction (group x time) effects. Effect sizes (ES) were calculated using partial eta squared (ηp2). The level of significance was set at $p<0.05$.

RESULTS: Both groups demonstrated significant improvements from pre to posttest in all variables ($p<0.05$). However, there were no group by time interaction effects for 5m ($F(1,16) = 0.597$, $p = 0.451$; $\eta p2 = 0.036$, Power = 0.11), 10m ($F(1,16) = 0.186$, $p = 0.672$; $\eta p2 = 0.011$, Power = 0.07), 20m ($F(1,16) = 2.535$, $p = 0.131$; $\eta p2 = 0.137$, Power = 0.32), zig zag ($F(1,16) = 1.387$, $p = 0.256$; $\eta p2 = 0.080$, Power = 0.20), and COD ($F(1,16) = 0.357$, $p = 0.558$; $\eta p2 = 0.022$, Power = 0.087) outcomes indicating that Yoga did not attenuate these performance metrics.

CONCLUSION: In conclusion, Yoga did not have a deleterious impact on running velocity, agility and COD deficit in football players and may thus provide players with a viable option to facilitate physical and psychological recovery during training.

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TRAINING LOAD AND MATURATION MONITORING IN YOUTH SOCCER: DOES UNDERSTANDING THE DATA IMPACT COACHING PRACTICE?

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INTRODUCTION: Training load and maturation monitoring is a practice widely used within professional soccer academies to aid player development and reduce growth-related injuries (1). While data can be used to inform coach decision-making on planning training, and retain and release decisions, the process can be ineffective in a fast-paced academy environment (2). Therefore, it is unclear how coaches interpret and deploy training load and maturation data as part of their coaching practice. Thus, the aim of this study was to explore how youth soccer coaches construct knowledge and resultingly, implement training load and maturation monitoring into their practice.

METHODS: Eleven experienced professional youth soccer coaches from a range of elite player performance plan (EPPP) (3) category clubs (1-3) were purposively sampled based on their coaching experience (>5 yrs working within an academy environment), coaching qualifications (> FA level 2), and were currently working in the youth development phase (YDP) within their club. Semi-structured interviews were conducted, and coding was carried out using NVivo, until data saturation was achieved (4). An inductive, reflexive, thematic analysis was used to identify themes from the interviews.

RESULTS: Three higher-order themes were identified (coach learning, club environment, and coach behaviour), which revealed that coaches' knowledge was constructed by learning through informal and formal sources. However, this was only reported within clubs that fostered a multi-disciplinary and social learning environment. Consequently, coaches' knowledge influenced the implementation and deployment of training load and maturation data into coaching practice. Category 2 and 3 status coaches (with the exception of clubs with significant funding) reported a lack of human resources, poor knowledge sharing, and limited communication between coaches/sports scientists as a barrier to using training load and maturation monitoring data.

CONCLUSION: Coaches and clubs of category 1 status fostered a multi-disciplinary, social learning environment that developed coaches' knowledge and use of training load and maturation monitoring as part of their practice. However, category 2 and 3 coaches reported a lack of human resources, knowledge sharing, poor communication of training load and maturation monitoring practices. Future research should aim to develop a coach learning framework for training load

and maturation monitoring, that can be used within resource-limited clubs, that are unable to facilitate a multi-disciplinary and social learning environment.

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13:15 - 14:15

Conventional Print Poster

CP-AP06 Wearables

AUTOMATED IMU-BASED TRAINING LOAD MONITORING IN BEACH VOLLEYBALL

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INTRODUCTION: Optimizing training load management is of great importance in beach volleyball to elicit elite performance and avoid injuries. Due to the sandy ground surface and the structure of the game (3-contact rule, two persons per team), in addition to jumps, it is primarily short sprints, fast lateral movements, and dig movements with direct follow-up action that determine the degree of stress and load on the players [1]. Therefore, we developed a practical and cost-effective monitoring approach to automatically identify and quantify relevant events and ultimately enable an informed training load and recovery management.

METHODS: The developed system consists of an IMU-based event detection (ED) as well as action classification (AC). Kaasa Data Collector application was used to collect raw data from standardized training sessions (n=7, male German national level) using six channels of data (3D accelerometer + 3D gyroscope) from three synchronized sensors (Movesense IMU, left/right upper arm and chest strap, 104Hz each). Basic techniques (set, pass, service), jumps (jump service, attack, block) and defensive actions (defense, digs, sprints) were tagged in real time with hot buttons and reviewed by video.

ED: two-stage sliding window approach (0.5 sec); stage I: suprathreshold L2-normalized values of accelerations and angular velocities of the sensor on the hitting arm (right arm); stage II: suprathreshold upward rotations of the hitting arm and supporting arm.

AC: classification of eight specific actions (serves with and w/o jumping, reception, defense/digs, sets, attacks, and blocks with and w/o preliminary movement) using data of -1.5/+0.5 sec around automatically detected events. (a) Normalized feature vectors (statistical: min, max, mean, etc., specific: rotation during the event, etc.) were classified with Naive Bayes, kNN and C4.5 Decision Tree; CV / LOSO-CV was performed by open-source software ECST [2]. (b) raw data was classified using a sequential neural network model (Tensor flow light, 70% training, 15% test, 15% validation).

RESULTS: ED: 1481 automatically detected events (1040 TP / 441 FP; 1346 manually annotated actions); recall: 77.3% (306 FN) and precision: 70.2%; AC: accuracy (a) 75.4% to 94.7% and (b) 90.1%.

CONCLUSION: Traditional classification approaches as well as machine learning methods were used successfully to automatically detect and classify beach volleyball specific movements. Machine learning appears to be superior compared to traditional approaches. However, recall and precision of ED as well as accuracy of AC still need to be improved further to effectively support training load management and recovery of athletes.

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RECOGNIZING KICKBOARD AND SKATEBOARDING BEHAVIORS USING WEARABLE ACTIVITY TRACKER DEVICES

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INTRODUCTION: Contemporary wearable activity tracker devices and smartphones are able to predict various physical activity parameters. The estimation of daily energy expenditure often relies on data provided by the accelerometer, gyroscope and altimeter sensors. Software that accurately estimates energy expenditure commonly integrates a sequence of 2 algorithmic operations. The first operation consists in allocating data to some activity-specific classes. The second operation consists in intra-class regression procedures to make quantitative estimations of the energy expenditure. Many activity recognition algorithms have been proposed to classify a wide range of physical behaviors. Kickboard and skateboarding activities recently became popular among people with active commuting habits. These activities can sometimes make significant contributions to daily energy expenditure. The present study aims at developing a kickboard and skateboarding activity recognition algorithm for wearable activity tracker devices and smartphones.

METHODS: Ten subjects performed the 9 following activities: sitting, standing, walking on a flat surface, walking upstairs, walking down stairs, running, bicycle, kickboard and skateboarding. They wore 2 multi-sensor wearable devices, one at the wrist and one in the trouser back pocket, where activity trackers and smartphones are commonly put. Raw data from

the accelerometer, gyroscope and air pressure sensors were collected for each activity during 10 minutes at a sampling rate of 100 Hz. A 10-second sliding window analysis allowed extracting a total 211 data features in both the time and frequency domains. The reduced dataset was split into training and test samples using a subject-wise assignment method. Random forest classifiers were trained to recognize activities. The resulting activity recognition algorithms were evaluated on the test sample.

RESULTS: Models built with the back pocket sensor data predicted the activities with an average success of 84%. The "kickboard" and "skateboarding" activities had a sensitivity of 73 and 55% respectively with the large majority of the confusion occurring between these two behaviors. Grouping the two activities into one single "push-push-glide" activity class raised the performance to 88%, and the "push-push-glide" class showed a sensitivity of 98%. Models built with the wrist sensor data predicted the activities with a balanced average success of 86%. The "kickboard" and "skateboarding" activities had sensitivities of 95 and 92%, respectively. Models integrating two classification layers to allocate data to a "push-push-glide" activity class before making classifications for "kickboard" and "skateboarding" separately were 100% sensitive to these two behaviors.

CONCLUSION: Automatic recognition of kickboard and skateboarding activities using data collected by wearable activity trackers is feasible. Integrating this operation to activity tracker software would increase the accuracy of energy expenditure estimations.

STUDY ON THE FEASIBILITY OF BUILDING AN UNSUPERVISED LOCOMOTION CHARACTERISTICS VARIABLE-BASED ACWR PREDICTION AI MODEL

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INTRODUCTION: The acute:chronic workload ratio (ACWR) is an essential regulator of performance and injury risk in high-intensity team sports. However, this method requires at least 7 to 28 days of data accumulation, and the results are only reasonable if the data is measured at regular intervals. Therefore, this study aims to determine the feasibility of building AI modeling with locomotion characteristics and unsupervised learning variables to build an accurate ACWR prediction model.

METHODS: For 14 Korean professional volleyball players, an LPS sensor (Catapult ClearSky T6, Catapult Sports, Australia) was attached to their chest during the game and practice games, and the exercise load of explosive actions (left, and right turns, jumps, accelerations, and decelerations) was measured. In addition, locomotion characteristics were measured on the morning of the game with a MotionCore device (MotionCore, JEIOS, Korea). The locomotion characteristics consisted of unsupervised learning categories Motor Identity (aG, aa), Tele-signal (ID), and Entropy. Multiple regression analysis was conducted to predict the explosive volleyball action workload AL (Acute workload) and CL (Chronic workload) from the raw data. Then, based on the unsupervised learning variables comprising AL and CL, the measured data of volleyball players were considered 174 nodes, and k-means clustering was performed to identify the optimal clusters. An independent t-test was performed on the unsupervised learning variables characterizing the locomotion characteristics variables between the specified groups.

RESULTS: The explanatory power of the multiple regression model for predicting AL and CL based on explosive volleyball action of unsupervised learning variables of locomotion characteristics was $R^2 = 0.792$ ($adjR^2 = 0.765$) and $R^2 = 0.875$ ($adjR^2 = 0.856$), respectively. Afterward, k-means clustering analysis showed that both AL and CL formed two clusters. In the independent t-test results, the unsupervised learning variables of ALs locomotion characteristics were aG (t-test: -8.12, $p < .001$, ES: -1.27), aa (t-test: 6.61, $p < .001$, ES: 1.04), entropy (t-test: -9. 69, $p < .001$, ES: -1.52), and CL was significantly different from aG (t-test: -10.44, $p < .001$, ES: -1.66) and ID (t-test: 2.84, $p < .001$, ES: 0.45).

CONCLUSION: The ACWR component, AL, was characterized by differences between clusters in aG, a 3-axis acceleration feature, aa, a 3-axis gyroscope feature, and entropy, which indicates the difference in the amount of information between the left and right sides. CL showed that ID, the distance feature of the center of gravity during locomotion performance, differed between clusters (aG was also significant). These unsupervised variables exhibited different characteristics between the divided clusters, suggesting that unsupervised variable modeling approaches for ACWR prediction have the potential to build further, more detailed AI models.

RELIABILITY AND VALIDITY OF THE COUNTERMOVEMENT JUMP HEIGHT ON THE POLAR VANTAGE V2 SPORTS WATCH WITH HIGH PERFORMANCE FEMALE ARTISTIC GYMNASTS

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INTRODUCTION: Under controlled measurements regarding countermovement and peak power (PP), the jump height of the Countermovement Jump (CMJ) may be an appropriate parameter to evaluate neuromuscular fatigue. It is proven to indicate both acute as well as accumulated fatigue based on changes to baseline values (1, 2, 3). Polar Electro conceived the "Leg-Recovery-Test" on their Vantage V2 sports watch (V2) to track changes in jump heights and consequently generate statements about fatigue of the lower extremities. This study aimed to evaluate the validity and reliability of the described test in comparison with a force plate (FP), to make further assumptions about neuromuscular functions.

METHODS: Ten elite female artistic gymnasts (age: 17.2 ± 2.5 y) performed the "Leg-Recovery-Test" (three consecutive CMJs) three days in a row on a portable FP (CYCESS medical, SPSport, Österreich) wearing the V2. In the middle and at the end of the study period, two additional days of CMJ testing took place for validity calculations. Regression model of Hopkins was used along with the coefficient of determination (r2) to test the validity against the FP (4). Intra-class correlation coefficient (ICC) and coefficient of variation (CV) were calculated for intra-session and inter-session reliability as well as the standard error of measurement (SEM) for the latter one (2, 4, 5).

RESULTS: After applying the regression model on vertical jump heights of the V2, about 78% could be determined by the FP (r2 = .78; CV = 4.70%) (4). Inter-session reliability displayed high values within the V2: ICC = .82; CV = 4.8%; SEM = 1.95 cm and the FP: ICC = .88; CV = 3.9%; SEM = 1.62 cm. Reliability of single trials (intra-session) of the V2 was low to moderate: ICC = .58, CV = 8.7% (Day1); ICC = .68, CV= 6.9% (Day2) and ICC = .43, CV = 9.0% (Day3), but high to very high for the FP: ICC = .87, CV = 4.3% (Day1); ICC = .93, CV = 3.4% (Day2) and ICC = .86, CV = 4.1% (Day3).

CONCLUSION: In highly trained gymnasts the "Leg-Recovery-Test" demonstrated acceptable validity and reliability within the mean CMJ height of three consecutive jumps, but less within single trials. Compared to existing literature, CVs of the FP were within the expected values of < 4% (3) and means of V2 fell into expectations around 6% as well (6). Hence, assuming familiarity of execution of CMJ, the V2 can be partly considered as plausible tool for practicable daily use to assess changes in jump heights, that could be further investigated for relationships with neuromuscular fatigue.

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REMOTE ASSESSMENT OF PELVIC KINEMATICS DURING SINGLE LEG SQUAT USING SMARTPHONE SENSORS: BETWEEN-DAY RELIABILITY AND IDENTIFICATION OF ACUTE CHANGES IN MOTOR PERFORMANCE

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INTRODUCTION: The biomechanical evaluation of pelvic movements during a single leg squat (SLS) often requires costly equipment which precludes its wider implementation out of the lab in real-world environments. To overcome such limitation, smartphone sensors could be a viable option to remotely measure pelvic movements, but their measure properties need to be tested before recommending their use in ecological settings. Hence, this study aimed to 1) assess the between-day reliability of pelvic kinematics measured remotely, when participants perform SLS at home using their own smartphones; and 2) identify changes in pelvic kinematics during an endurance task.

METHODS: A remote assessment was conducted on thirty-three healthy young adults on two separate days. Participants collected kinematic data using their personal smartphones positioned on their lumbosacral area. Pelvic orientation including tilt, obliquity and rotation, as well as acceleration signals along the three axes, were collected during three sets of seven SLS and an endurance task of twenty consecutive SLS. Time- and frequency-domain features related to pelvic orientation and balance/smoothness of movement were extracted. Between-day reliability was assessed using Intraclass Correlation Coefficient (ICC2,k), Standard Error of Measurement, and Minimal Detectable Change. Pelvic kinematics changes during the endurance task and between-day bias were assessed using T-tests.

RESULTS: Good to excellent reliability (ICC2,k ≥ 0.79) was found for measures of pelvic orientation and frequency features of the acceleration signals, with the latter showing a shift of the power spectrum to lower frequencies ($p<0.05$) on the second day suggesting better balance performance or smoother movements. During the fatiguing condition of the endurance task, participants exhibited an increase in contralateral pelvic drop and rotation ($p<0.05$), as well as a more irregular frequency content (i.e., spectral entropy, $p<0.05$).

CONCLUSION: The results of this study indicate that measures of pelvic kinematics and acceleration obtained remotely using participants' smartphones during SLS are reliable between days. Also, smartphone sensors can detect alterations in motor control like contralateral pelvic drop during an endurance task. These findings contribute to building evidence for the use of smartphones as a low-cost, objective assessment of movement strategies and to monitor exercise performance remotely.

LOCALIZATION AND TRAJECTORIES OF ATHLETES ON INDOOR ENVIRONMENTS

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INTRODUCTION: The position, the velocity and the trajectory of the players have become essential data in order to assess the work load. These data are still not widely measured by current systems, especially at indoors and outside the high-competition. To address this, the present paper focuses on the athlete positioning for indoor sports, analyzing the capabilities of existing technologies.

With regard to the positioning and trajectory of athletes, systems are mainly based on vision or on wearables. Computer vision systems are expensive on hardware as well as on computation capabilities. For indoor positioning, there is not yet any universal GPS-like solution. Indeed, the presence of multi-paths, the importance of None Line-of-Sight (NLoS) visibility, the fading of signals due to the presence of obstacles, are all characteristics that make localization particularly complex.

Among wireless localization technologies, UltraWide Band (UWB) is well suited for high-accuracy applications and commercial products can reach centimeters in well controlled environments. UWB is a radio technology for short-range communications (less than 100 meters). This technology works in the frequency range between 3.1 and 10.6 GHz, with a large bandwidth and low power consumption. In indoor localization, UWB has a strong resistance against multi-paths. Nevertheless, this localization system has a high cost for high-scale deployments.

As a result, the proposed solutions are optimized for specific environments and scenarios of use with an accuracy that varies from a few tens of centimeters to a few meters. The aim of this paper is to review the classical techniques used for catching, in real-time, the position and the trajectory of the athlete on indoor sports, which means a reliable accuracy around tens of centimeters for a moving target (the athlete).

METHODS: Aspects addressed are the identification of the field's requirements and assessment of applicable localization technologies in terms of their capability to cope with such requirements. A complete wearable system for indoor localization based on UWB is defined, implemented and evaluated in a real-world scenario. Tests have been performed in a real environment, in the sports arena.

RESULTS: After processing the data, it has been obtained that the test subject has made the route it was obtained that the player completed the course with an average speed of 13 m/s and a and a maximum of 127m/s2.

CONCLUSION: After analyzing the main technologies and conditions associated to the implementation of positioning techniques for indoor sports, the present work developed a low-cost UWB-based indoor localization system. Its evaluation shows the capabilities of the approach to support players localization for its intended application. The low price and portability of this approach paves the way for future implementations affordable enough for use by modest professional teams and even amateurs, allowing for detailed monitoring and analysis of players and team performance.

HEART RATE MONITORING DURING GOLF PUTTING TO ESTIMATE MENTAL LOAD

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KU LEUVEN

INTRODUCTION: It is common knowledge that many factors, including physical activity and mental stress, elevate the heart rate from its resting baseline. Quantifying mental loads during training and competition gives coaches and athletes a tool to make informed decisions about the training process. Even though the physical load of golfing cannot be neglected, it is often referred to as a mental game. When the skill level between golf players is comparable, the mental toughness will be decisive. Moreover, the mental load is not a constant. In theory, all shots have an equal weight on the score, but missing or making certain shots makes a world of difference in the head of the player. This research investigates whether heart rate (variability) monitoring provides insights in the mental part of golfing.

METHODS: 7 youth golfing athletes (ages 14 – 17; 1 female) have participated in this study. Athletes have performed the test protocol multiple times, resulting in a total of 16 test measurements. The goal of the test is to score five consecutive putts from 3m distance to the hole. Ten different positions are marked in a circle around the hole. With each attempt, the athlete takes the shot from a different position to make sure that no two consecutive putts are the same. The exercise is self-paced, meaning that the golfers take as much time as they want to perform the shots and they only finish when scoring five consecutive times. The average duration of the exercise was 45 minutes. Throughout the exercise, a Zephyr Bioharness 3.0 is worn to continuously measure heart rate (variability) and accelerometer-based physical activity at 1 Hz. Video footage is used to label the putts as 'made' or 'missed' and add timestamps to these events. Unpaired t-testing of pre-shot heart rate (variability) was performed to identify differences between successful and failed putts.

RESULTS: Five out of seven athletes show significantly increased heart rate levels (on average +6.2 bpm) during their preparatory routine when the previous putt was a success. The heart rate levels did not change significantly when the previous putt was missed and they essentially start over again. The other two athletes did not show any changes in the heart rate levels, regardless of the putting results. Interestingly, these two athletes are labelled by the coaches as being the most 'stress-tolerant'. In the case that heart rate levels were elevated, the physical activity levels were not.

CONCLUSION: Our results show how heart rate monitoring in a specific golf context provides coaches with insights about the pre-shot mental load during putting. Additional data collection and analyses will be performed throughout February 2023 to June 2023.

Conventional Print Poster

CP-SH20 Mental health and psychological well-being

CAN ACUTE LIGHT-INTENSITY EXERCISE REDUCE NEGATIVE MEMORIES?

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INTRODUCTION: Remembering unnecessary negative information can lead to depression and anxiety disorders [1]. Recent evidence suggests that exercise modulates memory function. Moreover, our research suggests that acute high-

intensity exercise may reduce negative memories. However, high-intensity exercise is a heavy physical and mental burden, and it is associated with injury risk. Thus, it is necessary to demonstrate whether negative memories can be reduced by a lower exercise intensity, which can be performed by anyone without burden. Therefore, we focused on light-intensity exercise, which is less burdensome, to examine whether acute light-intensity exercise reduced negative memories.

METHODS: Twenty-eight healthy adults (14 men, 14 women; M age = 21.89 years, SD = 1.93 years) completed a 20-min intervention (rest and light-intensity exercise conditions). The rest condition required the participants to sit quietly for 20 min with their eyes open. The light-intensity exercise condition required the participants to perform 20 min of cycling with a 30-35% heart rate reserve. In the memory task performed two days after the intervention, participants were required to recall the images (neutral and negative) that had been presented before each intervention. We determined emotional memory assessment as the hit rate and sensitivity index (d') based on the signal detection theory. We performed 2 (conditions: rest, light-intensity exercise) × 2 (valences: neutral, negative) repeated measures ANOVA separately for men and women.

RESULTS: The results revealed a significant main effect of valence for men and women and a higher hit rate for negative than for neutral images [men: $F(1, 13) = 30.49$, $p < .001$; women: $F(1, 13) = 17.08$, $p = .001$]. However, there were no significant main effects of condition [men: $F(1, 13) < 0.01$, $p > .05$; women: $F(1, 13) = 0.45$, $p = .51$] or interactions between condition and valence [men: $F(1, 13) = 2.28$, $p = .15$; women: $F(1, 13) = 0.08$, $p = .78$] for men and women. Furthermore, d' revealed a significant main effect of valence for men and women, and a higher sensitivity for negative than for neutral images [men: $F(1, 13) = 22.03$, $p < .001$; women: $F(1, 13) = 8.49$, $p = .01$]; however, there were no significant main effects of condition [men: $F(1, 13) = 0.45$, $p = .51$; women: $F(1, 13) = 0.90$, $p = .36$] or interactions between condition and valence [men: $F(1, 13) = 0.26$, $p = .62$; women: $F(1, 13) = 1.63$, $p = .22$] for men and women.

CONCLUSION: These findings suggest that negative information is more likely to be remembered and discriminated than neutral information. However, negative memories may not be reduced by acute light-intensity exercise.

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IMPAIRED SLEEP QUALITY WAS RELATED TO MENTAL HEALTH DISORDER IN FEMALE LONG-DISTANCE RUNNERS

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Athletes have higher risk of sleep disturbances with impaired sleep quality than the general populations (Knufinke et al. 2018), even though sleep plays an important role in recovery (Vitale et al. 2009). It has also been reported that sleep deprivation is associated with facilitated negative mood status (Blumert et al. 2007) and iron deficiency (Neumann. et al. 2020). However, the relationship between sleep and psychological aspects or physiological indicators of iron status in female long-distance runners remains unclear.

PURPOSE: We evaluated the relationships between mental health and both sleep quality and serum ferritin level in female long-distance runners throughout a competition season.

METHODS: Seven-teen female college long-distance runners were evaluated serum ferritin level (an indicator of iron status). They also completed questionnaires related mental health and sleep 3 times (July, September and November) during 5 months. Mental health was evaluated using the Center for Epidemiological Studies Depression Scale (CES-D) and Depression, Anxiety and Stress Questionnaire (DASS-21). Sleep quality was evaluated by Pittsburgh Sleep Quality Index (PSQI). RESULTS: At all time points, PSQI scores were significantly correlated with CES-D scores ($P = 0.01$ in July, $P < 0.001$ in September, $P = 0.012$ in November), DASS anxiety scores ($P = 0.005$ in July, $P = 0.007$ in September, $P = 0.02$ in November) and DASS stress scores ($P = 0.003$ in July, $P = 0.002$ in September, $P = 0.006$ in November), indicating the relationships between lowered sleep quality and aggravated mental statuses. Serum ferritin levels significantly correlated with DASS anxiety scores ($P = 0.015$) and DASS stress scores ($P = 0.045$) in July, but the relation was not observed in September and November. Also, no significant relationship was found between PSQI scores and serum ferritin levels.

CONCLUSION: These findings suggest that impaired sleep quality is associated with the scores of depression, anxiety, and stress throughout a competition season in college female long-distance runners.

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THE EFFECT OF A SUPERVISED 9-WEEK EXERCISE PROGRAM ON SELF-REPORTED DEPRESSION, ANXIETY, AND STRESS IN COLLEGE STUDENTS

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INTRODUCTION: The prevalence of depression, anxiety, and stress in college students is on the rise [1], underscoring the need for more mental health services and resources on college campuses [2]. Research has shown that exercise can protect against depression, anxiety, and stress [3]. Accordingly, our objective was to determine whether a 9-week exercise program protects against depression, anxiety, and stress in college students.

METHODS: Fifteen participants ([EXS] 8 females, age = 25.0±11.0 years, VO2max = 31.5±8.0 mL·kg-1·min-1) attended nine weeks of supervised exercise classes three times per week for 50 minutes, while sixteen acted as control participants ([CON] 5 females, age = 22.4±6.0 years, VO2max = 35.6±9.4 mL·kg-1·min-1). We measured pre- and post-intervention depression, anxiety, and stress using the 21-item Depression, Anxiety, and Stress Scale (DASS-21 [4]). We conducted a one-way between groups ANCOVA to compare post-intervention DASS-21 scores with sex and pre-intervention DASS-21 scores set as covariates in the analysis.

RESULTS: After adjusting for sex and pre-intervention DASS-21 scores, we found that post-intervention depression (EXS: 5.1±5.8, CON: 5.4±4.3, p = 0.413), anxiety (EXS: 4.3±3.4, CON: 3.9±3.0, p = 0.836), and stress scores (EXS: 5.7±4.3, CON: 6.3±4.0, p = 0.641) did not significantly differ between EXS and CON.

CONCLUSION: Contrary to similar research [5], we found that a 9-week exercise program did not significantly affect college students' depression, anxiety, and stress scores. Future exercise-based, intervention studies might consider targeted adjustments to exercise program parameters (e.g., duration, type, intensity), incorporating larger samples, and finding ways to promote program adherence.

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DETERMINANTS OF RECOVERY BEHAVIOURS IN OLYMPIC SWIMMERS: A QUALITATIVE INVESTIGATION USING THE REASONED ACTION APPROACH

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Background

An adequate management of training and recovery allows swimmers to continuously achieve high performance and avoid illness and injuries. In the few weeks prior the Olympics Games, swimmers have a taper phase of training, during which recovery is one of the most important factors to reduce the cumulative training-induced fatigue and improve performance. Although swimmers' recovery behaviours have been recently described, the barriers and levers for their adoption have not been studied based on behaviour change theories. Using the reasoned action approach, we aimed to explore the sociocognitive determinants of swimmer's recovery behaviours.

Methods

Semi-structured interviews were conducted to explore the determinants of the adoption of recovery strategies. 14 French swimmers were interviewed among the 42 eligible swimmers who participated in the Summer Olympic Games in 2012, 2016, and/or 2021. The interviews were analysed using thematic analysis. The main themes and codes were first generated inductively and then mapped to the Reasoned Action Approach.

Results

Swimmers reported a daily use the bedrock of recovery (sleep, hydration, nutrition) and adopting various recovery routines. The number and variety of recovery techniques adopted were higher among swimmers who participated in Tokyo 2020. Despite negative attitudes (e.g. painful, unpleasant) reported towards the adoption of some recovery techniques, this does not prevent swimmers from considering that recovery is efficient and necessary to optimize subsequent training

or competition. The approval of swimmer's coaches was reported to be important and positively influencing the adoption of recovery strategies. Access to recovery equipment or resources was seen as both a barrier and an enabler as swimmers have access to a physiotherapist but had to adapt to their availability and get to their office. Swimmers describe that knowledge and perceived effectiveness of a recovery technique strongly influenced its adoption.

Discussion

Analysis of the semi-structured interviews provided insight into the specific determinants of swimmer's recovery behaviours. The present study could be of interest when designing theory and evidence-based behaviour change interventions to improve elite swimmers' adoption of recovery strategies. For example, targeted interventions for swimmers could include monitoring of swimmers recovery behaviours combined with feedbacks on performance self-efficacy or self-reported measures of perceptual recovery outcomes.

IMPACT OF PSYCHOLOGICAL PROCESSES ON MENTAL HEALTH SYMPTOMS IN COMPETITIVE ATHLETES: A CROSS-SECTIONAL STUDY BASED ON THE TRANSDIAGNOSTIC APPROACH

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Introduction: Mental health disorders can impair performance and lead to injuries [1]. Transdiagnostic psychological processes are associated with the development of mental disorders [2]. The transdiagnostic approach of mental health posits that motivational, emotional, cognitive, meta-cognitive, and behavioral processes are common to several mental health disorders. In the general population as well as in competitive sports, women tend to show higher prevalence of mental health disorders [1]. The aim of the this study was twofold: (a) to evaluate the association of transdiagnostic psychological processes with mental health disorders in adult athletes practicing their sport at a competition level, and (b) to explore gender differences in mental health symptoms and transdiagnostic psychological processes.

Methods: A total of 159 competitive adult athletes aged between 18 and 40 years old (44% female; mean: 24.2 ± 4.88 years old) participated in this cross-sectional study. Participants were invited to fill in psychometric questionnaires to evaluate mental health symptoms, motivation to practice their sport, emotional competences, self-efficacy, ruminations, meta-cognitive beliefs, and impulsive and perfectionist behaviors. Correlational tests were performed to evaluate the association between mental health symptoms and transdiagnostic psychological processes, and mean group comparison tests were used to explore gender differences.

Results: Mental health symptoms were significantly and positively correlated with extrinsic regulations of motivation, ruminations, meta-cognitive beliefs, and impulsive and perfectionist behaviors; and significantly negatively correlated with emotional competences and self-efficacy. Female athletes showed significantly higher scores of mental health symptoms, ruminations, meta-cognitive beliefs, and impulsive and perfectionist behaviors; and significantly lower scores of emotional competences and self-efficacy.

Discussion: The results of the present study showed that transdiagnostic psychological processes were associated with mental health symptoms; and that female competitive athletes were more likely than males to experience mental health symptoms in addition to lower emotional, cognitive, meta-cognitive and behavioral processes. These results are in line with previous findings in clinical psychology, and allow investigating the risk mental health issues through psychological processes (including some specific measures to the context of sport). Further investigations may focus on the identification of the most relevant processes to estimate a risk of mental health disorder in competitive athletes.

1. Reardon et al. (2019) 2. Philippot et al. (2019)

Keywords: Mental health, transdiagnostic psychological processes, gender difference, competitive sport

ASSESSING AFFECTIVE RESPONSES IN STRETCHING EXERCISES

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Introduction

Affective responses during exercise have been identified as a predictor of exercise adherence. However, research on core affect assessment has been mostly limited to aerobic and resistance exercises. Considering that stretching activities are also an important component in improving physical and psychological fitness, this quasi-experimental study was designed to 1) compare the affective responses during and immediately after stretching exercises in apparently healthy adults, and 2) verify the reliability and agreement of the affective responses assessment through a test-retest performed one week apart.

Methods

For that purpose, we applied and analyzed the Feeling Scale (FS) and Felt Arousal Scale (FAS) using Time (during and after stretching) x Intensity (light, moderate, and vigorous) x Stretched Muscle Group (quadriceps, hamstrings, glutes, latissimus dorsi, and triceps) with repeated measures analysis of variance (ANCOVA) in 34 participants (21 males; aged 32.8±8.6 years). Repeatability assessments of FS and FAS performed on different days were performed using a two-way mixed effects absolute agreement Intraclass Correlation Coefficients (ICC) and Bland-Altman plots.

Results

FS scores were higher following the stretching exercises, whereas FAS scores were lower, particularly in the vigorous intensity. The inter-day repeatability for FS and FAS measurements was generally good across muscle groups. ICC tended to be higher at vigorous intensities.

Discussion

An affective rebound effect could be verified in all stretched muscle groups and intensities but was particularly pronounced in stretches with vigorous intensity. This demonstrates the importance of the timing of core affect assessment in stretching activities, leaving suggestions that a measurement not conducted during the stretch could be reflecting the affective response of something other than the stretch itself. Regarding the test-retest results, the inter-day ICC at different intensities was, in general, moderate to good, with a tendency for higher reliability during vigorous-intensity stretching. Additionally, high variability in affective valence was identified between individuals, supporting an approach towards a more individualized intensity prescription of stretching exercises, in accordance with what the literature had previously indicated for aerobic and resistance training activities. Overall, the FS and the FAS applied during the execution of a static stretch represent a feasible and ecologically valid approach to measuring core affect. These results suggest that an adequate assessment of core affect in stretching activities should be performed during the exercise. Future studies should attempt to replicate these results with other types of stretches, with different muscle groups, and with more inexperienced participants.

COPING AND PAIN MANAGEMENT IN THE CONTEXT OF INJURY IN ELITE SPORTS

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Pain is an unpleasant experience combining sensorial, cognitive and affective dimensions (e.g., O'Reilly, 2011). It is a stressor with which athletes have to cope. The IOC has underlined the need to address acute and chronic pain management in elite athletes (EAs, Hainline, et al., 2018). Experts have searched literature and best practices seeking a consensus on guidance for clinical practice and athlete management. They have highlighted the need for better understanding of acute pain management, including post-injury pain management. Athletes are known to have higher pain tolerance than the general population (e.g., Tesarz et al., 2012), suggesting that they may have a specific coping mechanism for dealing with pain. According to the transactional model of stress (Lazarus & Folkman, 1987), coping has two main functions: problem-focused and emotion-focused coping. This study aims to: (a) formalise the coping strategies used by EAs when they are managing acute pain due to injury, and (b) compare the frequencies of these coping strategies.

Semi-structured interviews were conducted individually with 12 EAs to ascertain their coping strategies while managing acute pain following a sport injury. Data were processed using the comparative method (Corbin & Strauss, 1990) and the transactional model of stress (Lazarus & Folkman, 1987). The results showed 14 pain management strategies relating to problem- or emotion-focused coping. Problem-focused strategies referred to: (a) modulating activity; (b) seeking instrumental support; (c) goal setting; (d) self-encouragement; (e) taking painkillers; and (f) reframing the perception of pain. Emotion-focused strategies referred to: (a) diverting attention; (b) acceptance; (c) relativizing pain; (d) repeating negative thoughts; (e) ignoring pain; (f) seeking emotional support; (g) hoping and praying; and (h) self-blame. The results highlighted that EAs reported greater use of problem-focussed (59% of occurrences of all strategies) than emotion-focussed strategies (41% of all strategies). EAs were shown to favour three strategies (49% of all strategies). Women and men reported problem-focussed and emotion-focussed coping strategies to a similar extent but the breakdown of emotion-focused coping strategies differed. Women more frequently reported strategies associated with "seeking emotional support" and "diverting attention" than men.

The results reinforce the transactional model of coping (Lazarus & Folkman, 1987). The variety of coping strategies suggests flexibility in coping with acute pain. The results highlight the multifaceted nature of pain management, going beyond the strategies elicited for coping with chronic pain in the general population (Rosenstiel & Keefe, 1983). This study demonstrates that exploring pain management strategies provides useful insights into ways to improve our understanding of pain management and clinical practice for athlete pain management.

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ANALYSIS OF COMBINATORY EFFECTS OF SYSTEMATIC STRENGTH TRAINING WITH FREE WEIGHTS AND PROTEIN SUPPLEMENTATION ON STRENGTH GAIN AND BODY COMPOSITION IN POSTMENOPAUSAL WOMEN - A 12-WEEK RANDOMISED CONTR

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INTRODUCTION: Menopause has a massive impact on the endocrine system of middle-aged women resulting in a loss of bone and muscle mass. Systematic strength training is an effective method to maintain or increase skeletal muscle mass. However, data on the effectiveness of strength training in postmenopausal women is limited. Preliminary data suggests that intensity and volume, plays a crucial role in this population. With respect to this the training recommendations of the World Health Organisation are not sufficient. To analysis which intensity and volume is suitable and whether the training result is affected by protein supplementation a four-arm randomised intervention study was conducted over 12 weeks.

METHODS: A total of 58 healthy postmenopausal women with no specific strength training experience (age: 58.2±5.6years, weight 69.1±9.6kg, height 166.5±6.5cm) successfully participated in the study. The initial examinations included hormone analyses (saliva samples), measurement of body composition (fat-free mass (FFM), skeletal muscle mass (SMM), fat mass (FM), as well as static grip strength and dynamic maximum strength in the squat and deadlift. After, the women were randomly assigned to either group A "training+protein (2.5g/kg FFM)", group B "only training"; group C "only protein (2.5g/kg FFM) or group D "control". Group A and B performed systematic strength training for the following 12 weeks with three training sessions and five exercises each. Groups C and D were prohibited from systematic training during the period. For statistical evaluation, all parameters were checked for normal distribution. Finally, FFM, FM and SMM had to be log-transformed. Then a 2x4 ANOVA was used with all parameters. In addition, the effect size of the changes (time*group) was calculated.

RESULTS: A time ($p<.005$) and a time*group ($p<.05$) difference was observed between groups A and B to control grip strength, deadlift and squat. Group A increased their grip strength by +4.7±2.4kg ($p<.001$; d:1.61), in the deadlift by +20.8±10.3kg ($p<.001$; d:1.59) and in the squat by +30.0±14.2kg ($p<.001$; d:1.63). Group B (training only) showed similar increases and improved in grip strength by +3.6±3.0kg ($p<.001$; d:1.41), in deadlift by +22.1±7.6kg ($p<.001$; 1.76) and in the squat by +32.5±12.0kg ($p<.001$; d:1.77). The protein group also showed a significant increase in the squat (+6.4±6.4kg; p:015; d:0.97). In body composition, a significant increase could only be observed in group A (+1.3±1.6kg; p:0.24; d:0.89) and a trend in group B (+1.3±2.6kg; p:.087; d:0.70). For SMM, a significant increase was observed in both training groups. Group A improved their SMM by +1.4±0.9kg ($p<.001$; d:1.38) and group B by 1.2±1.3kg (p:.004; d:1.09). In FM, both training groups also showed a significant reduction. Group A reduced their FM by -1.5±2.0kg (p:.019; d:0.75) and group B by -2.4±2.9kg ($p<.001$; d:0.93).

CONCLUSION: In conclusion, it was clearly shown that intensive strength training with free weights can promote both strength capacity and body composition in postmenopausal women and can be a preventive strategy against muscle atrophy. In addition, the effects show slight tendencies for additional protein intake to have an additive effect on muscle growth. However, in reducing FM, this can be inhibitory if consumed over-calorically.

DOES DIFFERENT-INTENSITY EXERCISE AFFECT THE REST-ACTIVITY RHYTHMS AMONG OLDER ADULTS?

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INTRODUCTION: Sleep disturbances and poor rest-activity rhythms are common in older adults and might reduce the quality of life. Exercise interventions at night (e.g., close to or long before bedtime, scheduled or freely) might be a crucial factor affecting sleep quality and rhythms. However, previous studies show the inconsistency in discouraging evening exercise and abstaining for 3-4 hours before bedtime to prevent sleep disturbance, or evening exercises do not disrupt subsequent sleep and even improve subsequent sleep. Thereby, whether exercise affects circadian rhythms remains unknown, especially for exercise in different intensities. This study aims to explore the effect of exercise in the evening on rest-activity rhythms and sleep quality among older adults.

METHODS: This randomized controlled trial investigates the effects of a home-based aerobic exercise intervention with different intensities for 12 weeks in the evening on 54 older adults (71.8 ± 3.9 years; female = 46; BMI: 22.6 ± 3.3 kg/m²) with lower sleep quality (PSQI ≧ 6 pt). Participants were recruited from the local community in Tsukuba, Japan, and randomly allocated to a low-intensity exercise group (LG, 60-70 steps per minute), a moderate-intensity exercise group (MG, 110-120 steps per minute), or a control group (CG). Each intensity exercise group was performed for 30-min daily at home in the evening (between 18:00 to bedtime). Outcomes included: nonparametric approach actigraphy data of 24/7 (inter-daily stability, IS; intra-daily variability, IV; relative amplitude, RA; nocturnal activity, L5; daily activity, M10; L5 and M10 start times; the midpoint of L5 and M10 start times); actigraphy sleep variables, and self-reported sleep diary. Outcomes were assessed at baseline (pre), after 6 weeks (middle), and after 12 weeks (post) during the intervention.

RESULTS: For rest-activity rhythm results, there were no significant differences in the IS, IV, RA, L5, and M10. The MG showed a delay in L5 start time (23.8, 24.2, and 24.4 hours; P for trends = 0.002), and the midpoint of L5 and M10 start times (4.0, 4.4, and 4.6 hours; P for trends = 0.004) during the intervention. However, the LG and CG did not change during the intervention. For objective sleep results from actigraphy, the MG showed an increasing number of awakenings (P interaction = 0.035) in the post compared to the pre ($P < 0.05$). No significant changes were found in waketime but in shorter total sleep time (P interaction = 0.013) for both the LG and MG in the middle and post (all Ps < 0.05). For subject sleep results, no significant changes were found in PSQI and diary, including self-report quality for all groups.

CONCLUSION: Moderate-intensity exercise in the evening leads to delayed rest-activity rhythms among older adults with lower sleep quality and no subjective sleep quality decline. Thus, it is necessary to consider the timing and intensity of exercise when suggesting exercise therapy (i.e., combination with CBT-I) to older adults with sleep disorders.

ISOMETRIC TRAINING IMPAIRS CARDIAC SYMPATHOVAGAL BALANCE DESPITE ITS HYPOTENSIVE EFFECTS IN MIDDLE-AGE AND OLDER ADULTS

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INTRODUCTION: Isometric exercise training is a powerful non-pharmacological method to reduce resting blood pressure (BP); however, the mechanism of the hypotensive effect remains unclear. Although the shift in sympathovagal balance toward parasympathetic activity dominance is a potential factor that mediates the hypotensive effects, controversial results have been reported [1, 2]. The present study aimed to determine the effects of isometric exercise training on heart rate variability (HRV). It was hypothesized that isometric exercise training could augment parasympathetic nervous dominance in the resting position by lowering resting BP.

METHODS: Fourteen middle-age and older adults (mean [±SD] age, 68.5±8.8 years; male/female, n=6/8) were randomly assigned to a control (CON [n=6]) or isometric handgrip training (IHT [n=8]) group for 8 weeks. IHT involved 4 sets of 2 min isometric contraction consisting of 30% maximal isometric voluntary contraction using alternate hands, 3 times per week. BP and HRV were assessed with the subjects positioned supine before and after the intervention. HRV measurements included time domains (SDNN, RMSSD, pNN50, cardiac sympathetic index, cardiac vagal index) and frequency domains (ln LF, ln HF, normalized LF, normalized HF, and ln LF/HF ratio). Changes in BP and HRV following the intervention were compared between the CON and IHT groups using the Mann–Whitney U-test.

RESULTS: Mean BP was significantly reduced in the IHT group compared with the CON group (median difference, -8.4 mmHg; p=0.02). Changes in HRV were statistically significant in normalized LF (p=0.01), normalized HF (p=0.01), and ln LF/HF ratio (p=0.04) between the CON and IHT groups. Surprisingly, these changes in HRV indicated that isometric exercise training increased sympathetic and lowered parasympathetic nervous activity.

CONCLUSION: Contrary to the initial hypothesis, isometric exercise training induced a shift in sympathovagal balance toward sympathetic activity dominance despite its hypotensive effects. These data may implicate cardiac autonomic nervous system-independent mechanisms in contributing to lowering resting BP after isometric exercise training.

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EFFECTS OF 8 WEEKS OF MULTICOMPONENT TRAINING ON FUNCTIONAL CAPACITY AND LIPIDIC AND HEMODYNAMIC PROFILE OF ACTIVE PRE-HYPERTENSIVE OLDER WOMEN AFTER THREE-MONTHS OF DETRAINING

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INTRODUCTION: Cardiovascular diseases have huge impact on the health and quality of life of older women. Exercise is a non-pharmacological method to prevent this type of diseases whether it is applied in the form of strength training, aerobic training or multicomponent training. Following some periods of exercise older women with pre-hypertension interrupt their training, which can range from less than one month to three months or more, depending on several factors such injuries or vacations. After detraining (DT) some older women return to practice. This retraining period can promote a faster return to the initial status before detraining, depending on the duration of this period. Our main goal was to evaluate the effects of eight weeks of multicomponent training in lipidic and hemodynamic profile and in functional capacity after three months of detraining in pre-hypertensive older women with the practice of nine months of multicomponent exercise before detraining.

METHODS: Nineteen pre-hypertensive older women (EG: n = 19, 67.4 ± 3.4 years) performed a nine-month multicomponent exercise program, followed by a three-month detraining period and an 8-week retraining period. Fifteen pre-hypertensive older women (CG: n = 15, 69.1 ± 2.1 years) maintained their daily routine. Functional capacity (FC) (Functional Fitness Battery Test), Total Cholesterol (TC), triglycerides (TG), blood pressure (BP) and resting heart rate (HRrest) were assessed before and after each training period.

RESULTS: After the first period of multicomponent training FC, TC, TG, HRrest and systolic blood pressure (SBP) improved ($p<0.05$). DT promoted declines in all variables compared to the end of training but when compared to baseline values only diastolic blood pressure (DBP) returned to the initial state ($p<0.05$). The retraining period improved BP and FC when compared to the end of DT (SBP: -8.7%; DBP: -5.1%; 30-second chair stand: 12.8%; 6-minute walk test: 16.5%; $p<0.05$) and end of the first training period (SBP: -5.2%; DBP: -3.6%; 30-second chair stand: 8.3%; 6-minute walk test: 11.5%; $p<0.05$). TC, TG and HRrest when compared to the end of DT also improved ($p<0.05$).

CONCLUSION: Eight weeks of retraining are enough to reverse the negative effects of DT in the lipidic and hemodynamic profile and FC. Moreover, it promoted greater benefits than the first training period which may mean that the benefits are quickly recovered with the return of exercise and that regular practice promotes quality of life and health in pre-hypertensive older women.

MINI-TRAMPOLINE AEROBIC TRAINING IMPROVES PULSE WAVE REFLECTION IN POSTMENOPAUSAL WOMEN

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INTRODUCTION: Arterial stiffness, an independent predictor of cardiovascular disease, drastically increases after menopause. Regular physical activity is an effective behavioral strategy to ameliorate arterial stiffness. Mini-trampoline exercise is known to improve cardiopulmonary and bone health. However, there is a lack of studies investigating the effects of mini-trampoline exercise on arterial stiffness in postmenopausal women. Therefore, the purpose of this study was to demonstrate the effects of mini-trampoline aerobic training on augmentation index (AIx) reflecting pulse wave reflection and pulse wave velocity (PWV) in postmenopausal women.

METHODS: Ten postmenopausal women (54±1 yrs) participated in this study and supervised mini-trampoline training was conducted for 40 minutes per day, 3 days per week for 10 weeks at a local community health promotion center.

The training intensity was set at 60% or more of the age-predicted maximum heart rate and participants' heart rate during training was monitored in real time using Polar heart rate monitors and Polar Team app. To evaluate arterial stiffness, AIx and carotid-femoral PWV were measured by SphygmoCor Xcel System.

RESULTS: AIx was significantly decreased after 10 weeks of mini-trampoline aerobic training (35±2.7 to 26±2.3%, P=0.002). However, there was no significant change in carotid-femoral PWV after the training (P=0.191).

CONCLUSION: To conclude, mini-trampoline aerobic training is an effective behavioral intervention to enhance pulse wave reflection, a measure of arterial stiffness, in postmenopausal women.

EFFECTS OF A 12 WEEK ONLINE PILATES BASED EXERCISE PROGRAM ON BALANCE AND CORE STRENGTH AND STABILITY IN OLDER ADULTS

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INTRODUCTION: Aging is accompanied by a series of physiological alterations that lead to physical and cognitive decline, with multifactorial causes, but mainly due to loss of bone and muscle mass and dysfunctions of the neuromuscular system. Some studies have been carried out to evaluate the effects of the Pilates Method for delaying or minimizing these losses in the older population. This experimental study aimed to evaluate the effects of an online program of Mat Pilates exercises on strength and stability of the trunk muscles to minimize the natural decline in the balance in an older population.

METHODS: Twenty-four participants with a mean age of 76.4 (±5.8) were recruited to an online Pilates program, divided into two groups: fourteen participants in the intervention group and ten in the control group.

The intervention, which included exercises of the Pilates Method lasted 20 weeks, with 2 weekly sessions of 60 minutes of moderate intensity. Strength was assessed using the 1 minute sit-up test, trunk stability with the Core Muscle Strength & Stability test, for static balance we've used the single leg stance, and dynamic balance was measured with the timed up and Go (TUG) and TUG with congitive task.

RESULTS: Despite the initial dificulties, the elderly were able to use correctly the online tool to acess the class. At the end of the 40 sessions, the Pilates group demonstrated significant improvements in static ($p=0.001$) and dynamic balance with a cognitive task TUG-C (0.010) compared to the Control Group. The Pilates group also showed significant improvements in strength ($p= 0.003$) and trunk stability ($p=0.014$) between baseline and the end of the intervention.

CONCLUSION: The results demonstrated that online Mat Pilates can be used as an alternative training method for older adults, as it seems to promote positive effects on trunk strength and stability and, possibly, on cognitive function.

RELATIONSHIP BETWEEN SERUM IRISIN LEVELS, MARKERS OF SARCOPENIA, AND FATIGABILITY IN MEDICALLY STABLE OLDER FEMALES

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INTRODUCTION: Sarcopenia often leads to reduced functional performance (1) and the development of disability, with women often having a worse prognosis (2). Detecting early changes related to muscle loss before frank sarcopenia occurs is crucial, as the adverse effects can be reversed through increased physical activity (3). This cross-sectional study evaluated and explored associations between serum irisin levels, fatigability and sarcopenia-related parameters, including the novel ultrasound sarcopenic index (USI) in medically stable older females.

METHODS: Thirty medically stable older females (mean age 70.0 ± 3.8) participated in this cross-sectional study. Serum irisin concentration was measured by the enzyme-linked immunosorbent assay. Body composition - skeletal muscle mass (SMM) was measured by bioelectrical impedance (BIA) (InBody 720, Biospace Co., Ltd., Seoul, Korea). Lower body isometric strength and fatiguability by dynamometry (Humac NORM, CSMi, Stoughton, MA). USI was calculated using muscle architecture measured on the right vastus lateralis at 65% distal length (4) by ultrasound (Mindray M5). Functional capacity was tested by gait speed and chair stand test.

RESULTS: Statistically significant negative correlations were found between serum irisin level and age ($r = -0.513$, $p < 0.01$), fatigability index and age ($r = -0.370$, $p < 0.05$), and USI and fatigability index ($r = -0.571$, $p < 0.01$). A positive correlation was found between irisin and the fatigability index ($r = 0.40$, $p < 0.05$). No correlations were found for SMM, lower body strength, gait speed and chair stand test.

CONCLUSION: This cross-sectional study indicates that serum irisin levels are negatively associated with age and positively with fatigability. Moreover, the fatigability index is negatively associated with USI, which together might be used as novel non-invasive biomarkers of muscle function in older age regardless of sarcopenia diagnosis and, as such, might allow for early intervention.

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ESTIMATE FOR POSSIBLE SARCOPENIA USING SEVERAL GRIP STRENGTHS AMONG COMMUNITY-DWELLING OLDER PEOPLE IN JAPAN

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INTRODUCTION: Grip strength is widely known as the diagnostic measure of sarcopenia. Recently grip strength asymmetry has been the focus for predicting future functional limitations (Parker et al., 2021). Although maximal strength with the dominant hand is commonly used for such estimations, strength with the non-dominant hand may also provide meaningful information in later life. The Asian Working Group of Sarcopenia (AWGS2019) sets the definition of grip strength for possible sarcopenia, which can be interchanged with the chair stand test. However, previous studies reported that the agreement between the measurements was inconsistent. The accuracy of the indicators has still to be investigated. The purpose of the present study was to estimate properties in several indexes of grip strength along with possible sarcopenia diagnosis among community-dwelling older people in Japan.

METHODS: The subjects were 39 men and 45 women aged 60 years and over, who were randomly selected and who had completed measurements for identifying possible sarcopenia using AWGS2019 in the health checkup in 2017. Measurements included body size, grip strength, sit-and-reach, functional reach, chair stand in 30 sec (CS-30) and maximum walking speed. Individual attributes, health conditions and lifestyle were also checked using a questionnaire. Grip strength was estimated in 3 indices including average grip strength in both hands, maximum grip strength for the stronger hand, and that for the weaker hand using AWGS2019 definition. Grip strength asymmetry was calculated as grip strength for the stronger hand/that for the weaker hand ratio, and >10% was evaluated as asymmetry. The definition of chair stand using CS-30 was referenced in a previous study (Sawada et al., 2021). Cohen's coefficient of agreement in definitions between grip strength and CS-30 were calculated.

RESULTS: The prevalence of possible sarcopenia was 5 (6.0%) in average, 1 (1.2%) in the stronger hand, 7 (8.3%) in the weaker hand grip strength, and 7 (8.3%) in CS-30. Cohen's coefficient of agreement with CS-30 was 0.46 on average, 0.23 in the stronger hand, 0.69 in the weaker hand grip strength. The average asymmetry ratio was 1.23±0.20. The participants with asymmetry were 13 (33.3%) in men and 19 (42.2%) in women, and there was no significant difference between

men and women (Chi-square test, p=0.40). Possible sarcopenia estimated by the weaker hand grip strength was significantly more in the participants with asymmetry than those without (Fisher exact test, p=0.01).

CONCLUSION: The estimation by grip strength in the weaker hand had the highest agreement with CS-30 in possible sarcopenia definition. Our results suggest that estimating grip strength in each hand may provide more information about sarcopenia among community-dwelling older people.

ALTERATIONS IN PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOURS MODERATE THE RELATIONSHIP BETWEEN DISEASE SEVERITY AND PHYSICAL FUNCTION IN RHEUMATOID ARTHRITIS

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INTRODUCTION: Rheumatoid Arthritis (RA) is a common autoimmune disease characterised by chronic systematic inflammation. RA is associated with a number of complications including an increase in cardiovascular disease (CVD) risk and a decline in physical function. Sedentary behaviour (SB) and physical activity may moderate the relationship between disease activity and severity, with physical function and CVD risk. Therefore, the aim of this study was to investigate the moderating role of SB and physical activity on the relationship between RA disease activity and severity, with CVD risk and physical function.

METHODS: People living with RA (n = 101) provided a fasted blood sample and underwent assessments of physical function. The Disease Activity Score 28-C-reactive protein (DAS28-CRP) was used to determine RA disease activity, and the Stanford Health Assessment Questionnaire (HAQ) was used to assess disease severity. Participants wore an Actigraph GT3X+ accelerometer on their right hip, and an ActivPAL on their right thigh for 7-days to assess physical activity and SB, respectively. Accelerometer data were analysed using the R package GGIR (version 2.0) to determine the M10 metric (i.e., acceleration/intensity above which a person's most active 10mins are accumulated). ActivPAL data were analysed using PAL analysis (PAL Technologies Ltd), to determine hours per day spent sedentary. CVD risk was determined by QRISK3, and 20m gait speed was used to assess physical function. Regression analyses examined associations between disease activity and severity with movement behaviours, and CVD risk and 20m gait speed. Moderation analyses were then conducted using Hayes Process Macro in SPSS.

RESULTS: Both disease activity and severity were significantly, negatively associated with M10 (DAS28-CRP, β = -.40; HAQ, β = -.32) and significantly positively associated with SB (DAS28-CRP, β = .27; HAQ, β = .23). No significant associations were identified between disease activity and severity scores with CVD outcomes. However, both disease activity and severity were significantly, positively associated with 20m gait speed (DAS28-CRP, β = .37; HAQ, β = .47). Moderation analysis revealed that a higher HAQ score was related to a slower 20m gait speed in patients engaging in ≥ 8 hours of SB, compared to < 8 hours of SB (unstandardised β = 4.1, P = 0.03). In addition, a higher HAQ score was associated with a lower 20m gait speed in patients with an M10 score ≥ 75mg (i.e., accumulation of 10-minutes of activity at an intensity similar to a slow walk), compared to < 75mg (i.e., did not accumulate 10-minutes of activity at an intensity similar to a slow walk) (unstandardised β = -5.4, P = 0.003).

CONCLUSION: Higher RA disease activity and severity are associated with lower M10 intensity and higher SB. Variability in these movement behaviours moderates the influence of disease severity on physical function.

EFFECTS OF NORWEGIAN HIIT AND CAFFEINE INTAKE ON COGNITIVE FUNCTION

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INTRODUCTION: High-intensity interval training (HIIT) or caffeine intake is reported to improve cognitive function. However, the effects of a combination of HIIT and caffeine intake on cognitive function are still unknown. The purpose of this study was to test our hypothesis that HIIT and caffeine intake would have a synergistic effect on cognitive function improvement.

METHODS: Eleven healthy adults (age: 21±1 years old, male/female: 8/3, height: 170.9±7.8 cm, weight: 63.0±12.4 kg) were recruited. The study was a double-blind, randomized, crossover design. The experiment consisted of three days. On the first day, maximal heart rate was measured by cardiopulmonary exercise testing and cognitive function tests were practiced. On the second and third days, a Norwegian HIIT was performed on a bicycle ergometer, which is a total of four sets of high-intensity exercise (90% of maximal heart rate for 4 min) and low-intensity exercise (30% of maximal heart rate for 3 min) with caffeine intake of 300mg or placebo. The cognitive function included a Stroop test (executive function) and reversal recitation of five-digit numbers (working memory). Emotional tests were performed with the Profile of Mood States 2nd Edition (POMS2). The autonomic activity was evaluated by HR variabilities using spectral analysis. These parameters were collected before and after HIIT. Two-way repeated ANOVA was used to analyze the effects of HIIT and caffeine intake on cognitive function, autonomic activity, and emotion.

RESULTS: Response time of the Stroop test shortened after HIIT ($p<0.05$) with a trend on the interaction between HIIT and caffeine intake (p=0.07). The number of wrong answers on the Stroop test was not affected by HIIT or caffeine intake. The duration to perform the five-digit number reversal shortened after HIIT ($p<0.05$), while it was not affected by caffeine intake (p=0.75). The total POMS2 score was not affected by either HIIT or caffeine intake. Among the items of POMS2, one item,

"Friendliness", showed an interaction effect between HIIT and caffeine intake ($p<0.05$). The high-frequency power of HR variability (index for ventral vagal activity) tended to be increased by caffeine intake ($p=0.085$) while it was not affected by HIIT. The ratio of low to high-frequency power of HR variability (index for sympathetic activity) tended to be increased by HIIT ($p=0.052$), while it was not affected by caffeine intake ($p=0.44$).

CONCLUSION: The combination of HIIT and caffeine intake may have synergistic effects on executive function. In addition, sympathetic domination was enhanced by HIIT, while ventral vagal activation was induced by caffeine intake in the present study, while friendliness emotion is affected by a combination of HIIT and caffeine intake. These changes in autonomic activity and emotion may be underlying mechanisms of acute changes in executive function.

Conventional Print Poster

CP-MH25 Health and Fitness IV

DATA INFORMING GOVERNING BODY RESISTANCE TRAINING GUIDELINES EXHIBIT SEX BIAS: AN AUDIT BASED REVIEW

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INTRODUCTION: The objective of this review was to examine the ratio of female and male participants utilised in data informing consensus statements and position stands in the field of resistance training (RT). A second objective of this study was to examine the gender of the authors of these position statements.

METHODS: We conducted an 'Audit' style review. We accessed three databases: SPORTDiscus, MEDLINE, and Google Scholar utilising the following search terms: resistance or strength training AND consensus statements or position statements/stands. Eligibility criteria included consensus statements and position stands for RT in youth, adults, and older adults from the year 2000 onwards. Reference lists from each guideline were screened with the number of male and female participants extracted from each study. For each consensus statement we also attempted to identify the proportion of male and female authors.

RESULTS: We located eleven guidelines encompassing a total of 104,251,363 participants. Youth guidelines were comprised of 69% male participants. There were 287 studies that included both sexes, 205 male-only and 92 female-only studies. Adult guidelines were comprised of 70% male participants. There were 104 studies that included both sexes, 240 male-only and 44 female-only studies. Older adult guidelines were comprised of 54% female participants. There were 395 studies that included both sexes, 112 male-only and 83 female-only studies. There were 121 authors across these 11 statements, with 103 male (85%) and 16 female (13%) authors. One out of 11 first authors (9%) were female and 3 last authors were female (27%). Three out of 11 papers had zero female authors.

CONCLUSION: These results demonstrate an under-representation of females in data informing youth and adult RT guidelines. In comparison, we observed a similar representation of male and female data informing older adult guidelines. We also observed a large underrepresentation of female authors and females in senior authorship positions across these statements. It is imperative to ensure that data informing governing body guidelines and consensus statements are representative of the population that they aim to inform. If this is not possible, guidelines should clearly state when their data and recommendations are based primarily upon one sex.

HEALTH STATUS ASSESSMENT OF INDUSTRIAL WORKERS IN A MID-SIZE COMPANY: A NOVEL APPROACH IN WORKPLACE HEALTH PROMOTION

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INTRODUCTION: Workplace health promotion is becoming essential to prevent absenteeism and negative economic impacts on manufacturers. Previous studies have focused on preventing of workplace accidents, predictable workloads, and hazardous working conditions (e.g., extreme heat or noise). However, potential health risks for industrial workers should be detected by appropriate screening procedures. This cross-sectional study examines whether different conditions influence the health status.

METHODS: A survey was used to assess the workplace characteristics of n = 373 workers in a mid-size metal-working company, thereof n = 64 (41.1 ± 11.6 years, BMI: 28.0 ± 4.1 kg/m²) operating in a forging (GF), n = 240 (40.5 ± 10.9 years, BMI:26.7 ± 4.5 kg/m²) in manufacturing (GM) and n = 69 (41.3 ± 10.9 years, BMI:26.9 ± 5.4 kg/m²) in a packaging environment (GP). The location of orthopedic complaints (neck, upper back, right/left shoulder, right/left elbow, right/left wrist, right/left hand, lower back, hip, right/left knee, foot) was documented based on the German Pain Questionnaire. Pain intensity, physical and psychological load were assessed using a visual analog scale (VAS: 0-100). The Global Physical Activity Questionnaire (GPAQ) and the Short Form Health Survey-36 (SF-36) were recorded to determine physical activity and physical and psychological domains.

Fishers exact test was applied to analyze the possible difference in the proportion of workers in the three environments reporting no pain and pain. The effect of the group on pain intensity was analyzed via a one-way ANOVA with post hoc Bonferroni correction.

RESULTS: Overall, 282 workers (75.6%) reported at least one orthopedic issue located in the neck n = 59 (15.8%), upper back n = 74 (19.8%), lower back n = 176 (47.1%), right shoulder n = 54 (14.5%), left shoulder n = 39 (10.5%), right elbow n = 30 (8.0%), left elbow n = 3 (.8%), right wrist n = 47 (12.6%), left wrist n = 33 (8.8%), right hand n = 6 (1.6%), left hand n = 4 (1.1%), hip n = 8 (2.1%), right knee n = 40 (10.7%), left knee n = 32 (8.6%) and foot n = 18 (4.8%). Fisher`s Exact Test revealed a statistically significant difference in the environments for the right elbow ($p < .01$). For the parameter pain-intensity (VAS), only the left shoulder showed a statistically significant effect ($F(2, 36) = 3.90$, $p = .029$, $\eta p^2 = .18$). Post hoc tests revealed a difference ($p = .046$) between GM (n = 22, 42.6 ± 24.8 au) and GP (n = 10, 68.9 ± 2.6 au). Other pain locations and intensities as well as GPAQ, SF-36, physical and psychological load showed no significant group effects.

CONCLUSION: There were no discrepancies or variations in the health status of the workers in the three industrial environments. Therefore, as no group differences were found, successful preventive and rehabilitative programs should focus on individual criteria (e.g., different workstations and working schedules).

PREVALENCE OF MARKERS ASSOCIATED WITH RED-S IN ELITE-LEVEL FEMALE FOOTBALL PLAYERS

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INTRODUCTION: Relative Energy Deficiency in Sports (RED-S) is a syndrome which describes impairments of several bodily systems, which main etiology is low energy availability. RED-S may have severe consequences for both performance and health, and different markers are often used to assess the occurrence and severity of the phenomenon. Despite increasing awareness of the syndrome, few studies investigating direct measures of RED-S have been done in female football players. Therefore, the aim of this study was to investigate the prevalence of symptoms associated with RED-S in elite-level female football players

METHODS: 60 players (age 22.5 ± 3.7, height 169 ± 6.0 cm, weight 64.1 ± 6.3 kg, BMI 22.4 ± 1.7) from three different teams in the Norwegian premier (n =2) and first (n =1) division were included in the study. The clinical findings were scored dichotomous as positive (1 point) or negative (0 points) using cut off values from the literature, and point prevalence for each condition was also calculated (point prevalence = (number of cases)/(population size for assessment)) . The Criteria's included amenorrhea, RMR < 30.kcal FFM.kg-day, ≥ 4 on the EDE-Q 11, Thyroid stimulating hormone (TSH(, free triiodothyronine (ft3), Low density lipids (LDL), ferritin, time loss caused by sickness using the Oslo sport trauma research center questionnaire, bone mass density and previous history of stress fracture, giving a maximum score of 13.

RESULTS: Preliminary results show that the cumulative percentage distribution of RED-S points was 30% (0 points), 33% (1 point), 17% (2 points), 17% (3 points) and 3% (4 points), respectively. For the individual RED-S markers, the prevalence was generally low ranging between 0 and 22 %. However, the prevalence of RMR < 30. kcal FFM.kg-day was 42%. There was a significant difference in RED-S points between individuals with low and normal energy availability (EA) calculated by RMR ($P < 0.001$) with a mean score of 2.0 ± 1.0 and 0.8 ± 0.9, respectively.

CONCLUSION: The prevalence of symptoms described by the RED-S model were present in this cohort. Nevertheless, few players had high rates of accumulated RED-S points, supporting the notion that female football players may not be predisposed to development of RED-S, given the characteristics of the game. Further, the usage of RMR as a surrogate marker of LEA should be further explored, as it provides promising results.

TESTING AND EVALUATION OF AN ADAPTATION OF THE RAPID UPPER LIMB ASSESSMENT (RULA) BY A KINEMATIC ANALYSIS FOR OCCUPATIONAL HEALTH PRACTICE - AN EXEMPLARY APPLICATION IN THE FIELD OF DENTISTRY

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INTRODUCTION: The Rapid Upper Limb Assessment (RULA) is used for the risk assessment of workplace-related activities. So far, the paper and pen method (RULA-PP) has been predominantly used for this purpose. In the present study, this method was compared with the MVN motion capture system (IMU) from Xsens (RULA-IMU). The aim of this study was, on the one hand, to work out the differences between these two measurement methods and, on the other to make recommendations for the future use

of the respective method on the basis of the available findings.

METHODS: For this purpose, 130 subjects from the dental profession were each photographed several times in pairs in lifelike working positions and simultaneously recorded with the IMU system. In order to compare both methods statistically, the weighted Cohens Kappa and the agreement chart (mosaic plot) were applied.

RESULTS: There were differences in the risk assessments in the Arm and Wrist Analysis A; assessment by RULA-PP (score of 3) was 1 point lower than with RULA-IMU (score of 4). The median of both overall risk assessment scores was 6, although RULA-IMU determined the assessment score to be more differentiated overall and was much more often 7 than when using RULA-PP. These results demonstrate a difference between the two measurement methods.

CONCLUSION: The new findings provide a form of key, especially for the evaluation of static movements, to be able to compare newly collected data by means of RULA-IMU with existing ergonomic data collected by means of RULA-PP. In

addition, the use of RULA-IMU can be recommended especially for assessing continuous motion sequences or motion sequences that are difficult for an observer to see, whereas RULA-PP appears to be sufficient for a general statement or initial findings as this method is less complex.

A 10-WEEK TRAMPOLINE EXERCISE PROGRAM ENHANCES CAROTID ARTERY COMPLIANCE IN POSTMENOPAUSAL WOMEN

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INTRODUCTION: With advancing age, postmenopausal women have a dramatically increased risk of cardiovascular disease. Carotid artery stiffness measures, including arterial compliance, distensibility, and stiffness, are non-invasive clinical indicators that can predict risk factors for atherosclerosis and cardiovascular disease. Regular aerobic exercise is recommended to maintain and promote cardiovascular health. Trampoline exercise is an effective aerobic exercise that consumes a lot of calories per unit time, improves balance and cardiorespiratory fitness, and strengthens the musculoskeletal system. However, research studies investigating the effect of trampoline exercise on carotid artery stiffness in postmenopausal women are difficult to find. Therefore, the purpose of this study was to evaluate the effect of 10 weeks of trampoline exercise on carotid artery stiffness in postmenopausal women.

METHODS: Ten postmenopausal women (47-61 years) voluntarily participated in this mini-trampoline exercise intervention study. Exercise intensity was set to moderate-high intensity corresponding to 65% or more of the age-predicted maximum heart rate. Participants performed mini-trampoline exercise with music for 40 minutes a day, 3 day a week, for a total of 10 weeks at a local public health center. To assess carotid artery stiffness, carotid artery compliance, distensibility, and stiffness index were measured and analyzed using an Aloka Prosound α7 ultrasound system and the FDA-approved Cardiovascular Suite software.

RESULTS: Ten weeks of trampoline exercise significantly improved carotid artery compliance in postmenopausal women (P=0.049). Although statistical significance was not obtained, distensibility (P=0.062) and stiffness index (P=0.052) also showed a strong tendency to improve after 10 weeks of trampoline exercise in postmenopausal women.

CONCLUSION: In conclusion, trampoline aerobic training is an effective behavioral intervention that can improve carotid artery compliance in postmenopausal women.

EFFECTS OF STEPPING EXERCISE WITH SINGLE-TOOTH SANDALS ON POSTERIOR TIBIAL ARTERY BLOOD FLOW AND SOLE SURFACE TEMPERATURE

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INTRODUCTION: Single-tooth sandals under new development have special material and shape characteristics, and exercises with single-tooth sandals can increase pressing stimulus on the soles of the feet. Our recent findings indicate that exercise with single-tooth sandals has a positive effect on a suppressing decline in the medial longitudinal arch and an elevation in sole surface temperature. However, the influences of exercises with single-tooth sandals on blood flow are now unknown. This study thus aimed to examine the effects of exercise with single-tooth sandals on posterior tibial artery blood flow and sole surface temperature.

METHODS: Eighteen young adults (21.7 ± 0.2 years) participated in 20 min of stepping exercise on the spot. They randomly put on a regular normal sandal (N conditions) or a single-tooth sandal (Z conditions) on each left and right side. Before (Pre) and 0, 15, 30 min after (Post) the exercise, posterior tibial artery blood flow (diameter, velocity, and blood flow volume) and sole surface temperature were assessed by ultrasound imaging device and thermography, respectively.

RESULTS: No significant differences in baseline parameters were observed between N and Z conditions. After the exercise, posterior tibial artery blood flow (diameter, velocity, and blood flow volume) significantly increased in both conditions compared with Pre values. Although no significant differences were observed between two conditions, the blood flow changes and responses tended to be higher in Z conditions than in N conditions. The area under the curve of blood flow between Pre and Post 30 min was significantly higher in Z conditions than in N conditions (N conditions: 821.9 ± 106.5 arbitrary units, Z conditions: 1055.4 ± 139.5 arbitrary units). Central sole surface temperature in Z conditions also increased significantly after the exercise (Pre: 29.2 ± 1.7°C, Post 0: 30.1 ± 1.6°C), but did not in N condition (Pre: 29.2 ± 1.7°C, Post 0: 27.8 ± 1.7°C). The central sole surface temperature changes were significantly higher in Z conditions than in N conditions (N conditions: -4.7 ± 1.0%, Z conditions: 4.8 ± 1.1%). The sole area ratio of surface temperature above reference values was also significantly higher in Z conditions than in N conditions.

CONCLUSION: Therefore, our data indicate that exercise with single-tooth sandals elevates posterior tibial artery blood flow and sole surface temperature. These findings raise the possibility that exercise with single-tooth sandals has a positive effect on sensitivity to cold by improving foot blood circulation and increasing sole surface temperature.

SMOKING STIMULATES MUSCULAR MURF-1 AND PGC-1 ALPHA EXPRESSIONS ON CIGARETTE SMOKE-EXTRACT ADMINISTERED MURINE MODEL.

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INTRODUCTION: Smoking is associated with increased risk of metabolic syndrome and type 2 diabetes, and one of the possible mechanisms might be caused by muscle atrophy. As a previous study supporting this, Petersen et al. has been reported that myostatin and MAFBx gene expressions of skeletal muscle are markedly elevated in smoker, furthermore aerobic exercise has been represented to affect the protein synthesis of skeletal muscle resulting in muscle hypertrophy by Konopka et al. Therefore, we hypothesized that the smoking reduces muscle protein synthesis and stimulate proteolysis in skeletal muscle.

METHODS: Fifteen 8-week-old male mice were divided into three groups (n = 5 in each group); control group, cigarette smoke-extract given (CS) group, and cigarette smoke-extract given with exercise (CSE) group. CS and CSE were administered cigarette smoke-extract once a week for 3 weeks, intraperitoneally. The mice of CSE group were allowed to voluntarily exercise in a running wheel. Three weeks after the exercise intervention, soleus (Sol), red-region of gastrocnemius (Gas) and extensor digitorum longus (EDL) of mice hind-limb muscles were removed and weighed. All muscle were extracted mRNA and measured P70S6 kinase (P70S6K), muscle ring-finger protein-1 (MuRF-1), E3 ubiquitin ligase Atrogin1, forkhead box protein O1 (Foxo1), and peroxisome proliferator-activated receptor gamma coactivator (PGC)-1 alpha expressions by reverse transcription real-time PCR.

RESULTS: One of the protein degradation-related gene, MuRF-1 mRNA expression of Sol and Gas was significantly elevated, and Foxo1, an upstream transcriptional regulatory gene of it, expressions were also markedly increased in CS group as compared with control group. On the other hand, P70S6K mRNA expressions of all muscle were not significantly changed in CS group. The elevated MuRF-1 and Foxo1 gene expressions of Sol were significantly reduced to control level by exercise intervention with the voluntarily exercise in a running wheel. Contrary to our expectations, PGC-1 alpha mRNA expressions of all muscles were significantly increased in CS group compared with control group.

CONCLUSION: An administration of cigarette smoke-extract might suppress muscle mass by stimulating muscle protein degradation via an activation of Foxo1 - MuRF-1 pathway. Cigarette smoke-extract may influence muscular mitochondrial function through upregulation of PGC-1 alpha, although reducing muscle mass.

EFFECTS OF MOTIVATIONAL MUSIC ON PERCEIVED EXERTION DURING AEROBIC EXERCISE

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INTRODUCTION: Music is associated with improved physical performance in a wide range of activities. When music is used during physical activity, it can elicit positive emotions and distract athletes from unpleasant feelings associated with physical exertion and fatigue(1). Some evidence shows no effect of time of day on the rating of perceived exertion (RPE) during aerobic performances(2). The aim of this study was to test the influence of self-selected motivational music, and time of training on RPE during a cycling exercise at moderate and vigorous intensity.

METHODS: Forty-seven university students were recruited: 24 males and 23 females (age 22.6±2.4 yrs; BMI 21.9±2.7 kg/m2; V'O2max 39.3±7.6 mlO2/kg/min). All subjects performed four randomized training sessions at two different times of day, with and without self-selected motivational music(3): two sessions in the morning from 8:30 am to 9:30 am (MO+M; MO-M) and two sessions in the evening from 5:30 pm to 6:30 pm (EV+M; EV-M). Each training session included 6 min of cycling at constant load at 60% of V'O2max (MOD), interspersed by a 10-min break, and at 90% (VIG) of V'O2max, estimated from a submaximal direct test. At the end of each 6-min bout, CR10 Borg's scale(4) was administrated to rate fatigue.

RESULTS: RPE was significantly influenced by music, indeed it decreased during exercise performed with self-selected motivational music both at MOD (MO+M: 2.3±1.2; MO-M: 2.6±1.3; EV+M: 2.2±1.1; EV-M: 2.5±1.3; p=0.025) and VIG (MO+M: 6.1±2.0; MO-M: 6.8±1.9; EV+M: 6.5±2.1; EV-M: 6.7±2.0; p=0.001) intensity, regardless of gender. Conversely, time of day did not influence RPE neither at MOD nor at VIG intensity, in both gender.

CONCLUSION: This research, taking into account both the influence of music and of time of day, confirms previous findings of a positive effect of motivational music(5) and no influence of time of day(2) on RPE. Exercisers are advised to listen to self-selected motivational music while training, which would help them to feel less fatigue and maintain a better adherence to their physical activity program.

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THE DEVELOPMENT AND ASSESSMENT OF A NOVEL COMBINED PHYSICAL AND COGNITIVE ASSESSMENT: THE FLANKER-Y

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INTRODUCTION: Sporting success intuitively relies on the combination of physical, mental, and cognitive performance. Strategies aimed at enhancing the preparation of team-sport athletes on the day of competition are integral to the optimisation of performance, yet acute physical strategies on game-day have been the focus of most research [1]. Whilst coaches and support staff may make assessments of on-field cognition, there are no readily available tools to assess the effectiveness of any strategies that may impact competition cognitive readiness. This study developed and assessed the implementation of a novel test that merged the cognitive requirements of an adapted Flanker task [2] with the reactive physical requirements of a Y-Agility test [3].

METHODS: Fifty-five (28 male, 27 female) physically active adults completed a computer-based modified Flanker task that included three different conditions (i.e., congruent, incongruent, switch), before completing our newly developed novel Flanker-Y task. The Flanker-Y task integrated the computer based Eriksen Flanker task (with an additional pre-planned task) with the reactive Y-Agility test. Timing gates were set up at 5 m in a straight line from the start (split 1), and 10 m at a 45-degree angle from split 1 (split 2). For this test, the computer task was presented on a 42-inch TV, with each condition displayed on the screen in response to the crossing of electronic timing gates at the 5 m mark. Participants completed 100 computer based Flanker tasks, before undertaking 12 combined Flanker-Y tasks at 30 second intervals.

RESULTS: In regards to the Flanker-Y, total time to complete the Flanker-Y task increased as the complexity of the task increased for both sexes ($p<0.001$, ES=0.46-2.97), with males faster than females across all conditions ($p<0.001$, ES=0.94). The difference in total time between conditions was mostly attributed to an increase in time to complete the second 10 m split ($p<0.001$, ES=0.29-11.08), while the time to complete the first 5 m split remained consistent between conditions ($p=0.923$, ES=0.00-0.11). The coefficient of variation (CV%) for split 1 were similar between conditions (3-4% for each condition, $p=0.086$), with the CV% for split 2 considerably worse (ranging from 8% for the pre-planned to 16% for the switch task, $p<0.001$).

CONCLUSION: The novel Flanker-Y task successfully demonstrated construct validity with varying degrees of reliability in physically active adults. Repeating this methodology in a homogenous, trained population is the next step to identify if reliability improves with training status. The application of this test is far reaching including the assessment of match-day strategies on competition cognitive readiness, as well as the ability to assess the impact of chronic training interventions and changes in cognitive capacity in a sporting context.

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A QUALITATIVE ASSESSMENT OF TRUCK DRIVERS' NEEDS FOR PHYSICAL ACTIVITY PROMOTION

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Introduction

Due to the accessibility of employees, the workplace is an ideal setting for health promotion. To develop health promotion measures in the workplace, specific needs of this target group need to be taken into account. Especially for working target groups with unhealthy working conditions and difficult accessibility, such as truck drivers, the current state of research is limited. Due to the nature of a truck drivers` workplace, one of the most neglected health behaviour is physical activity. Thus, the aim of the present study was to qualitatively identify the individual needs in terms of capabilities, opportunities, and motivation of truck drivers in relation to increasing their physical activity behaviour. Based on identified needs specific measures and interventions to increase truck drivers' motivation for more physical activity at work can be developed.

Methods

A qualitative study with semi-structured interviews was performed with N = 19 truck drivers (M = 50.5 years, SD = 11.4 years; 89.5% male). The interview guide was based on the COM-B model to identify the needs of truck drivers in form of capabilities, opportunities and motivation regarding physical activity. The interviews were transcribed and coded by two independent investigators.

Results

In sum, the codes encompassed N = 395 statements from the participants. The developed code system contained a total number of 14 sub-categories related to the study aim of identifying the individual needs of truck drivers regarding a physical activity change in terms of capabilities, opportunities and motivation. Three additional sub-categories describe other individual needs of truck drivers related to other health behaviours (nutrition, recreation) or their thoughts about company external incentives for health promotion interventions. Quantitative results show that 11% of the truck drivers' suggestions referred to capabilities, 73% to opportunities, and 16% to motivation.

Discussion

The results represent a large number of identified needs that comply with the COM-B model and can be fundamental for the development of physical activity promoting intervention approaches for truck drivers. Possible approaches should include practical implications such as the linking of automatic motivation and psychological capabilities, which comprise

the combination of motivational techniques coupled with information in the psycho-education of truck drivers. To conclude, truck drivers have particularly high and various needs in terms of opportunities to improve their physical activity behaviour. However, the satisfaction of these needs is closely intertwined with the contentment of their motivational and capability needs, which were smaller in proportion but should not be neglected when targeting a holistic implementation of workplace physical activity programs for truck drivers.

Conventional Print Poster

CP-PN16 Hormonal Biology

THE EFFECT OF ACUTE COMBINED ORAL CONTRACEPTIVE ADMINISTRATION ON SUBSTRATE METABOLISM: A RANDOMISED-CONTROLLED TRIAL

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INTRODUCTION: Combined oral contraceptives (COCs) are the most common hormonal contraceptive used by athletes and are and ingested daily, containing synthetic oestrogens (e.g., 17-α-ethinyl oestradiol) and progestins (e.g., levonorgestrel) which peak in the bloodstream ~60-90 minutes post-ingestion. To date, no research has considered how the acute pharmacokinetic profile of COCs affects physiological function related to sport and exercise. The aim of this study was to assess whether acute changes in synthetic hormone concentrations that occur with daily COC use affect substrate metabolism.

METHODS: Nine COC (30 micrograms ethinyl oestradiol, 150mg levonorgestrel) users completed a familiarisation including a lactate threshold (LT) and VO2max test, followed by two main trials. In the main trials, at 8.00 h after a 24h abstinence from COC consumption and an overnight fast, participants ingested their COC or a matched, lactose, placebo (PLA) in a double-blind, randomised and counter-balanced manner. Ninety minutes following COC or PLA ingestion, participants exercised on a treadmill at 60% and 90% LT for 6 minutes each, with respiratory exchange ratio (RER) measured in the final minute. Upon completion of exercise, participants ingested the pill corresponding to alternative condition to maintain contraceptive efficacy. Two-way repeated measures ANOVAs were used to assess the effects of condition (COC and PLA) and intensity (60% and 90% LT) with statistical significance set at $P < 0.05$ and Cohen's D used to calculate effect size.

RESULTS: There was a significant effect of exercise intensity ($P < 0.001$) and condition ($P < 0.01$) on RER, with no intensity x condition interaction effect ($P = 0.337$). RER at 60% LT was significantly ($P < 0.05$; $d = 0.47$) lower in COC (0.845 ± 0.049) compared to PLA (0.864 ± 0.035) and RER at 90% LT was significantly ($P < 0.05$, $D = 0.92$) lower in COC (0.904 ± 0.044) compared to PLA (0.933 ± 0.012).

CONCLUSION: The acute increase in circulating synthetic reproductive hormones shortly after COC ingestion resulted in lower RER values during exercise compared to a placebo, indicating differences in substrate utilisation. To the authors knowledge, this is the first study to show that the timing of COC ingestion can be manipulated to affect aspects of physiological function. Further work is needed to explore the potential applications of this novel concept to sporting populations. N.B. Data for 7 participants are pending (total n = 16) and cognitive function, subjective measures, performance measures (e.g., VO2max) and blood data are to be included in final work.

DESCRIPTION OF THE SEXHORMONAL VARIATIONS ON MENSTRUAL SYMPTOMS AND WELLNESS OF ELITE ATHLETES DURING THEIR MENSTRUAL CYCLE.

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INTRODUCTION: The different phases of the menstrual cycle can be characterized by sex hormonal variations. Each of these variations can impact the athletes' wellness (i.e. fitness, mood, sleep quality). During their menstrual cycle, some women will develop premenstrual symptoms [1]. Studies have shown that a consistently higher level of progesterone in the luteal phase is associated with low levels of premenstrual fatigue [2]. Objective : to determine the sex hormonal profile of elite athletes (i.e. estradiol, progesterone and testosterone) and the impact of its variations on their wellness and menstrual symptoms, comparing athletes with a natural menstrual cycles (MC) or IUDs* and athletes on combined oral contraception (OC).

*abbreviation for intra-uterine device

METHODS: 27 elite athletes (12 skiers, 11 rowers, 4 cyclists) volunteered to participate in the study. There were 14 athletes on OC and 13 with a MC. For MC eumenorrheic athletes were included. Salivary samples were taken on average every 3/4 days for x cycles on average. In order to identify abnormal data, while still considering the atypical hormonal profiles of some athletes, we used the Z-scores-based methods [3]. Wellness data and different menstrual symptoms (i.e. soreness, headaches, increased fatigue) were collected. In order to model hormonal profiles, a mixed model with random effect on athletes was used.

RESULTS: In MC athletes, a significantly higher level of progesterone was observed in the luteal phase than in the follicular and menstrual phase (Wilcoxon test: p-value <0.001). There was also a significant difference in estradiol levels between

natural cycle and pill athletes (Wilcoxon test: p-value <0.001). There is a greater variation in testosterone for MC athletes than for OC athletes. In addition, for the MC athletes, the menstrual symptoms were significantly different across the cycle's phases (Kruskall-Wallis test: p-value <0.001). The number of symptoms observed, on the whole of the MC athletes, in the menstrual phase is more important than in the follicular phase and the luteal phase (13.03% in fol., 41.96% in lut. and 45% in menst., n=591). Premenstrual symptoms (i.e. increased fatigue, headaches, breast pain) were reduced in athletes taking hormonal contraceptives.

CONCLUSION: Through this study, we observed the variations of estradiol and progesterone according to the different phases of the cycle while testosterone seems to remain rather stable across the MC. The study of estradiol and testosterone through wellness and symptoms in high performance athletes is still very under researched. Understanding these variations will allow athletes and staff to optimize and adapt their training loads to improve performance.

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DOES TIMING OF ORAL CONTRACEPTIVE PILL INTAKE AFFECT EXERCISE PERFORMANCE? A RANDOMIZED CROSSOVER CONTROLLED STUDY

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AARHUS UNIVERSITY

INTRODUCTION: Use of combined oral contraceptives (OC) containing synthetic estradiol and progesterone is prevalent among female athletes. Proportions between 27 and 41% have been reported for different athlete populations in various European countries [1-3]. Research to date indicates a potential slightly reduced exercise performance in OC users compared to non-OC users [4]. However, the acute effect of OC pill intake on athletic performance has not been studied.

During OC use, endogenous sex hormones are downregulated to fairly constant low levels. However, serum concentrations of exogenous hormones from the OC pill peak between one and two hours after pill intake [5, 6]. Nevertheless, already after eight hours, the concentrations of exogenous hormones have declined to a more stable low level. Whether these fluctuations affect exercise performance remains undetermined.

We aimed to investigate a potential acute effect of OC pill intake on strength, power, and endurance performance in trained women.

METHODS: Trained women using monophasic 2nd generation OC pills were tested in a randomized cross-over controlled study. Participants completed a physical performance test protocol one hour after intake of the OC pill and 24 hours after intake of the OC pill. The physical tests included balance stand test, muscular endurance push-ups test, agility test, isometric handgrip strength, countermovement jump height, flexibility test and a maximal oxygen uptake bike test. In addition, a questionnaire about psychological wellbeing was completed before testing. Time of the day, energy intake and exercise preceding the tests was standardized and participants were familiarized with the tests beforehand.

RESULTS: Six out of thirty women have completed tests. Recruitment and testing is ongoing. Analysis of preliminary data showed that countermovement jump was numeric 3,8% higher and maximal oxygen uptake numeric 3.9% lower one hour after OC pill intake compared to 24 hours after OC pill intake. However, the preliminary data showed no significant difference in any of the physical tests between OC pill intake one hour before testing versus 24 hours before testing.

CONCLUSION: Preliminary data of only six participants showed no acute effects of OC pill intake on exercise performance.

In female elite athletes, a minor difference in performance related to OC intake will be of great importance during competition. Thus, this study will bring important knowledge to the female athlete.

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RESTING HEART RATE FLUCTUATIONS DURING THE MENSTRUAL CYCLE IN COMPETITIVE FEMALE TRACK AND FIELD ATHLETES

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INTRODUCTION: Early morning resting heart rate (rHR) is an important parameter for athletes to monitor the state of recovery. There are several parameters that might influence rHR, among them the menstrual cycle. The menstrual cycle can be divided into different phases by its hormonal fluctuations of estrogen and progesterone. Some aspects relevant to athletic performance are that estrogen, which peaks in the late follicular phase prior to ovulation can increase endothelium-dependent vasodilatation, while progesterone can increase cardiac excitability. The purpose of this study was to

analyze the influence of the phase of the menstrual cycle on rHR in female elite athletes to gain more detailed knowledge on the interpretation of rHR in the context of load control and regeneration management.

METHODS: In this controlled monitoring study, rHR was assessed at different phases of the menstrual cycle in 9 eumenorrheic competitive female track and field athletes with a total of 22 tracked menstrual cycles. Subjects did not take any hormonal contraception. During the study period, the athletes measured their HR each morning after awakening and documented the value in a monitoring APP. rHR of the 22 cycles were averaged in either 1) five (5-phase-model) or 2) three (3-phase-model) different phases of the menstrual cycle, namely: 1) menstruation (M), late follicular phase (lateF), ovulation (O), early luteal phase (earlyL), late luteal phase (lateL)), and 2) follicular phase (F), ovulation (O), luteal phase (L). Phases of the menstrual cycle were determined by the ovularing©. One-way ANOVA was used for the comparison of mean rHR of the different phases. The significance level was set $\alpha \leq 0.05$.

RESULTS: The following rHR values were determined: 5-phase model: M: 57.0±6.2; lateF: 57.1±6.6; O: 57.4±6.2; earlyL: 57.6±6.5; lateL: 57.1±6.8 (1/min), p>0.05); 3-phase model (L: 57.0±6.2; O: 57.0±6.6; L: 57.5±6.3 (1/min, p>0.05). We could not detect any influence of the phase of the menstrual cycle on rHR in neither of the two models. Individual rHR profiles showed a high inter-individual variability.

CONCLUSION: Despite known influences of female sex hormones on the cardiovascular system, no menstrual cycle-related influences of the variation in the blood concentrations of estrogen and progesterone on early morning rHR in elite athletes were detected in this study. As vagal influence might be higher in endurance athletes and their rHR accordingly lower, a larger number of female athletes from different disciplines (e. g. endurance, sprint, power/strength disciplines) should be recruited in follow-up studies. In addition, heart rate measurements should be performed with identical technically equipment to ensure more accurate determination. This study was part of an investigation about the implementation of menstrual cycle tracking in the German athletics association. This project was funded with research funds from the Federal Institute for Sports Science based on a decision by the German Bundestag.

CLASSIFICATION OF ELITE FEMALE CYCLISTS SESSIONS AND THE IMPACT OF MENSTRUAL CYCLES

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INTRODUCTION: The menstrual cycle of female athletes may impact training effort, particularly those in high intensity[1]. We aimed to i) classify the training sessions of elite female cyclists based on the power meter data of each session to ii) identify the effect of the menstrual cycle phases on the different types of training sessions.

METHODS: 13 elite cyclists volunteered to participate in the study. They declared the beginning and the end of their menstrual periods and the other phases of their cycle were determined relying on a prediction method[2]. Three phases make up the female hormonal cycle: the menstrual period is the first phase, followed by the follicular phase which ends with ovulation and begins the luteal phase where progesterone level is highest. Eight of the 13 cyclists met the criteria of a regular cycle between June 2017 and November 2022 . A total of 2,858 cycling sessions were then collected during this period of follow up. A principal component analysis (PCA) was implemented to determine the variables the most discriminants of the effort performed by the cyclists. 14 external load variables were then selected, (e.g., session distance, time, average speed and power, Coggan loads).Then a K-means Clustering was implemented to group similar cycling sessions together stablishing a classification of different types of training. A Wilcoxon test was performed to look for differences in effort between phases of the menstrual cycle.

RESULTS: Two groups of variables were distinguished in the PCA, one representing the training volume, the other the intensity. Four clusters were established: intensive effort (medium Volume, high Intensity), moderate effort (medium Volume, medium Intensity), long effort (high Volume, medium Intensity), and light effort (low Volume, low Intensity). We found a significant difference ($p = 0.005$) between the Intensity of the sessions, in the cluster of intensive effort, during the menstrual phase compared to the follicular. The Intensity indicator the cyclists displayed were 2 times higher during the follicular phase in comparison with the menstruation phase. No differences across the menstrual cycle phases were found in the clusters of moderate, long or light effort ($p > 0.05$).

CONCLUSION: The clustering of cycling sessions allows comparisons among similar training sessions. We showed greater training intensity during the follicular phase among the most intense training sessions, possibly suggesting an impact of the menstrual cycle on the most intense sessions among an elite of female athletes. These findings suggest that the hormonal phases of the menstrual cycle influence elite cyclists performance.

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HORMONAL AND IMMUNOLOGICAL RESPONSE TO A COMBINED BIOPSYCHOSOCIAL STRESSOR AND RESISTANCE EXERCISE - A PILOT EXPERIMENT

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INTRODUCTION: The notion that stress (both physical and psychosocial) has a negative impact on recovery and training adaptations is widely accepted, which is reflected by the recommendation to closely monitor stress as an indicator of an

athlete's state of recovery [1]. Nevertheless, currently, no experimental studies have been performed to directly test the effect of stress on exercise reactions. In this pilot study, we investigated the endocrine and immunological response to resistance exercise (RE) following the Maastricht Acute Stress Test (MAST) [2]. A Solomon 4-group design was used to differentiate between the effects of RE and the stress test.

METHODS: Eight healthy male participants (age = 20 - 35 yrs) were scheduled for a familiarization session and two tests separated by a two-week washout period. Two blocks of n = 4 randomly selected participants underwent the MAST or a non-stress-inducing sham version of the MAST prior to executing either an isokinetic leg press protocol (LP; 4 × 10 reps) or a sham version of the protocol (sLP). In the latter, participants had to perform the same LP protocol while generating only minimal force. The order of the two test days was assigned in a counterbalanced manner.

On both days, blood samples were taken at four timepoints (baseline, post-MAST, post-LP, and 30' post-LP) for analysis of serum cortisol, testosterone, and IL-6 .

All results are presented as change scores from baseline (mean ± SD) and standardized mean differences (SMD) as measure of effect size. Considering the small sample size and associated lack of statistical power, no inferential statistics were computed.

RESULTS: Baseline levels of cortisol, testosterone and IL-6 were similar between the testing days and groups.

Prior to exercise, the stress test had a large effect on cortisol levels (MAST: +3.3 ± 3.2 µg/dL compared to sham-MAST -1.7 ± 0.8 µg/dL; SMD = 2.3). After LP, no differences in blood cortisol were observed between the MAST conditions.

Testosterone levels were unaffected by either MAST condition but increased directly following the LP (+76 ± 45 ng/dL) but not the sLP (-27 ± 56 ng/dL) protocol (SMD = 2.2). Within the LP block, testosterone showed considerably higher increase (SMD = 3.6) after the MAST (+111 ± 22 ng/dL) than after the sham-MAST (+40 ± 27 ng/dL).

No meaningful changes for IL-6 were detected in either group.

CONCLUSION: In our sample, the MAST was effective in increasing blood cortisol levels, but the effect was outweighed by the subsequently performed resistance exercise. The LP protocol increased testosterone, with the effect being larger when the exercise was preceded by the MAST. While the generalizability of the present study is limited by the small sample size, we found promising results for a higher-powered follow-up, to better understand the interaction of stress and exercise adaptations.

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SEX STEROID HORMONES IN YOUNG AND MASTER MALE ENDURANCE RUNNERS

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INTRODUCTION: Testosterone is one of the most potent naturally secreted androgenic-anabolic hormone in men. Ageing beyond 35 to 40 years is associated with a decline of 1% to 3% per year in circulating testosterone concentration (1.6% in total and 2% to 3% in bioavailable testosterone). Previous research showed that rather than decline in total testosterone concentrations, increases in sex hormone binding globulin (SHBG), albumin and decrease in free and bioavailable testosterone are of higher physiological importance in aging. We aimed to compared selected sex steroids hormone parameters in young and senior endurance runners and their untrained age counterparts.

METHODS: Four groups of young and sedentary men were compared: young endurance runners (YE, n=11, 28.2 ± 0.6 yrs, BMI 21.9 ± 0.4 kg.m-2), young sedentary (YS, n=11, 25.5 ± 0.7 yrs, BMI 27.8 ± 1.6 kg.m-2), master endurance runners (ME, n=10, 69.0 ± 1.0 yrs, BMI 24.4 ± 0.8 kg.m-2) and elderly sedentary (ES, n=10 71.1 ± 1.2 yrs, BMI 27.7 ± 0.8 kg.m-2). Young and master endurance runners done more than 300 min per week of running and competition from 10 km to marathon. Sedentary subjects were defined as individuals with no history of regular physical training and activity less than 150 minutes of moderate or 75 minutes of vigorous intensity per week. Early morning fasting sera were assayed for total oestradiol, testosterone, free testosterone and SHBG.

Data were controlled for normality and heterogeneity. Based on the results, parametric or non-parametric tests were calculated. All data are expressed as means ± SEM.

RESULTS: No significant differences were found in total testosterone between the groups (18.6 ± 1,2; 17.7 ± 2.3., 18.1 ± 1.2., 14.8 ± 1.2 nmol/L in YE, YS, ME and ES, respectively). Free testosterone was significantly higher in merged young vs. elderly groups regardless of training status and in sedentary compared to runners (both $p<0.05$). In addition, young runners had higher percentage of free testosterone compared to master runners (1.84 ± 0.01 and 1.57 ± 0.08 % in YE and ME, respectively). SHBG was higher in both YE and ME compared to their age-matched groups. SHGB levels in ME (53.3 ± 3.9 nmol/L) were significantly higher also compared to YE (36.9 ± 0.8 nmol/L, $p<0.05$). Oestradiol levels were significantly higher in YS compared to the other groups.

CONCLUSION: Neither aging nor training status affected the serum concentration of total testosterone. Free testosterone decreased with aging and endurance training did not significantly affect the decline. SHBG level increased with age as

expected, however, the serum levels were higher in both young and master athletes compared to their age-matched groups. Endurance running training may have some effects on bioavailability of testosterone in men regardless of age.

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GENDER DIFFERENCE IN GASTRIC EMPTYING RATE AND GASTROINTESTINAL SYMPTOMS AFTER ENDURANCE EXERCISE

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INTRODUCTION: Consumption of nutrition within the early few hours after exercise is recommend (1). Gastric emptying (GE) could affect exercise-induced changes in appetite and energy intake. GE has been shown to be delayed after high-intensity endurance exercise (>70% VO2max) (2). Although females presented delayed GE of both solid and liquid types of meals compared to males (3), little is known about gender difference in GE after endurance exercise. Therefore, the purpose of the present study was to compare the exercise-induced changes in gastric emptying and gastrointestinal symptoms between healthy males and females.

METHODS: Nine healthy males (22.2 ± 1.7 years; 173.5 ± 6.1 cm, 62.5 ± 9.4 kg) and eight healthy females (21.5 ± 3.1 years; 164.7 ± 3.3 cm, 57.3 ± 3.5 kg) were recruited. Participants initially evaluated maximal oxygen consumption (VO2max) by an incremental running test. Then, they conducted 60 min run on a treadmill at 70% of VO2max, followed by a 1-h rest period. Participants were allowed to consume 2 mL/kg BM of water in every 15 min during running. Female participants conducted the 60 min run during the first 10 days of the menstrual cycle. During the 1-h rest period, the gastric emptying rate was determined using 13C-sodium acetate breath test. Appetite and gastrointestinal symptoms (fullness, hunger, stomach distension, stomach pain, desire to eat, nausea) were measured using visual analogue scales before exercise, immediately, 30 min, and 60 min after exercise.

RESULTS: The appearance time of maximum 13C excretion (Tmax, an indication of GE rate) was 40.56 ± 12.4 min in males, and 49.38 ± 12.7 min in females, respectively. However, there was no significant difference between males and females (P = 0.167). No participants complained of GI symptoms before exercise. While the score of hunger increased during 1-h rest period (P = 0.012), it did not differ significantly between males and females (P = 0.146). Also, there was no significant difference in the score of fullness, stomach distension, stomach pain, desire to eat, and nausea.

CONCLUSION: During high-intensity exercise, GE is thought to be delayed mainly through the augmented sympathetic nervous system (4). However, in the present study, there was no significant difference in heart rate during exercise (P = 0.900), post-exercise blood lactate concentrations (P = 0.964) between males and females. In conclusion, there were no significant gender differences in gastric emptying rate and gastrointestinal symptoms after endurance exercise.

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AEROBIC EXERCISE TRAINING IN OVERWEIGHT YOUNG ADULTS DOES NOT INDUCE WEIGHT LOSS BUT A REDUCTION IN RESTING METABOLIC RATE

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INTRODUCTION: Exercise training intervention studies have shown that total daily energy expenditure (TDEE) increases less than expected, and consequently, less weight than predicted is lost. However, the physiological mechanisms for exercise-induced energy compensation remain unclear. This study aimed to identify changes in the metabolic efficiency that occur as a physiological adaptation to moderate exercise training.

METHODS: Using a clinical trial protocol, 16 overweight (body mass index: 28.1±2.1 kg/m2) men (n=8) and women (n=8) aged 38.9±3.7 years were enrolled in a 3-month exercise intervention. Exercise training was supervised at a moderate intensity (65%-75% HRmax) of 20 kcal/kg/week. Changes in resting metabolic rate (RMR) were evaluated by whole human room indirect calorimetry ("metabolic chamber"), and total TDEE was evaluated by double-labeled water. Body composition was assessed by multi-frequency bioelectrical impedance before and after the intervention

RESULTS: Mean adherence to exercise training was 95%, with a significant increase of TDEE by 194±304 kcal/day (p=0.03) and VO2max by 1.77±2.91 ml/min/kg (p=0.04). However, no change was observed for body weight, fat mass, or fat-free mass (0.1±2.1 kg, 0.4±1.7%, and 0.4±1.2 kg, respectively). Following the exercise intervention, RMR decreased significantly (p=0.02) by -70±102 kcal/day.

CONCLUSION: Compensatory mechanisms induced by chronic exercise at moderate intensity may be mediated, at least partly, by reducing RMR. This trial was registered at clinicaltrials.gov as NCT04460040.

THE EFFECTS OF REPEATED COLD WATER IMMERSION ON THE IMMUNE SYSTEM AND CARDIOVASCULAR FACTORS IN HEALTHY MALES: A PILOT STUDY

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INTRODUCTION: In recent years, cold water swimming has received much attention due to its potential health benefits. Despite the growing interest and popularity, there is little evidence available that repeated cold water immersion (CWI) has positive effects on the immune system and cardiovascular health [1]. Therefore, this pilot study aimed to investigate the effects of a 3-week CWI intervention on inflammatory markers (blood cell counts of total leukocytes, neutrophils, basophils, eosinophils, monocytes, lymphocytes, thrombocytes) and cardiovascular factors (mean arterial pressure [MAP], heart rate [HR]) in healthy males.

METHODS: 12 healthy men (26.0±3.7 years, 171.0±7.5 cm, 74.9±8.0 kg), non-habituated to CWI, were randomly allocated to the CWI or control (CON) group. The CWI group underwent a 3-week CWI intervention (12 min at 7°C., 4x per week). The CON group was instructed to maintain their daily habits and were not allowed to perform any type of cold therapy. Blood cell counts (total leukocytes, neutrophils, basophils, eosinophils, monocytes, lymphocytes, thrombocytes) and cardiovascular factors (MAP, HR) were assessed at baseline and after the 3-week intervention period. Wilcoxon matched-pairs signed rank test was used to compare the before-and-after differences, with a significance level set at $p<0.05$.

RESULTS: Total leukocyte count decreased significantly ($p=0.031$) in CWI, with a median difference of -1.10 x 10^3/µL (95%CI: -2.80 to -0.20) while CON did not show a significant change ($p>0.05$). Leukocyte differential count revealed a significant decrease in neutrophils in CWI ($p=0.031$), with a median difference of -0.65 x 10^3/µL (95%CI: -2.20 to - 0.10) while no change was observed in CON ($p>0.05$). There were no significant differences in the counts of basophils, eosinophils, monocytes, lymphocytes or thrombocytes in either CWI or CON (all $p>0.05$). CWI showed a significant decrease in MAP ($p=0.031$), with a median difference of -12.00 mmHg (95%CI: -25.00 to -7.00). HR was significantly reduced ($p=0.031$) in CWI, with a median difference of -3.50 bpm (95%CI: -9.00 to -1.00). In contrast, CON did not show a significant change in either MAP or HR ($p>0.05$).

CONCLUSION: The preliminary results of this pilot study indicate that a 3-week CWI intervention may have a suppressive effect on the immune system in healthy males. However, the findings suggest potential beneficial effects on cardiovascular health. Further studies with larger sample sizes are needed to more thoroughly examine the effects of repeated CWI on health markers. Given the potential for sex differences in response to the intervention, future research should also explore the effects in a female population.

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Conventional Print Poster

CP-AP09 Team Sports Analyses

IDENTIFYING KEY PERFORMANCE INDICES THAT DISTINGUISH ELITE MIDFIELDERS FROM SUB-ELITE COUNTERPARTS IN PROFESSIONAL MENS FOOTBALL USING A MULTIPLE-MODEL MACHINE LEARNING APPROACH

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INTRODUCTION: Previous research has effectively employed multiple machine learning algorithms (MMLAs) to investigate Key Performance Indicators (KPIs) that differentiate elite football players from sub-elite ones in the top 5 European soccer leagues. These studies have focused primarily on goalkeepers [1]. The present study employs the same approach to investigate KPIs that distinguish elite and sub-elite midfielders.

METHODS: 272 distinct performance statistics were collected from the top five European football leagues for the seasons 2013-2018 using Opta sports data, a highly reliable source [2]. A total of 2600 midfielders, corresponding to 82527 unique match performances, were examined by dividing them into two groups: those who played in the Champions League (CL: 1) and those who did not (NCL: 0). This classification was similar to the previous studies performed on goalkeepers [1]. The performance statistics were pre-processed through scaling, normalization, and K-best feature selection, resulting in 20 features as input to the chosen models. Three Machine Learning classifiers - logistic regression (LR), XGBoost (XGB), and decision tree classifier (DT) - were used to analyse the chosen features. The imbalance in the data set was addressed by balancing "class weights" for each algorithm. A data science expert conducted hyperparameter optimization for the ten-fold cross-validation scores to optimize 'balanced accuracy'. Relative feature importance or odds ratios were reported to identify the top features that differentiated CL midfielders from NCL midfielders. All analysis was performed using python 3.10.0

RESULTS: XGBoost outperformed logistic regression and decision tree classifier across multiple model performance matrices. "Passes received," "Successful Passes Opposition half," "Touches open play opp box," and "Successful short passes" were the top four features (KPIs) across all models, with "Passes received" being the most influential. Odds ratios showed that an increase in these top features enhanced the likelihood of a midfielder being classified as CL. However, the odds

ratios were relatively high due to scaling and normalization, and a one-unit increase in KPIs does not directly translate to a literal unit increase in game-specific terms.

CONCLUSION: Successful short passing and the number of touches in the opponents penalty area were identified as features that distinguished elite from sub-elite midfielders. The findings suggest that successfully executing passes and involving oneself in attacking play are key distinguishing features of elite midfielders. However, the study had limitations such as the use of only one proxy measure of talent, and a lack of physical/psychological performance data and advanced performance metrics. Future research should aim to address these limitations and expand this area of research using a similar multiple-machine learning approach with a wider range of measures and proxy measures of talent.

1. Jamil et.al (2021) 2. Liu et. al (2013)

RELATIONSHIP BETWEEN GAZE BEHAVIOUR AND DECISION MAKING DURING ON-FIELD SPORT SITUATIONS IN PROFESSIONAL VS YOUNG ELITE RUGBY LEAGUE PLAYERS.

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INTRODUCTION: This study was initiated by a rugby league coach who wanted to gain insight about the visual cues that expert players use to make decision in a specific 3 vs 2 game situation, in order to provide better guiding cues for perception and decision performance of young elite players. Our aim was to study gaze behaviour in relation with the quality of decision, during on-field offensive situation [1], and to compare between professional and young elite players.

METHODS: Four male professional and international rugby league players (mean age 30+/-1 years) and 4 male young players (mean age 17+/-1 years) from a national talent development program participated. All had normal vision. On a 10 x 10m delimited area, three attackers had to bring the ball over two defenders. The ball carrier, equipped with a wearable eye tracker (Tobii Pro Glasses 2), had to either run with the ball, or pass it to one of his teammates, depending on the situation. An experienced coach coded the relevance of the decision and the quality of the action performed. Eye tracking data was analysed by means of Tobii Pro Lab software. Seventeen areas of interest (AOI) were defined, representing the various locations of fixations in the visual scene. Repeated measures ANOVAs were performed on the relative duration of the fixations. The link between quality of decision and action performance was analysed by a chi-square test.

RESULTS: Only AOI had a significant main effect ($F_{16,96}=6.87$; $P<0.01$). The space between defenders was fixated for longer time than others areas. A significant interaction expertise level x AOI ($F_{16,96}=4.13$; $P<0.01$) showed that professional players and young elite players had different gaze patterns. Experts spent more time fixating the outsider defender and defenders' shoulders whereas younger elite players focused on the space between defenders and defenders' lower body. The quality of decision had no effect on fixation relative duration. The decision quality was linked to performance in professional players (chi-square1=9.77; $P<0.01$), whereas no significant link was found in young players (chi-square1=0.56; $P>0.05$).

CONCLUSION: Visual fixations on the space between defenders may represent a visual pivot or gaze anchor [2] allowing players to take information on surrounding areas. Both professional players and young elite players spent time fixating defenders' bodies, allowing them to anticipate the running direction and detecting deceptive movement [3]. Visual information pick-up was not clearly linked to decision quality in this explorative study. For professional players, a good choice always lead to a good performance, but not for young athletes: an issue of motor skill or of timing of decision making?

1. Dicks et al. (2010) 2. Klostermann et al. (2020) 3. Brault et al. (2009)

CHARACTERIZING THE PEAK KINEMATIC AND MECHANICAL MOST DEMANDING PERIODS IN ELITE FOOTBALL: COMPOSITION ANALYSIS OF EACH HALF AND MATCH DEMANDS

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INTRODUCTION: A comprehensive understanding of the most intense periods (MIP) of elite football activity is critical to informing training design to ensure optimal preparation of athletes. The characterization and reporting of MIP demands in current studies [1,2] are limited in their application in performance monitoring and designing of training sessions. Therefore, the aim of this study was to characterize the 5-min peak kinematic (5'MIPk; running distance) and mechanical (5'MIPm; acceleration/deceleration) periods in elite football through describing the composition of the respective MIP in terms of the percentage magnitude, percentage duration, and number of efforts of the constituent performance variables.

METHODS: Global positioning system (GPS) data was collected during 45 matches of two teams in the Swedish first division (n=329 observations) across two seasons. The 5'MIPk periods were identified based on the maximal total distance covered concurrently at 15-19.8 km·h-1 (high-intensity running; HIR), 19.8-25.2 km·h-1 (high-speed running; HSR), and ≥25.2 km·h-1 (sprinting; SPR). The 5'MIPm were identified as the maximal average magnitude of concurrent high-intensity acceleration (ACC3; ≥3 m·s-2) and deceleration (DEC3; ≤ -3m·s-2) demands. The percentage of the total distance (MIPk) and average acceleration/deceleration (MIPm), percentage duration of the 5-min period, and the number of efforts for the performance variables and their respective constituent variables were analyzed between each half and the full match.

RESULTS: Linear mixed-effects models revealed small to moderate significant ($p\leq0.05$) decreases of 5-9% and 9-11% between halves for the magnitude, number of efforts, and duration of both 5'MIPk and 5'MIPm, respectively. Similarly, small

to moderate significant (p≤0.05) differences of 11-12%, 7-10%, and 5-10% between halves were observed for the magnitude, number of efforts, and duration of HIR, HSR, and DEC3, respectively. The percentage distance, percentage duration, and number of efforts composition of MIPk and constituent kinematic performance variables were small to very large significantly (p≤0.05) greater in the match 5'MIPk compared to 5'MIPm. Similarly, the high intensity mechanical constituent variables and MIPm were significantly (p≤0.05) greater in the match 5'MIPm compared to 5'MIPk.

CONCLUSION: Results of this study provide greater insight into the composition of peak kinematic and mechanical demands in elite football and demonstrate that MIPk and MIPm represent distinct periods of peak demands in each half and the full match. The detailed characterization of the respective MIP allows coaches to design bespoke training sessions targeting specific locomotor activities, and the design of MIP in standardized settings to assess individualized physiological response and fatigue development to the respective MIP based on match demands.

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IMPACT OF WELLNESS INDICATORS IN THE RELATIONSHIP BETWEEN EXTERNAL AND INTERNAL LOAD IN FOOTBALL

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INSEP

INTRODUCTION: Understanding the relationship between external and internal load according to the wellness monitoring commonly used in elite sports can be of great interest in order to adapt and optimise the athletes' training sessions.

We aimed to determine whether the external load performed in a training session is below or above what is expected for an athlete considering a specific internal load, based on the athletes' individual profile, and then to identify the wellness parameters that may be associated with these variations.

METHODS: Training and wellness data from 15 elite female footballers (23.7 ± 4.4 years) was collected during a 7-month follow-up throughout the 2021-22 season.

Wellness data (i.e. sleep duration and quality, perceived fitness, wake up mood), were collected through a daily mobile app questionnaire.

Regarding the training data, the players wore GPS Catapult tracking devices which provide information on their displacements, speeds, accelerations and related metrics.

We chose to use Catapult Player Load, which is the sum of the acceleration across all axes of the internal tri-axial accelerometer during training session as our external load metrics, and Rating of Perceived Effort (RPE) as our internal load metrics [1,2]. A total of 1,419 training sessions containing both Player Load and RPE were collected. The internal-external load pairs were grouped by player and by RPE, to calculate the 15 and 85 percentiles of Player Load for each RPE category. The "expected zone" of external load was determined when the Player Load corresponded to the estimated within the 15 and 85 percentile values; "below the expected " when Player Load is below 15 percentile values and "above the expected" when Player Load is above 85 percentile values.

Thereafter we compared the wellness indicators of the specific days where the external load variable was not in the "expected" range, through a Mann-Whitney U test.

RESULTS: The internal training load is highly and significantly associated with the external load ($r = 0.65$; $p = 0.01$).

Considering the whole group, sleep duration is significantly higher (p-value = 0.011) when external load is above the expected for a specific RPE.

At individual level, sleep duration is significantly higher (p-value < 0.05) when external load is above the expected for 7 players. For other players the factors the most determinants for an external load above the expected is the sleep quality for 2 players, emotional feelings for 4 players and perceived physical condition for 4 player

CONCLUSION: We showed that RPE is an excellent measure of external load. Yet, variations on such correlation occurs. We showed that increased sleep duration is the wellness indicator that is mostly associated with an external load above the expected for a similar level of internal load, suggesting that increased time of sleep is associated with a lower perception of fatigue.

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LEUKOCYTE TELOMERE LENGTH IN ELITE MALE SOCCER PLAYERS: EXERCISE INTENSITY ROLE STUDIED

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INTRODUCTION: Biological aging is associated with changes in the metabolic pathways. Leukocyte telomere length (LTL) is a predictive marker of biological aging; however, the underlying metabolic pathways remain largely unknown. The aim of this study was to investigate the metabolic alterations and identify the metabolic predictors of LTL in elite male soccer players.

METHODS: Levels of 837 blood metabolites and LTL were measured in 126 young elite male soccer players who tested negative for doping abuse at anti-doping laboratory in Italy. Multivariate analysis using orthogonal partial least squares (OPLS), univariate

linear models and enrichment analyses were conducted to identify metabolites and metabolic pathways associated with LTL. Generalized linear model followed by receiver operating characteristic (ROC) analysis were conducted to identify top metabolites predictive of LTL.

RESULTS: Sixty-seven metabolites and seven metabolic pathways showed significant associations with LTL. Among enriched pathways, lysophospholipids, benzoate metabolites, and glycine/serine/threonine metabolites were elevated with longer LTL. Conversely, monoacylglycerols, sphingolipid metabolites, long chain fatty acids and polyunsaturated fatty acids were enriched with shorter telomeres. ROC analysis revealed 8 metabolites that best predict LTL, including glutamine, N acetylglutamine, xanthine, beta-sitosterol, N2-acetyllysine, stearoyl-arachidonoyl-glycerol (18:0/20:4), N-acetylserine and 3-7-dimethylurate with AUC of 0.75

(0.64-0.87, $p < 0.0001$).

CONCLUSION: This study characterized the metabolic activity in relation to telomere length in elite soccer players. Investigating the functional relevance of these associations could provide a better understanding of exercise physiology and pathophysiology of elite

athletes

THE CLOCK IS TICKING: EFFECTS OF SHOT-CLOCK RESET RULES CHANGES ON EUROLEAGUE BASKETBALL PERFORMANCE

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INTRODUCTION: Rules in sport ensure players compete in fair conditions. In basketball, the shot clock reset rules limit the time during which the team that possesses the ball may attempt a field goal. Following recommendations from the International Federation of Basketball Association (FIBA), the EuroLeague adopted the shot clock reset rules changes in 2008 and 2014. This means the 14-second shot clock reset is implemented when certain defensive fouls are committed, or when certain offensive rebounds are collected. The shortening of the shot clock reset time has the potential to increase the number of ball possessions, reflected by the pace of the games. While the number of possessions is not recorded in the basketball box scores, an estimate is made possible from the box scores based on the equation proposed by (1). Thus, this study aims to examine the effects of the shot-clock reset rules changes on possession related team performances over the last 22 seasons for the EuroLeague.

METHODS: Data included 494 sets of box scores from the EuroLeague regular season 2000-01 to 2021-22. Each set of box scores was the averaged box scores of a team over a season. The data was divided into three periods: before the rule changes in 2008, between 2008 and 2014, and after the rule changes in 2014. The Field-goal Attempts (FGA), Free-throw Attempts (FTA), Turnovers (TOV), and Offensive Rebounds (OREB) from the box scores were used to calculate the number of ball possessions (POSS) in a game, and were also analyzed individually. One-way ANOVA was used to examine the effect of rule changes on the possession related variables.

RESULTS: FTA and TOV were reduced significantly over the 3 periods, ($ps < .001$). There was also a significant effect of the rule changes on FGA and OREB, and the post-hoc paired comparisons showed that a significant increase was only observed after the second change of the shot clock reset rule ($p < .01$). There was no significant effect of rule changes on POSS.

CONCLUSION: The overall number of possessions in a game did not change significantly over the two changes of the shot clock reset rules. The pace of the EuroLeague games was not affected by these rule changes. The effect of the rule changes mainly influenced the specific performance that contributed to the overall number of possessions. The reduction of FTA may have been the balance effect from the encouraged non-shooting defensive fouls as a result of the reduction of the shot clock reset time. Increased pressure from the defense, as well as the reduced shot clock reset time after offensive rebound, could have both contributed to the increase of FGA and OREB. The reduced TOV, although without direct evidence, we deduce could be the result of reduced deploy time.

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CP-BM13 Jumping

THE DISCRETE VARIABLES DERIVED FROM THE FORCE-TIME CURVE CAN CLUSTER DIFFERENT LEVELS OF DROP JUMP PERFORMANCE RATHER THAN SPORT-SPECIFIC BACKGROUND

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INTRODUCTION: Drop jumping (DJ) tests the effectiveness of the stretch-shortening cycle. Multivariate analysis methods, i.e. Principal Components Analysis (PCA), have been used to examine sport-specific differences in DJ that were evident due to different sporting background (1). Recently, cluster analysis revealed different patterns and dissimilarities for the force, power and vertical stiffness-time curves that identified the level of DJ performance across different sport-specific backgrounds (2). Thus, it is still unclear whether DJ performance parameters are unbundled to sports-specificity. This study aimed at investigating if the DJ discrete (0D) variables can reveal specific patterns that can cluster DJ performance.

METHODS: Data of DJ from 0.4m (n = 128) were used (2). A PCA with varimax rotation over the 0D variables (force output, F; rate of force development, RFD; power output, P; duration, T; vertical stiffness, K) was performed. The scores of the 0D variables in the resultant principal components were hierarchically clustered (Ward's method) to summarize the characteristics of the formed subgroups. The assessment of the derived clusters' quality was conducted by calculating the cophenetic correlation coefficient between the hierarchical cluster tree and the pairwise distances. The R v3.6.1 software (R Foundation for Statistical Computing, Vienna, Austria) was used.

RESULTS: PCA revealed three principal components (Kaiser criterion; eigenvalues > 1) that explained 87.0% of the total variance. The first rotated principal component accounted for 60.9% of the variance and was associated with the DJ kinetic characteristics (eigenvalue: 7.31), as it was mostly related to the force derived parameters (RFD, F, P, K). The second PCA dimension explained 17.6% (eigenvalue: 2.12) of the variance and was related to T. The third component represented the 8.5% (eigenvalue: 1.02) of total variance and had a strong association with the downward peak RFD and P, as well as with T for peak F. Hierarchical clustering (cophenetic correlation coefficient: 0.75) revealed three clusters: Cluster 1 with lower-than-average values for P, T, F and downward peak RFD, Cluster 2 with lower-than-average values for K, P, RFD and F, but the common variables considered in the partition for Cluster 2 had greater values than Cluster 1, and Cluster 3 with higher-than-average values for P, F, RFD, K and T.

CONCLUSION: Results suggest that F and P measures can identify distinct levels of DJ performance (1,2). This confirmed past research that found that clustering techniques applied on DJ force-time curve data relate distinct movement strategies with different functional performance outcomes (3). In conclusion, data reduction methods applied on DJ variables can be used to classify the level of performance regardless of the sport-specific background.

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THE ACUTE EFFECTS OF ASSISTED AND RESISTED VARIABLE RESISTANCE BACK SQUATS ON COUNTERMOVEMENT JUMP PERFORMANCE

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INTRODUCTION: Back squat warm-up activities using elastic band (EB) resistance in combination with free weight resistance (FWR) can improve subsequent countermovement jump (CMJ) performance [1], a phenomenon termed post-activation performance enhancement (PAPE). However, across the literature sub-maximal loads of 85% are commonly used, with limited research existing on the effect of lighter loads on acute performance enhancement under both FWR or EB (resisted [RES] or assisted [ASS]) conditions. The aim of the present study was to compare the effects of back squats at 50% 1-RM under two EB attachment sites (ASS and RES) and FWR alone after a task-specific comprehensive warm-up on subsequent CMJ performance.

METHODS: Twenty active males (age = 24.9±3.7 y, height = 1.7±5.7 m, mass = 83.4±12.6 kg) volunteered for the study and completed three separate experimental conditions (FWR, RES, ASS) separated by 48 h following a randomised crossover design. During each condition, participants first completed initial baseline CMJ tests (BL1) followed by a task-specific comprehensive warm-up that involved 5 min of cycling, two sets of 5 bodyweight squats, 5 continuous CMJs at 70% of perceived maximum, and finally, maximal CMJs every 30 s until 3 consecutive jumps were within 3% of jump height. Baseline 2 (BL2) CMJ tests were then completed and followed by 3 back squats following either the FWR, RES or ASS protocols at 50% 1-RM with 35% of the load generated by EBs during the RES and ASS conditions. CMJs were then performed 30 s, 4 min, 8 min and 12 min later.

RESULTS: Significant increases ($p<0.05$) in both jump height (4.6-18.8%) and peak power (5.3-10.8%) were observed across all timepoints when compared with BL1 measure in all conditions. In the ASS condition, significant increases in jump height

(4.6-11.8%) and peak power (6.5-2.0%) were observed at 30 s, 4 min, 8 min, and 12 min compared to BL2. In the RES condition, significant increases in jump height (7.1-1.2%) and peak power (2.3-5.4%) were observed at 30 s, 4 min, and 8 min, and in the FWR condition, significant increases in jump height (2.2-5.7%) and peak power (1-4.6%) were observed at 30 s and 4 min.

CONCLUSION: The implementation of back squats into a warm-up activity at 50% 1-RM increased jump performance when EBs were used during both the ASS and RES conditions, with the increase in jump height being greater than that observed in the FWR condition. The use of EB resistance speculatively reduces loading at the sticking point, potentially allowing for greater acceleration during the concentric phase as lower-limb joints extend at the point where more optimal muscle lengths are achieved [2].These data have important implications for warm-up design for strength and power activities.

EFFECTS OF HAMSTRINGS-TO-QUADRICEPS RATIO AND THE LOWER EXTREMITY PERFORMANCE DURING SINGLE-LEG DROP JUMP IN FEMALE BASKETBALL PLAYERS: A PILOT STUDY

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INTRODUCTION: Lower limb injuries commonly occur in female basketball players due to basketball having a unilaterally dominant characteristic, which may lead to an imbalance in the strength and reaction of the lower limbs. In past studies, the effect of knee flexor and extensor strength differences in the lower limbs has been extensively discussed to the risk of injury. Additionally, lower limb strength and landing style significantly influence jumping performance. This may increase the incidence of non-contact injuries while landing and jumping. In contrast, the reactive strength index (RSI) is reliable for evaluating plyometric performance and examining both jump and landing capability. However, the relationships between the hamstrings-to-quadriceps (H/Q) ratio value and sports performance in both legs have yet to be thoroughly investigated. Therefore, this study aimed to examine the differences between single-leg drop jump (SLDJ) performance and H/Q ratio in female basketball players.

METHODS: This study included seven professional women basketball players (age 24.1±1.5 years; height = 1.7±0.5 m; weight = 67.3±8.5 kg) who performed three SLDJ tasks for each leg from a 30 cm height platform. A motion analysis system with six cameras (Motion analysis crop, 200Hz) and one force plate (Kistler, 9260AA6, 2400Hz) was used to collect the lower extremity kinetic and kinematic data during SLDJ. The joint angle, moment, and joint stiffness were processed by Visual 3D software (C-Motion, USA). The dominant sides of the Participants lower extremities in this study were decided according to their H/Q ratio from manual muscle testing (MMT), which was conducted using the handheld dynamometer. A paired t-test was used to compare the differences between SLDJ performance, lower extremities MMT, and biomechanical variables of the dominant and non-dominant sides.

RESULTS: There were significant differences between the H/Q ratio (62% vs. 43%, p=.021) on the dominant and non-dominant sides. The H/Q dominant sides performance was significantly better in jump high (p=.046) and RSI (p=.009) than the non-dominant side. Besides, the MMT showed that H/Q dominant sides hamstring strength was significantly higher (p=.035). In contrast, the quadriceps strength was significantly lower (p=.047) than the non-dominant side. Though the biomechanical variables during SLDJ have no significant difference in lower extremity angle and moment, the ankle and knee joint stiffness showed significantly greater in the H/Q dominant side.

CONCLUSION: Our present results indicate that asymmetry of the H/Q ratio and lower limb strength affect their jumping performance. The difference in strength, RSI, and joint stiffness between the H/Q dominant and non-dominant side in womens basketball players may be a potential risk of injury in the future. We suggest players require appropriate lower limb muscular strength, especially for knee flexors in H/Q non-dominant side, to elevate performance and avoid injuries.

COMPARISON OF MUSCLE ACTIVITY IN LOWER EXTREMITIES BETWEEN HIGH JUMPERS AND GENERAL ATHLETES DURING RUNNING SINGLE-LEG VERTICAL JUMP OVER DIFFERENT DISTANCES

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INTRODUCTION: The running vertical jump is a common action on sports fields, and most running vertical jump applies single-foot takeoff [1]. With special training, horizontal kinetic energy can be effectively converted into vertical kinetic energy. The speed of the approach run affects jumping performance, which is affected by the running distance. Therefore, the ideal jumping performance requires a balance between the vertical jump and the speed of the approach run. However, the differences regarding muscles and the speed of the approach run between professional athletes of jumping events and general athletes have rarely been discussed. The aim in this study was to determine how different approach run lengths affect single-leg vertical jumps. The jumping performance and characteristics of lower limb muscle activation of professional and general athletes were observed.

METHODS: In this study, 23 junior college athletes divided into two groups: 11 athletes in the general group and 12 professional jumping-event athletes in the specialty group. The distance of the approach run was set to 1, 3, and 5 m from the force plate boundary. The participants were required to perform a vertical take-off with single-leg on the force plate after an approach run, and then land on both feet. Kinetic data were collected by Two Kistler force plates and seven Noraxon wireless EMG. The phase was divided into the pre-landing, landing, descending, and ascending. The statistical method used was two-way ANOVA, mixed design.

RESULTS: In the pre-landing phase, 100 ms before landing, the activation of ST in the specialty group with a 1 m approach run was significantly higher than that in the general group; the activation of VL, RF, ST, and TA in the specialty group with a 3 m approach run was significantly higher than that in the general group. We further compared the effects of different distances on muscle activation. The results indicate that the activation of VL, RF, and VM with the 3 m approach run in the specialty group was much higher than with the 1 m approach run.

CONCLUSION: We found that the rectus femoris and vastus medialis muscles with 1, 3, and 5 m approach runs were more activated than the hamstring tendons during the process of landing to take-off, which indicates that the main function of the quadriceps during the take-off process was to assist the knee joint to extend the knee and perform concentric contraction. In this study, different approach distances and groups were used to analyze the changes in the muscle activation of the lower limb during a single-leg vertical jump. We found that the degree of muscle activation in the specialty group was significantly higher than that in the general group for the different approach distances. Because vertical jump performance is closely related to the performance on the horizontal approach run, the results show that only those with a certain level of skill could achieve higher running vertical jump performance.

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DOES THE LIMITATION OF THE FIRST METATARSAL-PHALANGEAL JOINT IMPACT VERTICAL JUMP PERFORMANCE?

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INTRODUCTION: Athletes who participate in high-impact sports are at higher risk for acute and chronic forefoot injuries, including hallux rigidus (1). This alteration can result from repeated traumas and mechanical overloads especially in case of hyper flexion at the hallux. Hallux rigidus affects 10% of patients between the ages of 20-34 years and a incidence of 1 in 40 adults over the age of 50 (2) (3). The physiopathology of hallux rigidus corresponds to a degeneration of the 1st metatarsal-phalangeal (MTP) joint of the hallux and is characterised by a progressive decrease in the range of dorsiflexion at this joint. Hallux rigidus can involve a variety of therapeutic interventions, conservative or surgical The use of insoles is one of the conservative treatments. Such insoles (Morton's extension), thanks to a rigid element, consist of limiting the mobility of the 1st MTP joints. While this intervention is known to reduce pain in patients (4), its impact on the wearer's motion is unclear. The aim of this study was then to determine the biomechanical impact of limiting the 1st MTP joint during a jump task in healthy participants.

METHODS: All participants were sportive people (9 males and 3 females, age 27 ± 7.89 yrs, height 1.76 ± 0.56 m, body mass 71.3 ± 11.08 kg), free of neuromuscular disorders, and with no lower limb injuries in the past 6 months. The study was approved by a Research Ethics Board.

Participants had to perform counter movement jumps (CMJs) with and without insoles, in a random order, and with sport shoes provided by the experimenter.

A 10-high speed digital video camera system (Vicon) was used to record the 3-dimensional trajectories of retro-reflective markers placed on the athlete. It allowed to assess the position of the centre of gravity of the body and then to determine jump height. Force platforms (Kistler) embedded in the ground were used to assess the vertical impulse.

RESULTS: For the CMJ condition, there were no significant differences in jump height (41.46 ± 8.55 cm vs 41.38 ± 8.74 cm ; p=0.64) nor vertical impulse (183.30 ± 26.75 N.s vs 169.30 ± 61.52 N.s; p=0.18) with the insoles and without the insoles, respectively.

CONCLUSION: The main finding of this study was that the limitation of the first MTP joint did not induce any significant impact on the CMJ performance While this was true for healthy patients, it would be very interesting to investigate the impact of such rigid insoles in people suffering from hallux rigidus.

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AGE-RELATED CHANGES IN THE KINEMATICS OF THE LOWER LIMBS DURING DOUBLE- AND SINGLE-LEG REBOUND JUMPS

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INTRODUCTION: The single-leg jump, used in plyometric training, is one of the most effective ways to improve the short-distance running and jumping abilities of children (1). Age-related changes in the performance and kinetics of the lower limbs in single-leg jumping are similar to those of double-leg jumping, but with differences in some variables (2). Age-related changes in jumping performance depend on force performance (3) and jumping technique (4). Therefore, investigating how the jumping technique changes with age may us help to understand the causes of age-related differences in double- and single-leg jumping abilities. This study aimed to determine age-related changes in the kinematics of the lower limbs during double-leg and single-leg rebound jumps.

METHODS: Forty-five untrained males 7–15 years-of-age performed double-leg (RJ) and single-leg (SRJ) rebound jumps. Participants were verbally instructed to keep the contact time as short as possible and to jump as high as possible. Jump movements in the sagittal plane were filmed using a high-speed video camera (300 Hz) and were recorded using a force platform (1000 Hz). Seven body points and four calibration markers were digitized; the digitized coordinates were converted into real coordinates using four reference markers on the ground. The joint angle of the take-off leg was calculated using these coordinates. For each joint angle, differences between age groups were compared using a two-way analysis of variance (two exercises, four age groups).

RESULTS: The analysis showed no significant interactions for all variables. Significant main effects were observed between age groups for the ankle and hip joint angles of the RJ and the ankle-joint angle of the SRJ when landing ($p < 0.05$). In addition, a significant main effect on the hip-joint angle of the RJ was observed at take-off ($p < 0.05$). A significant main effect was observed between the exercises for the delta ankle joint angle of the RJ and SRJ of the flexion phase ($p < 0.05$). In addition, a significant main effect was observed for the delta ankle and knee joint angles of the RJ and SRJ of the extension phase.

CONCLUSION: The age-related changes in the ankle and knee joint angles at the point of landing and take-off showed similar trends in RJ and SRJ, whereas the age-related changes in hip angle showed different trends in RJ and SRJ. The delta-ankle angle of the flexion phase and delta ankle and knee joint angles of the extension phase in RJ were shown to be greater than that SRJ, except for some grades. These results suggest that age-related changes may cause differences in kinematics in the lower extremities during RJ and SRJ.

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THE EFFECT OF TENDON STIFFNESS ON MUSCLE POWER PRODUCTION DURING COUNTERMOVEMENT JUMP

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INTRODUCTION: Making good use of the stretch-shortening cycle (SSC) is important for enhancing sport performance. Previous studies suggested that compliant tendon may contribute to augmentation of jump height due to SSC (Kubo et al., 1999; 2007). While this is consistent with the traditional idea that the compliant tendon is advantageous for utilizing elastic energy (Cavagna, 1977), the stored elastic energy itself should not affect the jump height (van Ingen Schenau et al., 1997) . However, the tendon stiffness might affect the power exertion by muscle fibers because the elongation of the tendon affects the contraction velocity of muscle fibers. Therefore, we aimed to systematically investigate the effect of the tendon stiffness on the muscle power production during movement with SSC using a computer simulation.

METHODS: A Hill-type muscle model was used to simulate countermovement jumps using only the ankle joint. The model consisted of a contractile component (CC), a series elastic component (SEC), and a mass. From the initial resting state, the mass typically exhibited countermovement-like motion. The moment when the mass passed the initial position with upward velocity once it had fallen some extent was defined as the take-off. The jump height was calculated from the velocity of the mass at the take-off. The neural inputs to CC were optimized using a genetic algorithm to maximize the jump height. The optimized motion for a different spring constant (100 to 400 kN/m) of SEC was obtained.

RESULTS: The jump height decreased with an increasing spring constant. Both the time from the initial state to the take-off and the time average of exerted power by CC (the product of these two is equivalent to the jump height) also decreased with an increasing spring constant. Regardless of the spring constants, the time series of the neural inputs was similar: it became almost none after the initial resting state, causing downward movement, and rose to the maximum level instantly at a certain moment, which we call the "rising phase". The CC power dynamics was significantly different among the motions with different spring constants at the rising phase. While the motion with compliant SEC showed positive CC power constantly, that with stiff SEC showed negative CC power at the former half of the rising phase. This negative power led to lower CC work and thereby lower jump height.

CONCLUSION: CC was able to perform larger work with compliant SEC than with stiff SEC for two reasons. First, the motion time of the compliant SEC model was long because the natural frequency, which is proportional to the square root of the spring constant, is low. Second, the time average of exerted power by CC was large for the compliant SEC because of slower force development, which enabled CC to exert positive power all the time during the rising phase . In conclusion, the compliant SEC enabled CC to exert high power over a long time, and therefore enhanced the jump performance.

AN UPPER LIMBS PLYOMETRIC PERFORMANCE COMPARISON BETWEEN EXPERIENCED AND NON-EXPERIENCED ATHLETES.

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INTRODUCTION: Lower limbs plyometrics is a topic that is extensively studied in scientific literature. There are however a very few studies about upper limbs explosive movements (1), performed with one's bodyweight only. Here, we aimed at

comparing the ability to perform the classical exercise of push-up in an explosive way, of Street Workout (SW) athletes, that are particularly trained on upper limbs, and athletes from various sports, by adapting classical tests usually performed on lower limb, and see if the behavior on upper limbs matches the latter ones.

METHODS: Eighteen healthy male participated to this study (22.6 ± 2.1 yrs, 71.9±6.6 Kg, 179.6±7.1 cm). They were divided into 2 groups : Nine were street workout athletes, and the nine others practiced various other sports.

They performed 3 different forms of the push-up : one in a concentric way (equivalent to squat jump), the 2 others were done in plyometric way (counter movement jump and drop jump), and they did a fatigue-inducing set. Jump heights, EMG (on PEC, DELT and TRI) and acceleration of the body were recorded.

Muscular ultrasonography was performed at rest on 4 muscles involved in the push-ups (pectoralis major (PEC), anterior deltoid (DELT), long and lateral head of triceps brachii (TRI LONG and TRI LAT)).

RESULTS: 3 types of PU :

An ANOVA revealed that SW group had higher jump heights than CO group (respectively 18.1±5.7 and 11.0±4.8 cm, $p< 0.001$), but the jump height did not differ between modalities of PU. They were no difference of the EMG between groups or modalities.

Accelerations :

The repeated measures of ANOVA showed no effect of modality or interaction effect of group*modality. The maximal values of acceleration were 2.94 ± 0.27 G for CONC, 2.99 ± 0.29 G for PLYO and 3.06 ± 0.26 G for .

Fatiguing PU Set (FS) :

T-tests showed that SW group maintained higher relative jump heights than CO group (92,2±22,8 % of the first repetition for SW and 74,9±29,9 % for CO). The mean ratio of EMG on the DELT was greater in CO group, but for TRI it were greater in SW group. There was no difference for PEC. The relative EMG activity increased for both groups, reaching up to 149 % of the first repetition.

Muscle architecture :

SW athletes had higher PEC and DELT muscles thicknesses (MT) than CO group ($p<0.05$), but there was no difference for TRI. SW had greater pennation angles than CO on PEC only (SW = 6.9 ± 2.9° ; CO = 3.7 ± 2.3° , $p<0.05$). The was no difference for DELT and TRI.

CONCLUSION: Highest values of MT in general, and of EMG in the FS tend to suggest that the greater height reached by SW athletes when doing the explosive push-up can be attributed mostly to peripheral adaptations, and in a smaller extent to neuromuscular ones. The transferability of plyometric abilities of lower limbs to upper limbs are questioned, even in trained athletes. Further studies should emphasize the validation of this kind of push up test to assess upper limbs plyometrics.

LOWER LIMB STIFFNESS: RUNNING AND SINGLE LEG HOPPING TEST, IS THERE A LINK ? A PILOT STUDY.

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INTRODUCTION: Return to run is a step in the continuum of return to sport for many injuries such as ankle sprains or anterior cruciate ligament ruptures. Rehabilitation and screening prior to return to run can consist in hopping to estimate lower limb stiffness (1). Stiffness could be estimated during hopping (Kn) and during running (two indexes, Kleg and Kvert) with ground contact and flight time measurement (2,3). But even if the estimation of stiffness at these two motor tasks is based on the spring-mass model, only few evidence investigates the relation between them. The aim of this study is to evaluate the relationships between Kn, Kvert and Kleg to assess the possible interchangeability of these indexes.

METHODS: 25 recreational runners performed 3 sessions of 6-min bout of running on a treadmill (Monark Exercise AB, Vansbro, Sweden) followed by 20-second of single leg hop tests. Running speed was set at the preferred running speed (PRS). Runners performed the hop test with each limb at an imposed frequency of 2.2 Hz and at preferred hopping frequency (PHF)(4). Computation of Kn, Kvert and Kleg was performed from spatiotemporal parameters measured with the optoelectronic system Optogait (Microgate, Bolzano, Italy). A repeated measurement correlation coefficient (RmCorr, 3 sessions datas) was performed between Kn at 2.2 Hz or PHF and Kvert or Kleg at PRS (5).

RESULTS: There was no correlation between Kvert, Kleg and Kn at 2.2 Hz hopping condition ($p>0.05$). There was a significant correlation between Kvert at PRS and Kn at PHF ($p<0.05$). The strength of the correlation between Kvert and Kn was moderate ($r = 0.49$, CI 0.24-0.68) when comparing limb to limb (right lower limb vs right lower limb) or when comparing Kn to an overall Kvert value (right and left lower limb combined; $r = 0.50$, CI 0.25-0.69). The strength of correlation between Kleg and Kn was also moderate for limb-to-limb comparison ($r =0.35$, CI 0.07-0.58) or combined limb comparison ($r = 0.33$, CI 0.04-0.56).

CONCLUSION: Frequency of 2.2 Hz is recommended for the single hop test (6), but this frequency is not relevant to compare stiffness measured in running and hopping (single leg) condition. Fixed frequency imposes a contact time that influences the value of Kn and the joint involved in the stiffness and could explain our results (4). Kvert, Kleg and Kn at PHF appear to be moderately correlated, but the confidence interval of the correlation makes the clinical applications unrelia-

ble. This may be explained by the variety of speeds at PRS and running styles. Future studies should investigate speed and running style influence on the correlation between Kleg and Kn and asymmetry of these parameters.

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LINEAR DISCRIMINANT ANALYSIS FOR AUTOMATIC CLASSIFICATION ON STANDARD MAXIMUM VERTICAL JUMP

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INTRODUCTION: Countermovement (CM) is a common element at several sports, with reversible action preceding the movement in the intended direction for efficient submaximal and powerful maximal action [1]. At lower limbs CM has been studied on standard maximum vertical jumps (MVJ) with long CM on countermovement jump (CMJ) and short CM on drop jump (DJ) for comparison to squat jump (SJ) without CM [2, 3]. Despite guidance provided to the performers on execution of SJ, CMJ and DJ there is a natural tendence to precede SJ with slight CM as well as on DJ to accomplish a long CM, thus leading to some mixture on the type of performed trials depending on subjects' jumping technique, and the need for improvement of automatic trials classification.

For this reason, we performed linear discriminant analysis (LDA) for segmentation-based learning on previous SJ, CMJ and DJ trials for subsequent automatic classification, reducing operator time consumption and improving objective classification supported by kinematic and dynamic extracted variables.

METHODS: A total of 46 dynamic and kinematic predictor variables were selected from best MVJ trial execution of 198 repetitions from 3 SJ, 3 CMJ and 3 DJ by two groups of nT=16 trained (T) athletes of the Portuguese national volleyball team (21.4±3.1)yrs, (85.2±5.8)kg mass and (1.93±0.04)m height and nU=6 untrained (U) students of sports and physical education degree, without specific sports records or injuries, ages (21.5±1.4)yrs, (76.7±9.3)kg mass and (1.79±0.06)m height.

Selected variables from 7 different categories of time (t), vertical resultant force (F), impulse (I), whole body vertical velocity (vz), vertical displacement (z), mechanical power (P) and work (W) were computed from ground reaction forces (GRF) acquired during impulse phase by an AMTI BP2416-4000CE force plate at 1000 Hz coupled to Mini Amp MAS-6 and grouped on four communities of (i) t-F-I, (ii) F-v-P, (iii) F-z-W, and (iv) global t-F-I-v-P-z-W community. LDA was applied to each community and results were compared among T, U groups individually and T&U together.

RESULTS: LDA yielded two statistically significative ($p<0.05$) discriminant functions with first function F1 accounting for larger explained variance (s2) at U, T, U&T for (i) 98.0%, 61.4%, 85.1%, (ii) 98.5%, 85.0%, 79.8%, (iii) 77.7%, 57.6%, 55.6%, (iv) 98.0%, 94.1%, 88.7%, whereas F2 accounts for the remaining s2.

CONCLUSION: F1 explained s2 point for a similar pattern at (ii)-(iv): U>T>U&T with (i): U>U&T>T and s2↓ with n↑. F1 explaining larger s2, discriminates more often SJ from DJ, whereas F2 discriminates mostly CMJ from SJ,DJ pointing for larger difference between SJ and DJ, with CMJ lower difference to SJ and DJ. LDA thus presented as powerful discrimination tool with learning ability for automatic classification of new MVJ trials.

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EFFECT OF DIFFERENT GAIT PATTERNS ON VENTILATION AND MUSCLE ACTIVITIES IN RESPONSE TO SINUSOIDALLY CHANGING TREADMILL SPEED

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INTRODUCTION: There is a U-shaped relationship between energy cost of transport per unit distance (CoT; J•kg-1•km-1) and gait speed (v) during walking and a linear relationship during running. The intersection between U-shaped and linear CoT-v relationships is termed energetically optimal transition speed (EOTS). We investigated the effect of different gait patterns on ventilatory and muscle activities in response to sinusoidally changing treadmill speed.

METHODS: Twelve healthy young subjects performed three sinusoidal exercise protocols on a treadmill. One sinusoidal protocol was the combination of walking and running (walk and run condition: WR) that the treadmill speed was sinusoidally changed in a range of individuals' EOTS ± 1.5 km•h-1. A second was the complete running (run condition: R) that the treadmill speed was changed in a range of ([EOTS ± 1.5 km•h-1] ± 1.5 km•h-1). A third was the complete walking (walk condition: W) that the treadmill speed was changed between 3 and 6 km•h-1. Breath-by-breath pulmonary ventilation (VE: integrating tidal volume [VT] and breathing frequency [Bf]) and metabolic demands (CO2 output [VCO2] and O2 uptake [VO2]) were measured under the WR, R, and W conditions. Muscle activities were measured by electromyography of the ankle dorsi-flexor (tibialis anterior [TA]) and ankle extensors (gastrocnemius [GAS] and soleus [SOL]) muscles throughout the sinusoidal walking.

RESULTS: Mean values of metabolic rate (VCO2 and VO2) and VE increased with the increase in gait speed (all $p<0.001$). The amplitude (Amp) response of VE, VCO2, and VO2 were significantly greater under the WR condition compared to the R or W conditions (all $p<0.001$). The mean and Amp values of the GAS muscle slightly increased under the R condition, but those values of the TA and SOL muscles decreased under the R condition. In addition, the significantly greater Amp response of VE under the WR condition was significantly associated with the greater Amp in VCO2 ($r2=0.97$, $p<0.001$) and VCO2 ($r2=0.90$, $p=0.003$) under the WR, but independent of the muscle activity.

CONCLUSION: Transition from walking to running induced a significant increase energy expenditure, hyperventilation, and a slight increase in the GAS muscle activity. On the other hand, the greater Amp response of ventilation at the EOTS may be primarily mediated by metabolic response rather than neural drive.

EFFECTS OF HIGH-INTENSITY INSPIRATORY MUSCLE WARM-UP ON HIGH-INTENSITY EXERCISE PERFORMANCE AND MUSCLE OXYGENATION

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INTRODUCTION: The inspiratory muscles become fatigued during high-intensity exercise performed to exhaustion. Inspiratory muscle fatigue (IMF) causes a metaboreflex, which reduces blood flow to an active limb. Therefore, IMF can have a negative impact on high-intensity exercise performance by impairing oxygen supply to muscles in the active limb. Inspiratory muscle warm-up (IMW) increases inspiratory muscle function immediately and is used to decrease and delay IMF. However, the effects of IMW on high-intensity exercise performance and active limb oxygenation are not consistent1,2. High-intensity exercise requires higher ventilation, which increases the activity of the inspiratory muscles and recruitment of accessory inspiratory muscles. Most IMW studies have been conducted at moderate loads (40% maximal inspiratory mouth pressure [MIP])1,2 but accessory inspiratory muscles become further active at higher inspiratory loads. Therefore, higher-intensity IMW may be necessary when performing high-intensity exercise. This study investigated the effects of high-intensity IMW on high-intensity exercise performance and muscle oxygenation.

METHODS: Eleven healthy men (mean age, 22 ± 2 years; mean VO_2max 52.6 ± 4.9 ml/kg/min) performed constant-load exercise to exhaustion on a cycle ergometer at VO_2max under two conditions in randomized order. The two conditions were IMW before exercise, namely, a placebo condition (PLA), and a high-intensity condition (HIGH) with respective inspiratory loads set at 15%MIP and 80%MIP. MIP was measured before and after IMW. Total hemoglobin was measured in the right vastus lateralis by near-infrared spectroscopy during exercise. Perception of leg exertion was measured at 1 and 2 min into exercise.

RESULTS: Mean exercise tolerance time was significantly longer under HIGH than under PLA (238 ± 57 s vs. 220 ± 47 s, $p=0.042$). MIP was significantly increased after IMW under HIGH (from 123 ± 20 cmH_2O to 133 ± 25 cmH_2O, $p=0.018$). Total hemoglobin was significantly higher under HIGH than under PLA at 40% and 60% of total exercise time. Perception of leg exertion was significantly lower under HIGH than under PLA at 2 min of exercise.

CONCLUSION: Considering that total hemoglobin is considered to be an index of local blood flow, the results of this study suggest that high-intensity IMW increases blood flow to active limbs during exercise. The results may also reflect a reduction in perception of leg exertion. IMW may increase blood flow to active limbs and improve exercise performance.

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TRANSFER FUNCTION ANALYSIS DETERMINED CEREBROVASCULAR CO2 REACTIVITY WITHOUT CARBON DIOXIDE INHALATION

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INTRODUCTION: The established methods for determining cerebrovascular carbon dioxide (CO2) reactivity (CVR), as an index of cerebral vascular regulation, require a CO2-inhalation challenge. However, CO2-inhalation potentially causes acute stress or hyperventilation that can modify CVR. The purpose of the present study was to test if CVR can be assessed without including a CO2-inhalation challenge.

METHODS: In twenty-one healthy participants, CVR was assessed by the transfer function analysis (TFA) between middle cerebral artery blood velocity (MCA V) and predicted arterial pressure of CO2 (PaCO2) during spontaneous respiration. TFA gain and phase were calculated to index the magnitude and time constant responses of CVR, and compared with CVR indices determined using a CO2-inhalation challenge. Response to orthostatic stress (50° head-up tilt; HUT) was ascertained because attenuates CVR indices determined using CO2-inhalation.

RESULTS: During HUT, the magnitude and time constant of MCA V responses to CO2-inhalation were decreased (P<0.001) and increased (P=0.001), respectively, indicative of attenuated CVR. In contrast, TFA gain in the very low-frequency range (VLF, 0.005-0.024 Hz) was unchanged, while the TFA phase in the VLF approached zero (–0.39±0.59 vs. 0.31±0.78 radians, P=0.003), indicative of enhanced CVR, during HUT.

CONCLUSION: These findings suggest that TFA-determined CVR during spontaneous respiration does not track HUT-evoked reductions in CVR identified using CO2-inhalation, suggesting that CO2-inhalation is necessary to assess CVR adequately.

IS THE VO2MASTER, A PORTABLE SPIROMETRIC DEVICE, A VALID TOOL TO ASSESS THE OXYGEN CONSUMPTION?

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INTRODUCTION: Measurements of human metabolism via indirect calorimetry are fundamental in many research areas such as health, exercise and training, and athletic performance. To date, laboratory-based gas analysis systems are considered as state-of-the-art measurements, however, several portable metabolic gas analyzers have emerged, allowing analysis in field-based setting[1] Field testing offers the possibility to replicate the actual demands of different sports disciplines, such as soccer, more realistically compared to laboratory-based assessments [2]. Recent research indicates that portable metabolic gas analyzers can be a valid and reliable tool in steady-state measurements [2], however, several analyzers show limitations in assessing moderate to vigorous intensities[3]. Therefore, this study aims to evaluate the validity of a novel portable spirometry (VO2Master Analyzer, VO2 Master Health Sensors Inc, Canada) compared to a stationary metabolic cart (Oxycon Pro, Jaeger, CareFusion, USA) in female soccer athletes.

METHODS: Twelve female amateur soccer athletes (Age: 22.2±3.7 years; BMI: 22±3.0 kg/m2; VO2max: 50.75±4.2 ml/min/kg) volunteered to participate in the randomized-controlled study which included two non-consecutive laboratory visits within one week. Demographic and anthropometric data were collected on the first visit, including age, weight, height, BMI, % body fat, and self-reported physical activity. On both test days, the same protocol was performed which included: assessments of heart rate (HR) and oxygen consumption (VO2) during 5min of running on a treadmill at a velocity of 7km/h (low intensity), and during an incremental step test on the treadmill until volitional exhaustion to measure the VO2peak (vigorous intensity). The incremental step test started at a velocity of 7km/h with an incline of 1%. Every minute the velocity was increased by 1km/h until volitional exhaustion. To assess VO2 and VO2peak, a portable spirometry (Vo2Master Analyzer) and a stationary criterion measure (Oxycon Pro, Jaeger) were used.

RESULTS: The results revealed a significant difference between the oxygen consumption under different loads assessed with the stationary metabolic cart (relative VO2peak: 50.75±4.2 ml/min/kg; low intensity: 1732.7±299.1 ml/min) and the portable spirometric device (relative VO2peak:43.44±5.8 ml/min/kg; low intensity: 1467.0±218.0 ml) (p<0.001; cohen's d=0.800 and p=0.001; cohen's d=0.423) in the female soccer athletes. Bland-Altman plots have shown a lack of reproducibility in the measurements between the two devices, with medium mean differences for the evaluated spirometric parameters and 30% of the measurements not being within the limits of agreement.

CONCLUSION: Our results don't support the use of the new portable spirometric device as a reliable spirometer for the assessment of various spirometric patterns in practice, but more data is needed in various populations is needed to verify the results.

PEAK OXYGEN UPTAKE IS SLOPE DEPENDENT: INSIGHTS FROM GROUND REACTION FORCES AND MUSCLE OXYGENATION

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INTRODUCTION: This study explores the effect of treadmill slope on ground reaction forces and local muscle oxygenation as putative limiting factors of peak oxygen uptake (VO2peak) in graded maximal incremental running tests.

METHODS: Thirteen healthy subjects completed five maximal incremental running tests on treadmill at -15%, -7.5%, 0%, 7.5% and 15% slopes while cardiorespiratory and local muscle oxygenation responses as well as ground reaction forces were continuously recorded. Blood lactate concentration and isometric knee extensor torque were measured before and after each test.

RESULTS: VO2peak was lower at -15% slope compared to all other conditions (from –10% to –17% lower, $p < 0.001$), with no difference between -7.5 to +15% slope. Maximal heart rate and ventilation values were reached in all conditions. The negative external mechanical work increased from steep uphill to steep downhill slopes (from 6% to 92% of total external work) but was not correlated with the VO2peak reduction. Local muscle oxygenation remained higher in -15% slope compared to level running ($p = 0.003$). VO2peak can be reached in downhill running up to -7.5% slope.

CONCLUSION: At more severe downhill slopes (i.e., -15%), greater negative muscle work and limited local muscle deoxygenation occurred, even in subjects familiarized to downhill running, presumably preventing the achievement of VO2peak.

DIAPHRAGMATIC FUNCTION ASSOCIATED WITH AEROBIC ENDURANCE IN LONG DISTANCE RUNNERS

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INTRODUCTION: Long-distance running has been proven be beneficial to the cardiopulmonary function in previous studies, and became a very popular exercise. Since the diaphragm is the most important respiratory muscle, the diaphragmatic function could be one of the key factors that influence the performance of long-distance running (Hellerstein & Moir, 1985; Zdziarski et al., 2016). However, to date none has investigated the diaphragmatic function in long-distance runners. The contributions of diaphragmatic functions to aerobic endurance remains unknown (Gopaladhas et al., 2014). Therefore, the main purposes of this study were to compare the diaphragmatic function in long-distance runners and young adults using the ultrasonography, and to investigate the correlations between the diaphragmatic function and aerobic endurance.

METHODS: This study was a case-control study including the 12 long-distance runners who have been regularly trained for at least 6 months (runner group), and 16 young adults without long-distance running experience (control group). All participants received the same measurement. Aerobic endurance including maximal oxygen uptake and exercise intensity were evaluated using the cardiopulmonary exercise testing (CEPT) (Ultima™ CardiO2®+ Corival CPET ergometer, MGC Diagnostic®, Saint Paul, USA). The diaphragmatic function including diaphragmatic mobility and thickness changes during maximal inspiration and expiration were assessed using the ultrasonography (ACUSON NX3TM Ultrasound system, Siemens Solution USA, Inc). In addition, diaphragmatic strength indicated as maximal inhalation and exhalation pressure (MIP, MEP) were tested using the gas gauge.

RESULTS: The results found that the MEP ($p=0.043$), maximal oxygen uptake ($p<0.001$) and maximal exercise intensity ($p=0.007$) for the long-distance runners were significantly higher than that for the control group. Group difference in MIP, diaphragmatic mobility and thickness change was not found. Furthermore, all diaphragmatic measures were significantly correlated with the maximal oxygen uptake ($r=0.22$ to 0.508, $p<0.05$), and MEP was correlated with the total exercise intensity ($r=0.515$, $p=0.01$).

CONCLUSION: Only diaphragmatic strength especially MEP was stronger in the long-distance runners but not diaphragmatic mobility and thickness change, although the runners have better aerobic endurance than the controls. However, the correlation analysis revealed that diaphragmatic function including strength, mobility and thickness change were all related to the aerobic endurance. Diaphragmatic training could be considered for the long-distance runners in the future.

ACUTE EFFECTS OF SINGLE VS. COMBINATORY INHALED B2-AGONISTS SALBUTAMOL AND FORMOTEROL ON TIME TRIAL PERFORMANCE, LUNG FUNCTION, METABOLIC AND ENDOCRINE PARAMETERS

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INTRODUCTION: High prevalence rates of β2-agonists amongst athletes makes it tempting to speculate that illegitimate use of β2-agonists might boost performance in competitive sports. However, data regarding the underlying molecular basis of potential performance-enhancing effects of β2-agonists are scarce.

METHODS: To investigate single vs. combinatory doses of nonprohibited, effects of the short-acting β2-agonists salbutamol (SAL) and long-acting formoterol (FOR), 24 competitive endurance athletes (12f/12m) participated in a double-blinded balanced 4-way block cross-over trial to evaluate the performance-enhancing potential of SAL and FOR compared to placebo (PLA). Measurements included skeletal muscle gene and protein expression of nuclear NR4A receptors, endocrine regulation, urinary and serum β2-agonist concentrations, cardiac markers, cardiopulmonary and lung function as well as the 10-min time trial performance (TT) on a bicycle ergometer as main outcome variables. Blood and urine samples were collected Pre-, Post-, 3h Post-, and 24h Post TT.

RESULTS: Mean power output during TT was not different between the respective study arms. Treatment effects regarding lung function, echocardiographic and metabolic parameters were observable without any influence on performance as well as higher total serum β2-agonist concentrations in female athletes for SAL and FOR. Muscle and microarray analysis did not show any treatment effect on NR4A protein and NR4A1/NR4A3 gene expression, whereas a whole group treatment effect was observable for NR4A2 and further target genes with strongest effect by SAL+FOR. Noradrenaline, adrenaline, and transforming growth factor-β concentrations in blood were not affected by treatment or sex, whereas insulin-like growth factor, follicle-stimulating hormone, luteinizing hormone, and insulin concentrations showed a treatment effect at different time points.

CONCLUSION: There is no performance-enhancing effect in this study design with the used doses of β2-agonists either alone (SAL or FOR) or in combination (SAL+FOR) compared to PLA.

An acute effect on the lung and cardiac function as well as endocrine and metabolic parameters was observable without clinically relevant side effects and with presumably no impact on exercise performance capacity in healthy subjects, but the impact of chronic applications of β2-agonists to healthy individuals and sex-specific thresholds have still to be determined.

EXERCISE-INDUCED BRONCHOCONSTRICTION IN CHINESE ELITE ATHLETES OF OLYMPIC SUMMER SPORTS EVENTS

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INTRODUCTION: The aim of this study was to investigate the prevalence of exercise-induced bronchoconstriction (EIB) among Chinese elite athletes who participated in the Olympic Summer Games. The study also aimed to compare the prevalence of EIB across different sport events and analyze the characteristics of key indicators related to respiratory inflammation and ventilatory function in athletes with EIB.

METHODS: A total of 413 elite athletes (235 females and 178 males) of 15 different summer sports were recruited for this study. They were categorized, based on their environments in which they received trainings, into either indoor (pool- or land-based) or outdoor sport events (road- or venue-based), and based on their sport events characteristics into endurance, skill, speed & strength, or team sport. Respiratory symptoms during exercise, asthma history, and EIB information were collected through a questionnaire. Pulmonary function data, including forced expiratory volume in the first second (FEV1), maximum ventilation, forced vital capacity, expiratory peak air flow rate, were collected during a bronchial exercise provocation test, and the drop rate of FEV1 was used to diagnose EIB. The inflammatory responses of each athlete were evaluated through venous blood samples, and chi-square tests, independent sample t-tests, or repeated measures analysis of variance were used to identify the significance.

RESULTS: Of all the 413 elite athletes, a total of 109 athletes were diagnosed with EIB, resulting in an overall prevalence of 26.5%. Swimming (51.5%), hockey (40.7%), synchronized swimming (40.0%), rugby (38.5%), and track and field (33.3%) had the highest prevalence of EIB, while judo (11.1%), rhythmic gymnastics (10.5%), badminton (9.5%), weightlifting (9.5%), and wrestling (6.5%) had the lowest prevalence. Female athletes had a significantly higher prevalence of EIB compared to male counterparts (30.2% vs. 21.3%, P = 0.049). The prevalence of EIB was significantly higher in endurance events athletes than speed & strength events ones (37.3% vs. 20.0%, P = 0.038) and significantly higher in outdoor sports events athletes than indoor sports events athletes (33.1% vs. 21.6%, P = 0.05). There was no significant difference between the venue- and road-based events in outdoor environments. All pulmonary function parameters were significantly lower in athletes with EIB, indicating lower lung function than those without EIB. Athletes with EIB also had significantly higher levels of certain blood-related indexes, such as eosinophil count, neutrophil count, IL-6, IL-8, and CC16 levels, compared to athletes without EIB.

CONCLUSION: The findings of the study reveal that Chinese elite athletes who participated in the Olympic Summer Games were significantly impacted by EIB. Athletes with EIB exhibited lower levels of lung ventilation and severe airway inflammation. As a result, stakeholders such as athletes, coaches, and sports administrations should pay close attention to EIB problems and take appropriate measures to prevent them. Specifically, monitoring inflammatory indicators is recommended as an early preventative strategy.

FIRE PROTECTION EQUIPMENT LOAD AND MOVEMENT SPEED AFFECTS RESPIRATORY PARAMETERS AND SUBSTRATE UTILIZATION OF BRAZILIAN FIREFIGHTERS: A PILOT STUDY

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INTRODUCTION: Firefighters are often exposed to complex tasks and situations that demand physical strain, requiring good tactical and physical conditions to burden their occupational performance [1]. The use of protective garments by firefighter's influences their metabolic cost [2] and limits the maximum speed of running [3]. Considering the submaximal aerobic demands of firefighting tasks [1], this study aims to test the effect of carrying the fire protection equipment load under different submaximal running speeds on respiratory parameters and substrate utilization of Brazilian firefighters.

METHODS: Five firefighters performed three minutes of walking (4 km·h−1 - WALK) and running (8 km·h−1 - RUN), under the conditions of wearing light clothes (LIGHT) or their personal protective equipment (PPE). PPE was composed of boots, gloves, a bunker jacket, a bunker pants, hood, helmet, and oxygen cylinder, and averaged 22.8 kg. Relative oxygen consumption (VO2), energetic expenditure, minute ventilation, breathing frequency, tidal volume, respiratory quotient, and relative use of carbohydrate (CHO) as substrate were retained for analysis, using the breath-by-breath data analysis (QUARK, COSMED). Two-way ANOVA was performed to test for speed and condition effects, with Scheffés S procedure as post-hoc whenever the interaction significance was met ($p<0.05$).

RESULTS: Relative VO2 consumption presented no effect for condition (LIGHT = 21.6±9.1vs PPE = 21.7±7.9 ml·kg−1·min−1), despite the effect for speed (WALK = 14.2±2.0 vs RUN = 29.15±4.1 ml·kg−1·min−1). However, the energetic cost was higher in PEE (604±273 kcal·min−1) than LIGHT (450±203 kcal·min−1), confirming PPE's effect on the metabolic cost of running [2]. Minute ventilation was also affected by both condition ($p = 0.01$) and speed ($p <0.001$). However, breathing frequency was not significantly higher in PPE (27.9±6.0 b·min−1) than in LIGHT (25.4±4.7 b·min−1), leaving the tidal volume (PPE=1.72±0.60 vs LIGHT=1.39±0.50L·min−1; p=0.04) as the major contributor for PPE effect on minute ventilation. The only variables with a significant interaction between condition and speed were the respiratory quotient (p=0.0041) and substrate use (p=0.002).

This revealed higher values for CHO use in RUN+PPE condition (94.2± 8.4%) than RUN+LIGHT (32.2±14.9%), but not significant different values between WALK+PPE (7.7±6.6%) and WALK+LIGHT (4.4±6.0%).

CONCLUSION: The use of PPE by firefighters altered the energy expenditure, minute ventilation, and tidal volume during walking and running. Relative VO2 was not altered by the PPE load because it considered the total weight of the system (firefighter+PPE). PPE load also affected the respiratory quotient in favor of CHO use only in the running speed, suggesting the need for attention on CHO depletion of firefighters when under higher intensity activity.

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MODERATE PHYSICAL ACTIVITY REDUCES THE LIKELIHOOD OF SARCOPENIA IN COMMUNITY-DWELLING OLDER WOMEN: A CROSS-SECTIONAL APPROACH

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INTRODUCTION: The time spent in different intensities of physical activity (PA) is associated with the risk for sarcopenia in community-dwelling older women. We aimed to evaluate the role of sitting time and PA level as predictors of sarcopenia risk.

METHODS: In a cross-sectional study, physically independent older women (n=67) performed the six-minute walk test to identify functional limitations (≤400m). Sedentary time (as sitting time) and PA (light, moderate and vigorous) were obtained with the International Physical Activity Questionnaire (IPAQ) [1]. Sarcopenia was diagnosed by the Society of Sarcopenia, Cachexia and Wasting Disorders (SCWD) [2] recommendations. Sarcopenia risk (low muscle mass and functional limitation) was predicted by binary logistic regression, considering the weekly sitting time and PA, as independent variables.

RESULTS: Sarcopenia prevalence was 7.5% (n=5), with functional limitation present in 38.8% (n=26), and low muscle mass in 22.4% (n=15). The predictive model (p=0.014) involved moderate PA as the only significant predictor (OR=0.999; p=0.005; 95% CI: 0.998–1.000) of functional limitation. Moderate PA prevents sarcopenia risk. Each weekly hour of moderate PA decreased the risk of sarcopenia by 6%.

CONCLUSION: The time spent in moderate PA of community-dwelling older women was found to be independently associated with sarcopenia risk. PA level is significantly associated with the functionality of older adults. The sarcopenia risk in community-dwelling older women decreases by 6% for each additional hour/day moderate PA performed. Even so, it is a compensatory strategy for the imminent risk of sarcopenia, which is 18% for every year lived. In conclusion, the time spent in moderate PA can prevent sarcopenia regardless of sitting time.

AQUATIC AEROBIC EXERCISE TRAINING PERFORMED IN WARM VS. COLD WATER IN ELDERLY PATIENTS WITH TYPE 2 DIABETES

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INTRODUCTION: Type 2 diabetes is a chronic condition with significant vascular complications. Aquatic aerobic exercise has shown promise as a therapeutic approach to improve vascular and other function in patients with diabetes, but the impact of water temperature on these effects remains unclear. This study aimed to compare the effects of warm water (36°C) and cold water (20°C) exercise training on macro- and micro-vascular function and other key indicators in elderly patients with type 2 diabetes.

METHODS: Twenty seven elderly participants (67 ± 1 years) with type 2 diabetes were randomly assigned to either a warm water (n=15) or a cold water (n=12) exercise training group. Both groups performed hip-level water cycling exercises with an intensity of 60-75% of their maximum heart rate, three times a week over a 12-week period. Exercise duration was gradually increased for 15 minutes in the first month, 20 minutes in the second month, and 30 minutes in the last month. Various parameters, including general characteristics, blood biochemistry, vascular function and quality of life, were measured before and after the training sessions.

RESULTS: The results showed that after 12 weeks, both warm water and cold water groups experienced decreases in heart rate at rest and systolic blood pressure ($p < 0.05$). Peak oxygen consumption measured on a cycle ergometer increased ($p < 0.05$) and quality of life improved in both groups. Both groups also experienced increases in plasma nitric oxide concentration, decreases in hemoglobin A1C, and lipid and lipoprotein concentrations ($p < 0.05$). Arterial stiffness as measured by brachial-ankle pulse wave velocity decreased and flow-mediated dilation in the popliteal artery improved in

both groups ($p < 0.05$ for both). Subcutaneous vasodilatory capacity increased in both exercise groups in the finger but only the warm exercise group improved it in the foot.

CONCLUSION: This study found that aquatic aerobic exercise training, regardless of water temperature, led to significant improvements in various functional measures in elderly patients with type 2 diabetes. However, warm water-based cycling exercise training was found to be more effective in improving subcutaneous vascular function.

PHYSICAL ACTIVITY LEVELS AND CARDIOMETABOLIC MARKERS IN INDIVIDUALS WITH NEWLY DIAGNOSED TYPE 2 DIABETES: A BASELINE ANALYSIS OF THE MOTIVATE T2D RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Physical activity (PA) is generally recommended to improve cardiometabolic health in people living with type 2 diabetes (T2D) with recent evidence suggesting that even small amounts of vigorous PA (up to 2 minutes per day) can lower mortality risk and improve cardiometabolic outcomes. However, the relationship between different levels of PA and metabolic health in people with newly diagnosed (<2 years) T2D needs further investigation. Our aim was to characterize device-measured PA in individuals with newly diagnosed T2D and explore relationships with measures of cardiometabolic health.

METHODS: This was a baseline analysis of the MOTIVATE T2D trial (NCT04653532); a feasibility RCT investigating an mHealth exercise intervention. Individuals aged 40-75 yrs (55.6 ± 8.9 years) living with newly-diagnosed T2D (12.6 ± 6.1 months diagnosis) living across Canada and the UK were recruited (N=120). Participants received self-testing health kits, via mail, at baseline to measure waist circumference (WC), height, weight, blood pressure (BP), HbA1c and PA levels. PA monitors (GENEactiv) were worn for 14 days. Sufficient wear time was defined as a minimum of 16 h per day on at least 5 days (11 ± 2 days). Relationships between HbA1c, BP, BMI and levels of PA were explored using multiple linear regression, with age and sex as covariates.

RESULTS: Data from individuals with complete anthropometrics (BMI: 34.4 ± 7.5 kg/m2), HbA1c (6.8 ± 0.9%), BP (SBP: 128 ± 13 mmHG, DBP: 81 ± 9 mmHG) and valid PA monitor days were used (n=88). Overall, individuals with newly diagnosed T2D completed an average of 157 ± 51 minutes of light activity (< 4 METS) per day, 32 ± 22 minutes of moderate activity (4-7 METS) per day, and 1 ± 2 minutes of vigorous activity (> 7 METS) per day. 49% (43/88) achieved > 30 minutes of MPA per day whereas only 18% (16/88) achieved VPA greater than 1 minute per day and 20% (18/88) achieved VPA greater than 2 minutes per day. There were no significant relationships between cardiometabolic health measures and levels of PA. Furthermore, additional explorations revealed no significant differences between age and sex amongst these variables.

CONCLUSION: Less than half of individuals with newly diagnosed T2D meet moderate exercise PA guidelines and spend very little time engaging in vigorous activity. Our preliminary results do not support a relationship between the outlined cardiometabolic markers and PA metrics in individuals with newly diagnosed T2D living across Canada and the UK. Results of this exercise/PA intervention should help to determine if increasing levels of PA can improve cardiometabolic health in newly-diagnosed T2D.

EFFECTS OF INSPIRATORY MUSCLE TRAINING AND NORDIC WALKING ON PHYSICAL FITNESS: A PILOT STUDY

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INTRODUCTION: Nordic Walking (NW) is a growing sport practise in Europe, specifically in older adults (OA) (1). Several studies have found interventions with positive effects in short and medium term (2,3). To expound on, the NW provide benefits on some aspects as gait pattern, gait velocity and step length, as well as in strength, balance, physical condition, and quality of life (3,4). Furthermore, the Inspiratory Muscle Training (IMT) increases VO2 peak, performance in exercise and inspiratory muscle strength (6,7). Up to our knowledge, it remains unknown the effect of combining NW and IMT on physical function and body composition in OA, which is the main objective of this intervention.

METHODS: Thirty-four OA was evaluated of body composition, dynamic inspiratory strength (S-Index) and physical condition (lower limbs: 5STS; manual gripping: HG; and cardiorespiratory fitness: 200m) before and after intervention. Thirty-four elderly were recruited from May and December 2022. Eighteen complete the final sample and were divided into two groups: Sham (S) (69.24±4.59yr; 72.32±11.65Kg; 27.80±3.31Kg/m2 n=9) and experimental (E) (68.43±4.33yr; 71.03±9.93Kg; 26.52±2.44Kg/m2, n=9). Combined training consisted in 8 weeks of three sessions for 60 minutes of NW (two supervised, one no-supervised), and 30 inspirations, twice daily, 7 days/week at 50% (experimental) or 15% (sham) of S-Index. Eighteen completed 70% of assistance. To find out the differences after intervention, two-way ANOVA repeated measures or Wilcoxon test were used according to the sample normality.

RESULTS: Eight weeks improved anthropometrical parameters. Fat mass (FM), Hip, Waist-Hip ratio and BMI decreased significatively in both groups (FM: S-IMT p=0.03, E-IMT p=0.049; Hip: S-IMT p=0.05, E-IMT p=0.012;ICC: S-IMT p=0.25, E-IMT p=0.26; BMI: S-IMT p=0.000, E-IMT p=0.04). Weight reduction trended to significance (p=0.54). Unexpectedly, we found a height improvement in both groups (S-IMT p=0.005, E-IMT p=0.02). Related to 200m, cardiorespiratory fitness enhanced only in the sham-IMT group (p=0.026, E-IMT p=0.33); and Handgrip only trended to a significance increase in the experimental group (p=0.05).

CONCLUSION: Up to our knowledge this is the first study to combined NW+IMT. Eight weeks are enough to improve body composition in both groups, despite cardiorespiratory fitness only improves in sham-IMT group. Despite the small sample, 8-weeks were also enough to improve 200m speed (3), which could be because the improvement in NW technique concerns an improvement of the gait technique. Waist-Hip ratio and fat mass decrease, helping a better cardiovascular health (1). Nevertheless, these results should be confirmed and the effect of adding IMT to NW regarding physical fitness should be investigated in future studies with a larger sample size.

1: Skórkowska, 2016; 2: Tschentscher et al., 2013; 3: Manosur 2018; 5: Dalton & Nantel 2016; 6: Aznar-Laín et al., 2007; 7: Mills et al., 2015.

CAN COOLING GARMENTS AID EXERCISE THERAPY IN PEOPLE WITH MULTIPLE SCLEROSIS?

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INTRODUCTION: Multiple sclerosis (MS) is an autoimmune neurodegenerative disease affecting an estimated 2.3 million people worldwide. There is strong evidence for the benefits of exercise therapy for people with MS, however, up to 80% of people with MS report experiencing heat sensitivity, where MS symptoms become worse with elevated body temperature. Therefore, practical and effective strategies to reduce body temperature are needed for people with MS who want to be active outdoors, especially in warmer environments. A range of cooling strategies designed to assist people with MS to manage heat sensitivity have been investigated, predominantly cold-water immersion and the application of specialised water-perfused cooling garments. Lightweight cooling garments have received recent research interest, and potentially present a practical and effective strategy for people with MS to wear during exercise to overcome heat sensitivity and better engage in exercise therapy. Therefore, the purpose of this systematic review was to assess the use of cooling garments to aid exercise therapy in people with MS, as well as provide practical applications and future research directions.

METHODS: A systematic review adhering to the PRISMA guidelines was performed. The eligibility criteria required investigations to have conducted a randomised controlled trial or cross over study to assess the effect of a cooling garment to aid exercise therapy in people with MS. Studies must have contained empirical data and been published in a peer-reviewed journal.

RESULTS: 13 empirical studies, published before August 2022, were identified as meeting the eligibility criteria. The study's compromised of acute cross-over designs (61.5%), longitudinal independent groups designs (23.1%) or a combination of both (15.4%) and included a total of 386 participants with MS. The cooling garments that were investigated included active liquid-perfused cooling vests/tops (50.0%), phase-change cooling vests (38.9%), a cooling thigh cuff (5.6%) and a palm cooling device (5.6%). The cooling garments were consistently reported to improve walking time to exhaustion and walking distance in the 6-minute walk test, and findings from most studies pointed towards an improvement in the time to walk short distances, and in assessments of muscular strength. There is some evidence that the cooling garments improved balance, but only when the balance assessment was very challenging. The vast majority of studies that assessed fine-motor skills/manual dexterity did not observe any improvement in these measures.

CONCLUSION: Cooling garments can be used to aid exercise therapy in people with MS, including both expensive liquid-perfused garments and more practical and lightweight phase change cooling vests. We recommend that people with MS try different cooling garments to determine what their preferences are. Future research is needed on novel cooling garments designed for people with MS that have not yet been independently tested.

IMPACT OF DISABILITY ON PHYSICAL ACTIVITY AND HEALTH VARIABLES IN SCOTLAND

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INTRODUCTION: It is well recognised that regular physical activity including sport participation is important in the maintenance of health. Sedentary behaviour is now also recognised as an independent risk factor for numerous health conditions including For individuals with a disability, the achievement of the recommended amount of physical activity and the avoidance of sedentary behaviour is additionally difficult depending on the nature and severity of disability. In Scotland, the National Health Survey provides a significant resource to describe the characteristics and behaviours of the Scottish population.

METHODS: As we were interested in physical activity and sport participation in the disabled popiulation we use the 2019 National Health Survey data to explore the relationships.

One of the key limitations of the national health survey is its definition of disability is based on a self -report of a long -term illness (>12 months), which is limiting daily living. Using this definition of disability we explored the relationships between disability, physical activity defined by the UK Chief Medical Officers recommendations, sport participation, sedentary behaviour, obesity prevanance.

RESULTS: Only 23% of those with a disability met the CMO recommendations on MVPA and muscle strengthening exercises, and 53.6% met neither. We found that individuals with a disability had on average 130 min (95%CI 118-142mins) more sedentary behaviour (TV and Sitting) on week days compared to non-disabled. This difference is diminished slightly at the weekend (95%CI 93–119 mins) mostly due to those without a disability being more sedentary at the weekend vs those with limiting illness. Never the less this data shows that these individuals classified as disabled are exceeding 7h of sedentary

behaviour daily over the whole week, which has significant health implications. Those with a disability also had significantly lower sport minutes per week (95% CI 12–27 min) and this was evident in both moderate and vigorous sport activity.

We specifically looked at the relationship between disability, sport participation and obesity. People with a disability who take part in sport have a significantly better BMI profile than those who do not. Of those people with a disability who do not take part in a sport a high proportion are classed as Obese/morbidly (44.2%), significantly higher than the general non-disabled population.

CONCLUSION: This data reveals high levels of inactivity, obesity and sedentary behaviour as well as low sport participation for those individuals with a disability in Scotland. This suggests that this group are at a significantly greater risk of the development of co-morbidities on top of their existing disability contributing to a faster rate of health decline than the general population. Further research is required in the development of appropriate intervention strategies to improve the health behaviours of this group to enhance their health outcomes.

AQUATIC EXERCISES ENHANCE PHYSICAL PERFORMANCE AND MAINTAIN METABOLIC HEALTH IN OVERWEIGHT OLDER ADULTS

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INTRODUCTION: Being overweight and obese can lead to metabolic and cardiovascular disorders as well as physical dysfunction in older adults. Those with a higher BMI and body fat percentage not only perform poorly physically, but are also more likely to develop type 2 diabetes and cardiovascular disease. Healthy aging requires addressing overweight and obesity. Prescription of regular exercise has outstanding effects on metabolic and physical function. Aquatic exercise mode provides aerobic and strength training benefits to older adults, obese individuals and even those with arthritis due to reduced weight pressure on joints. We hypothesized that 28 weeks of combined aquatic exercise (aerobic and resistance) would improve daily physical performance and lower metabolic indices in overweight, healthy older adults.

METHODS: Thirty-two subjects of both genders (72.06±5.8) were randomly assigned into two groups: an aquatic exercise group (EG; n=19) and a control group (CG; n=13). Body composition, anthropometric measurements, blood pressure, lipid profile, fasting glucose, insulin, and leptin were assessed before and after the training program.

The Senior Fitness Test (SFT) was used to indirectly assess the main physical parameters associated with functional and motor ability. Leptin, and insulin were measured with ELISA kits.

RESULTS: There were no differences between or within groups in lipid profile, fasting glucose and insulin, or insulin resistance ($p>0.05$). There was a worsening of the lipid profile in the CG. In the aquatic exercise group, body fat mass, waist circumference, and leg circumference were reduced, while free fat mass was gained ($p\leq0.05$). A trend towards lower glycemia was also observed. Systolic and diastolic blood pressure significantly improved in the exercise group (P=0.003, P=0.001). A significant difference was found between the aquatic exercise group and the control group in aerobic endurance (P=0.008) and lower body flexibility (P=0.049). Also, upper body flexibility (P=0.001, P=0.020), lower and upper body strength (P=0.001, P=0.031), and handgrip (P=0.001, P=0.006), showed a significant difference after the exercise intervention.

CONCLUSION: The EG body fat decreased significantly (4.4%), but not enough to induce changes in leptin levels (a minimum weight loss of 10% is usually required). As a result of water properties, such as water viscosity, the motor cortex is more involved, resulting in more firing of motor neurons, which could explain the improvement in muscular strength and possible physical function. In addition, hydrostatic pressure facilitates venous return, aids fluid return to the heart and lymph nodes, which increases cardiac filling volume and reduces heart rate and blood pressure. Therefore, aquatic exercise has the potential to improve the daily physical performance of the aging population and prevent metabolic and cardiovascular diseases by improving blood pressure and body composition.

Conventional Print Poster

CP-MH27 Sports medicine and orthopedics

BACK AND HAMSTRING MUSCLE STRENGTH IN HEALTHCARE WORKERS WITH DIFFERENT INTENSITY OF BACK PAIN

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INTRODUCTION: Back pain is often associated with weakness of the back and hamstring muscles. The question, however, remains to what extent such an insufficient muscle strength contributes to first-time back pain occurrence in individuals who are at high risk of back problems. This study investigates the association of maximum isometric strength of the back and hamstring muscles with intensity of perceived back pain in healthcare workers with mild to moderate back pain and those with no pain.

METHODS: Altogether 55 healthcare workers (male: n=13, age 34.2±16.0 years, height 177.9±7.1 cm, body mass 84.2±13.3 kg; female: n=42, age 37.0±10.0 years, height 167.7±5.1 cm, body mass 63.6±10.7 kg) completed a Visual

Analogue Scale reflecting their intensity of back pain on a 0-10 Numerical Rating Scale. Accordingly, they were divided into three groups, i.e. no pain (score 0), mild pain (score 1-3) and moderate pain (score 4-6). Subjects performed three trials of maximum voluntary contraction (MVC) of the back muscles with the highest value used for data analysis. They also performed MVC of the hamstring muscles while average of better of the two trials of each leg was analysed. Peak force was measured using the FiTRO Back Dynamometer (FiTRONiC, Slovakia).

RESULTS: Peak force produced during MVC of the back muscles was significantly higher in healthcare workers with no pain (945.0±292.1 N) than in those with mild (696.9±181.9 N, p=0.002) and moderate pain (653.5±89.9 N, p=0.014). Similarly, MVC peak force of the hamstring muscles was significantly higher in healthcare workers with no pain (129.2±37.7 N) than in those with mild (96.1±31 N, p=0.005) and moderate pain (93.7±20.8 N, p=0.024). The intensity of their perceived back pain correlated with both maximum isometric strength of the back muscles (r=-0.433, p=0.001) and hamstrings (r=-0.427, p=0.001).

CONCLUSION: Findings indicate that healthcare workers suffering from mild to moderate back pain display lower maximum isometric strength of their back muscles by 27-31% and hamstrings by 25-27% as compared to those with no pain. Strengthening of these muscle groups may prevent their first-time back pain occurrence.

THE ASSESSMENT OF PATIENT OUTCOMES AT RETURN-TO-SPORT FOLLOWING A SPORT-RELATED KNEE SPRAIN INJURY: A REPORT FROM THE ATHLETIC TRAINING PRACTICE-BASED RESEARCH NETWORK

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INTRODUCTION: Recent findings suggest that patients with ankle sprain injuries experience some degree of pain, functional limitation, and disablement at return-to-sport (RTS) despite being medically cleared for unrestricted participation. However, little is known whether similar deficits exist in patients returning from knee sprain injuries. Our purpose was to evaluate self-report of pain, function, improvement, and disablement at RTS following a knee sprain injury.

METHODS: We completed a retrospective review of electronic medical records created by athletic trainers (eg, physiotherapists) within the Athletic Training Practice-Based Research Network. Patient cases were included if the patient was diagnosed with a knee sprain injury, restricted from sport following injury, and subsequently cleared for unrestricted participation (RTS). Patients received usual care from an athletic trainer and completed a series of single-item patient-reported outcomes at RTS including self-report of pain (Numeric Pain Rating Scale [NPRS]), function (Global Rating of Function [GROF]), improvement (Global Rating of Change [GROC]), and disablement (Global Rating of Disability [GROD]). All measures have established measurement properties (eg, reliability, responsiveness). Descriptive statistics (percentages, frequencies, mean, median, interquartile range [IQR]) were used, as appropriate, to summarize patient demographics, sport, number of days to RTS, and patient-reported outcome scores at RTS including NPRS (0-10 points), GROF (0-100%), GROC (15-point Likert-scale) and GROD (7-point Likert-scale).

RESULTS: One hundred fifty-two patient cases (male=61.2%, age=17.2±2.8 years, height=171.9±12.3 cm, mass=75.6±20.3 kg) were identified for our study. Most knee injuries occurred during American football (32.2%, n=49), basketball (23.7%, n=36) or soccer (18.4%, n=28) and were diagnosed as medial collateral (57.9%, n=88), cruciate (23.7%; n=36), or lateral collateral (18.4%, n=28) ligament sprains. Patients received care for 33.4±63.9 days (median=11.0, IQR=3.0-25.8) before returning to sport. Despite being medically cleared for unrestricted participation, most patients reported some level of pain (63.8%, n=97; NPRS=1.7±1.8, median=1, IQR=0.0-3.0) and functional deficit (51.3%, n=78; GROF=85.4±15.2%, median=90.0, IQR=80.0-95.0) at RTS. Similarly, while most patients reported some level of improvement since injury (86.2%, n=131; GROC>"a little bit better"), 37.5% (n=57) reported some level of disablement (GROD>"very mild difficulty with my activities of daily living") at RTS.

CONCLUSION: Despite being medically cleared for unrestricted participation, patients continue to exhibit some level of pain, functional deficit, and disablement at RTS following a knee sprain injury. It has been recommended that patient outcome measures be used throughout care and to support RTS decision-making. Future research should determine if deficits at RTS predispose patients to recurrent injuries, chronic conditions, or lower quality of life.

LOWER LIMB KINEMATICS, FORCE, AND QUALITY OF LIFE AMONG RECREATIONAL ATHLETES AFTER AN ANTERIOR CRUCIATE LIGAMENT RUPTURE: A LONGITUDINAL STUDY OF THE FIRST THREE MONTHS AFTER AN ACL RECONSTRUCTION

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INTRODUCTION: Successful rehabilitation of ACL injuries requires a bio-psycho-social approach. Assessing gait kinematics involves analyzing joint angle minima/maxima, but it is also possible to analyze the kinematics over a full gait cycle using Statistical Parametric Mapping (SPM). Kinesiophobia is a common measure, but only a few studies have assessed anxiety. We aim to describe changes in lower limb kinematics, quadriceps force and Rate of Force developed (RFD), quality of life, anxiety, and kinesiophobia before and up to 3 months after ACL reconstruction.

METHODS: Gait kinematics, force, and RFD were evaluated 2 weeks pre-surgery (T1) and 3 months post-surgery (T3) using inertial measurement units (XSENS) and a handheld dynamometer (Microfet2). Quality of life, kinesiophobia, and anxiety were assessed at T1, T2 (2 weeks post-surgery), and T3 using IKDC, Tampa, and GAD-7 questionnaires, respectively. Limb Symmetry Index (LSI) was calculated for the force measurements. Kinematic assessment was done while walking in a 30-meter corridor. Mean±SD was used for descriptive statistics, and SPM was used to analyze the full-wave kinematics.

RESULTS: 25 recreationally-active participants were recruited (mean age 24.5±5.9). At T1, the knee flexion angle (KFA) of the injured leg during walking was higher than the contralateral KFA at 30-44% of the gait cycle, seen by a supra-threshold cluster exceeding the critical threshold of t=3.1. No differences were seen in hip and ankle joint kinematics.

At T3, the KFA of the injured leg was higher than the KFA of the contralateral knee at 33-47%, 68-74%, and 90-97% of the gait cycle, seen by three supra-threshold clusters exceeding the critical threshold of t=4.1. The hip flexion angle of the injured leg was lower than that of the contralateral knee at 68-82% of the gait cycle, seen by a supra-threshold cluster exceeding the critical threshold of t=3.9. No differences were seen in the ankle.

The T1 quadriceps LSI values for the peak force and RFD are 80±19.6% and 69.7±21.9%. The T3 peak force values were 46.2±27.3% and 30±26.6% for the RFD.

The IKDC score was 55±15 at T1, 26.8±13.4 at T2, and 49.8±14.4 at T3. The GAD-7 scores were 8.8±5.8 at T1, 7.7±5.4 at T2 and 6.3±7.1 at T3. Lastly, the Tampa scores were 43.9±8.1 at T1, 42.8±5.4 at T2, and 39.1±4 at T3.

CONCLUSION: Patients before an ACL surgery walk with their injured knee in a more extended position during weight bearing at the terminal stance phase of the gait cycle. Three months post-surgery, these deficits expand to the initial and terminal swing of the knee and the initial and mid-swing phases in the hip. Those deficits can be missed using the common minima/maxima analysis. Furthermore, looking only at the peak force might not be optimal as well, as the RFD is more affected than the peak force LSI. Lastly, although their quality of life almost returns to pre-surgery levels, their kinesiophobia and anxiety remain high, similar to before the surgery.

TOWARDS DETECTING NEUROMUSCULAR CONTROL DEFICITS INDICATIVE OF KNEE INSTABILITY DURING THE RETURN TO SPORTS PROCESS AFTER AN ACL INJURY

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INTRODUCTION: A successful return to sport (RTS) after an anterior cruciate ligament (ACL) injury requires adequate neuromuscular control of the knee to protect the ACL [1]. However, detecting deficits in muscular control has proven challenging. We investigated single-leg jump-landings and hypothesized that compromised control might manifest as a change in (a) frontal plane knee stiffness [2], (b) fluency of the knee movement [3], or (c) smoothness of the overall (center of mass, COM) trajectory. The aim of the study was to detect compromised neuromuscular control in the knee movement (A) produced through a fatiguing intervention, or (B) due to a group comparison between volunteers with a previous ACL injury (ACLG) compared to healthy controls (CON).

METHODS: A convenience sample of 15 (11 females) and 22 (12 females) volunteers were recruited into ACLG and CON, respectively. We recorded 3D motion data (250 Hz) during single-leg forward hops (three per leg) onto a force plate (1000 Hz) before and after a fatiguing protocol (single-leg squats and step-ups). Participants were instructed to stabilize their body upon landing and to keep their lowest body position for 2s. Inverse kinematics were conducted in OpenSim from initial contact to the first local minimum of the knee flexion velocity. Frontal plane knee stiffness was quantified as the change in knee adduction/abduction angle. Knee fluency was calculated as the number of zero crossings (zc) of the medio-lateral knee joint velocity per second. Smoothness was quantified as the normalized vertical jerk of the COM trajectory [4]. Group-by-fatigue (2x2) mixed-factor ANOVAs ($\alpha = 0.05$) and effect sizes ($\eta 2$) were computed.

RESULTS: Fatigue affected knee fluency ($p < .001$; $\eta 2 = .50$; ACLG: fatigued: 15.1 zc/s vs. non-fatigued: 11.2 zc/s; CON: fatigued: 14.8 zc/s vs. non-fatigued: 11.2 zc/s). All other statistical results were non-significant.

CONCLUSION: One of the three hypothesized variables, knee fluency, proved sensitive to a fatigue-induced reduction in neuromuscular control. The likely underlying mechanism for this finding is compromised intermuscular coordination of hip and thigh muscles due to fatigue. Further, neither differences between ACLG and CON, nor interaction effects were significant; suggesting that in our convenience sample of previously ACL-injured individuals no chronic neuromuscular control deficits remained after they had all successfully returned to sport. Nor were they differently affected by fatigue than the control participants. We conclude that knee fluency is the most promising among the tested variables for detecting reduced knee control and that after a successful recovery no detectable difference remained in the knee stability of our ACL-injured volunteers.

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LONG-TERM EFFECTS OF THE 11+ AND THE FOOTBALL+ WARM-UP PROGRAMS ON MOTOR PERFORMANCE AMONG FEMALE AMATEUR PLAYERS

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INTRODUCTION: Warm-up modalities, as the last phase of preparation before high intensive loads, should not only mitigate injury risk but also improve performance. Although acknowledgeable for injury prevention, the lack of a link to foot-

ball-specific goals and unclear effects on motor performance have raised serious concerns regarding the applicability of the 11+ program as a warm-up routine in amateur football and have resulted in low compliance and poor implementation of the program. Given that the 11+ effects on performance parameters among amateur female players have not yet been studied, this study aims to address the long-term effects of the 11+ and Football+, a newly developed warm-up, on motor performance in this population.

METHODS: Three female teams competing in German amateur leagues participated in this study and were assigned to the 11+ (n= 20, 23.6± 3.9 yrs, 1.69±0.05 h, 65.3±8.5 w), Football+ (n= 25, 26.5± 5.7 yrs, 1.69=±0.07 h, 63.4±7.5 w) and control (n=15, 22.53 ± 3.16 yrs, 1.66±0.08 h, 65.16±7.77 w) groups and underwent a 12-week intervention. Both warm-ups consisted of three parts, lasting 25 minutes, and required no additional equipment but differed in content. In comparison to the 11+, the Football+ included more plyometric and high-intensity exercises and more football-specific drills. The experimental groups performed their specific warm-up modality twice a week with 100% team compliance, whereas the control group followed its routine warm-up. Linear 20-m sprint, countermovement jump (CMJ), Illinois agility (IA), and dribbling test (DT) were performed in pre- and posttest. Means, SD, and effect sizes were calculated for each outcome measure. Intergroup differences were analyzed using one-way repeated-measures ANOVA at a significance level of $\alpha < 0.05$.

RESULTS: Significant time-group differences were observed for sprinting (p=002, $\eta 2$=0.20 power=0.92), IA (p=001, $\eta 2$=0.29, power=0.99), CMJ (p= 0.02, $\eta 2$=0.13 power=0.71) and DT (p=0.01, $\eta 2$=0.14, power= 0.76), with the Football+ and control groups having the best and poorest scores, respectively. A follow-up independent t test revealed no significant differences between the 11+ and CG in the 20 m sprinting (p= 0.26) and agility (p= 0.25) tests. However, the 11+ group outperformed the CG in the CMJ (p=001), while the CG outperformed the 11+ group in the dribbling test (p= 0.025).

CONCLUSION: Twelve weeks of application of Football+ significantly improved sprinting, agility, CMJ and dribbling skills compared to the 11+ and CG while having large effect sizes. Except for CMJ, the 11+ did not improve performance parameters but possibly reduced dribbling skill compared to the CG. Amateur female players are highly recommended to apply the Football+ program as a warm-up routine before training and benefit from the advantages it entails on motor performance. Further studies are required to evaluate the effects of Football+ on injury prevention and performance measures among other populations.

COMPENSATION STRATEGIES AFTER A COMPLETE AVULSION OF THE PROXIMAL RECTUS FEMORIS MUSCLE: A SINGLE CASE ONE-YEAR FOLLOW-UP

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INTRODUCTION: The rehabilitation after severe muscle injuries is an individual process, which follows no predefined time and criteria schedules. However, it is clear that biomechanical data can be helpful to optimize the return-to-sport and to evaluate long-term outcomes. This is the first study, which has investigated an one-year follow-up after the surgical treatment of a complete avulsion of the proximal rectus femoris muscle to get more functional insights into changes in neuromuscular control, structural muscle characteristics, and performance variations.

METHODS: Within the case report, a 41-year-old recreational endurance athlete (VO2max 58.7 ml/min/kg) was monitored during the rehabilitation process and frequently performed different biomechanical tests (e.g. EMG, isokinetic strength tests, MRI, cycling ergometry, leg volume) during the one-year follow-up. The endurance performance was revealed by an ergospirometry before the injury, as well as after six and twelve months after the surgery.

RESULTS: Almost no voluntary contraction of the rectus femoris muscle could be observed within the first month post-surgery. During early rehabilitation, a stepwise reduction in crank torque asymmetry was measured during cycling ergometry. Muscular intra-limb compensations were found at six months post-surgery and also after one year, which were in line with the long-term adaption of the muscle characteristics and leg volumes. During cycling ergometry, asymmetric muscle activation patterns revealed an altered motor control strategy, even while the power output was nearly symmetric and the endurance performance on a pre-injury level.

CONCLUSION: In the first month after surgery, an almost total neuromuscular inhibition of the rectus femoris muscle was present. Therefore, it is questionable to perform training sessions with the intention of selected muscle activation. Even if the endurance performance recovered after six months, asymmetries in neuromuscular control and structural muscle characteristics indicate the long-term presence of inter- and intra-limb compensation strategies. The impact of those long-term compensation strategies on subsequent injuries and/or physical health should be investigated in future studies.

THE EFFECTS OF CARBOHYDRATE LOADING ON BRACHIAL AND THIGH MUSCLES

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INTRODUCTION: Muscle glycogen is a main energy source for prolonged exercise. Therefore, carbohydrate loading has already been investigated as a way to increase muscle glycogen content in the sport nutrition area. However, it remains unclear whether carbohydrate loading similarly increase glycogen content in upper and lower extremities. Since muscle recruitments are different depended on exercise characteristics and motilities, it is indispensable to understand the changes and specificities in each muscle. Therefore, the present study aimed to determine the changes in muscle glycogen content of the triceps brachii (arm) and vastus lateralis (leg) after 3 days of high carbohydrate intake without exercise.

METHODS: Eleven healthy participants (10 males and 1 female) were recruited in the present study (age: 29.3 ± 1.7 years, height: 173.2 ± 5.5 cm, weight: 70.2 ± 9.5 kg). They conducted 3 days of control period (6g/body mass/day of carbohydrate intake) followed by 3 days of loading period (10g/body mass/day of carbohydrate intake). Throughout the intervention period (6 days), physical activity was monitored using an accelerometer (Active style Pro, OMRON Healthcare, Japan). Muscle glycogen content in the triceps brachii and vastus lateralis were evaluated noninvasively using 13C-magnetic resonance spectroscopy (Magnetom Verio and Magnetom Skyra; Siemens, Germany) before, at 24 and 72 hours of the loading period. Body compositions were also measured before, at 24 and 72 hours of the loading period via a body composition analyzer (Inbody730, Inbody Japan, Japan).

RESULTS: Body mass (pre: 70.8 ± 8.9 kg, 72 h: 72.3 ± 9.4 kg), fat free mass (pre: 58.0 ± 7.2 kg, 72 h: 59.2 ± 7.6 kg) and water volume (pre: 42.5 ± 5.3 L, 72 h: 43.4 ± 5.6 L) were significantly increased by 72 hours of carbohydrate loading ($P < 0.05$). Although the muscle glycogen content in both muscles were significantly elevated at 72 hours of the loading period (triceps brachii: 122.8 ± 29.2 %, vastus lateralis: 122.5 ± 24.0 %, $P < 0.05$), there was no significant differences in the increase between the muscles ($P > 0.05$). On the other hand, the present study did not observe significant correlation in the changes between the two types of muscles ($P > 0.05$).

CONCLUSION: Three days of carbohydrate loading (10g/body mass/day) without exercise increased muscle glycogen content (approximately 23%) in both upper arm and thigh muscles. In addition, the present results indicate that the time-course changes in muscle glycogen content in the upper arm and thigh muscles within the same subject may not necessarily be equivalent.

THE EFFECT OF ACUTE RESISTANCE EXERCISE ON URIC ACID IN HEALTHY ADULTS FOLLOWING FRUCTOSE INTAKE

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INTRODUCTION: Regular exercise is an effective method to maintain or improve overall health, but strenuous exercise rapidly depletes adenosine triphosphate (ATP) in skeletal muscles and results in overproduction of uric acid [1]. Sports drinks help recuperate nutrients and fluids lost during exercise; however, fructose is a common component in sport drinks and its metabolism increases blood uric acid levels. This is due to lack of a negative feedback system for fructose metabolism that would otherwise to prevent excessive phosphorylation [2]. Therefore, both exercise and sports drinks can increase blood uric acid levels, which may synergistic effect and cause hyperuricemia. This study aimed to investigate the effect of acute resistance exercise combined with high fructose intake on uric acid levels.

METHODS: Twelve healthy young men (age: 23.00 ± 2.50 years, body mass index: 22.91 ± 1.61 kg/m2) participated in four randomized crossover trials (EF: fructose intake after exercise; EW: water intake after exercise; CF: fructose intake without exercise; CW: water intake without exercise). The participants performed 4 sets (8 repetitions × 3 sets + 1 failure set) of a whole-body resistance exercise (deadlift → bench press → squat → row) at 70% of 1-repetition maximum (1RM). A fructose drink was given by 0.75 g/kg of body weight. Blood uric acid and other laboratory parameters (blood lactate, heart rate, and blood pressure) were measured at fasting, before exercise, immediately after exercise, and 0.5 hr, 1 hr, 2 hr, 4 hr, and 24 hr after exercise. All testing data were analyzed using 4 (trial) × 8 (time) two-way repeated-measures analysis of variance. The level of significance was set at $\alpha=.05$.

RESULTS: Blood uric acid levels were increased after acute resistance exercise or fructose ingestion alone. This increase was further exacerbated by the combination of resistance exercise and fructose ingestion (EF: 9.03 mg/dL, ↑3.59 mg/dL, 63%; EW: 8.28 mg/dL, ↑2.52 mg/dL, 44%; CF: 6.24 mg/dL, ↑0.58 mg/dL, 10%; ps < .05). Blood lactate levels were similar: increases in conditions of either resistance exercise alone or fructose ingestion alone, and a greater increase with a combination of the two (ps < .05). Furthermore, heart rate was significantly higher in the EF trial than in the other three trials (p < .05). Blood pressure was not significantly different among trials (p > .05).

CONCLUSION: Fructose intake following resistance exercise induces greater increase in blood uric acid levels than either exercise or fructose intake alone, thereby demonstrating their synergistic effect on uric acid levels. Moreover, the combination treatment produced no differences in blood pressure, but blood lactate and heart rate increased more than re-

sistance exercise alone. These findings indicate that ingesting fructose-containing food should be avoided after resistance exercise.

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THE EFFECT OF HIGH-FAT DIET ON INTRAMYOCELLULAR LIPID CONTENT IN HEALTHY ADULTS: A SYSTEMATIC REVIEW, META-ANALYSIS AND META-REGRESSION

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INTRODUCTION: Intramyocellular lipid (IMCL) may accumulate following consumption of a high-fat diet (HFD). Discrepancy across studies may be explained by differences in 1) diet fat content, 2) HFD duration, and/or 3) measurement techniques used to measure IMCL content. HFD is also associated with a reduction in insulin sensitivity, and this may occur alongside IMCL accumulation. The primary aim of this study was to synthesise evidence through a systematic review and meta-analysis of the effect of a HFD on IMCL content in healthy individuals. A secondary aim was to determine associations of diet fat content, HFD duration, and IMCL measurement technique with IMCL responses to a HFD by meta regression. The relationship between HFD-associated changes in IMCL content and insulin sensitivity was also investigated.

METHODS: Studies were included if they examined the effect of ≥3 days of hypercaloric or isocaloric HFD (>35% total daily energy intake from fat) on IMCL content in healthy individuals. A total of 16 studies met the inclusion criteria, having used microscopy, biochemical extraction, or 1H Magnetic Resonance Spectroscopy (1H-MRS) techniques to measure IMCL. Ten of the included studies reported insulin sensitivity, assessed by Homeostatic Model Assessment for Insulin Resistance (HOMA-IR) and/or the hyperinsulinemic-euglycemic clamp (Clamp). Changes in IMCL content and insulin sensitivity are presented as standardised mean difference (SMD) using random-effects model.

RESULTS: Compared with pre-HFD or post-control diet, IMCL content increased following a HFD (SMD = 0.58, 95% CI 0.29 to 0.87, p = 0.001). Meta-regression analysis revealed that the increase in IMCL content was not associated with the diet fat content (p = 0.735), or the duration (p = 0.858) of the HFD, or the type of technique used to assess IMCL content (p > 0.05). Insulin sensitivity decreased following a HFD when assessed by HOMA-IR (SMD = 0.51, 95% CI 0.07 to 0.95; p = 0.033) or Clamp (SMD = -0.36, 95% CI -0.56 to -0.16; p = 0.005). Meta-regression analysis revealed there was no relationship between the increase in IMCL content and reduction in insulin sensitivity following a HFD (p = 0.121).

CONCLUSION: Consumption of a hypercaloric or isocaloric HFD (>35% total daily energy intake from fat) for 3 days is sufficient to increase IMCL content in healthy individuals. Diet fat content, HFD duration, and the measurement techniques used to quantify IMCL were not associated with the increase in IMCL content. The reduction in insulin sensitivity was not related to IMCL accumulation, which suggests factors other than IMCL accumulation are more important in HFD-induced impairments in insulin sensitivity in healthy individuals.

FOUR-WEEK SUPPLEMENTATION OF SOY MILK POST DAILY TRAINING IMPROVES BLOOD LIPID STATUS AND INCREASES EXPLOSIVE POWER IN FEMALE SOCCER PLAYERS

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INTRODUCTION: It has been widely accepted that protein supplement can promote the synthesis of skeletal muscle protein and relieve muscle injury induced by exercise. The most commonly used protein is whey protein derived from milk, but lactose in it will make people who do not produce enough lactase prone to diarrhea, nausea, stomach cramps and other symptoms of lactose intolerance, which will also interfere with the effect of protein supplement on fatigue recovery. Meanwhile, more and more vegan athletes or sports enthusiasts are seeking alternatives to animal protein supplements. Therefore, the purpose of this study is to evaluate the effects of long-term supplementation of soy protein after daily exercise training on the related indicators of fatigue, metabolism, inflammation, muscle damage and athletic ability, providing scientific basis for the effectiveness of soy milk as a substitute for whey protein for lactose intolerant people and vegan sports people.

METHODS: The study was designed as a randomized controlled experiment. Twenty professional female soccer players from Shanghai were recruited. The experimental group was supplemented with 500ml soy milk, and the control group was supplemented with 500ml water added isocaloric oligosaccharides after training from Monday to Saturday for 4 weeks. Blood samples were taken before and every Saturday morning through the study to evaluate their nutritional status, fatigue levels and inflammatory response changes, and their athletic ability (Counter Movement Jump CMJ, Squat Jump SJ, 20/30m sprint) were also assessed at the same time points.

RESULTS: During the four-week supplement period, compared with the control group, the body fat percentage of the soy milk group showed a downward trend, the muscle mass showed an upward trend, and the change of serum glycerol was significantly lower (30.69±2.99 vs. 39.43±2.83mmol/ml, p=0.042). The decrease in serum triglyceride (-0.23±0.05 vs. -0.04±0.05mmol/L, p=0.012) and the increase in HDL (0.14±0.02 vs. 0.02±0.04mmol/L, p=0.024) were both significantly higher after one week in the soy milk group than the control group. CMJ and SJ height and 20/30m sprint time showed an

upward trend, and the increase in SJ height was significantly higher in the soy milk group than the control group after four weeks of supplementation (1.97±0.86cm vs. 0.19±0.50cm, p=0.007).

CONCLUSION: The intake of plant-based soy milk immediately after daily exercise training can improve the blood lipid status and increase the explosive power of lower limbs. Long-term supplementation of soy milk may also increase muscle mass and reduce body fat. Soy milk can be used as an effective substitute for whey protein for lactose intolerant people and vegan sports people.

CO-INGESTION OF COLLAGEN WITH WHEY PROTEIN PREVENTS THE POST-EXERCISE DECLINE IN PLASMA GLYCINE AVAILABILITY IN HEALTHY YOUNG MALES

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INTRODUCTION: Whey protein ingestion during the recovery from exercise increases myofibrillar but not muscle connective protein synthesis rates. It has been speculated that whey protein does not provide sufficient glycine to maximize post-exercise muscle connective protein synthesis rates. In the present study, we assessed the impact of co-ingesting various amounts of collagen protein with whey protein as a dietary strategy to increase plasma glycine availability during recovery from a single bout of exercise.

METHODS: In a randomized, double-blind, cross-over design, 14 young men (age: 26±5 y; BMI: 23.8±2.1 kg/m2) ingested 30 g protein provided as whey protein with 0 g (WHEY), 5 g (WC05); 10 g (WC10) and 15 g (WC15) of collagen protein during recovery from a single bout of resistance exercise. Blood samples were collected frequently over 6 hours of post-exercise recovery to assess plasma amino acid availability. Time-dependent variables were analyzed by a two-factor repeated-measures ANOVA. Non-time-dependent variables were compared between treatment groups using a one-way ANOVA. A statistical level of $P<0.05$ was accepted. All data are expressed as mean±SD.

RESULTS: Protein ingestion strongly increased plasma amino acid concentrations ($P<0.001$) with no differences in total amino acid availability between treatments ($P>0.05$). The post-prandial rise in plasma leucine and total essential amino acid availability was greater in WHEY compared to the WC10 and WC15 treatments ($P<0.05$). Plasma glycine and total non-essential amino acid concentrations declined following whey protein ingestion, but increased following collagen co-ingestion ($P<0.05$). Post-prandial plasma glycine availability averaged -8862±5829, 9246±3736, 23108±6523 and 39818±10976 µmol·360 min/L in WHEY, WC05, WC10, and WC15, respectively ($P<0.05$).

CONCLUSION: Co-ingestion of a small amount of collagen (5 g) with whey protein (25 g) prevents a decline in plasma glycine availability during recovery from a single bout of resistance type exercise in healthy young males.

ANABOLIC SIGNALING IS NOT COMPROMISED IN LEAN HEALTHY OLDER MEN FOLLOWING RESISTANCE EXERCISE AND INTAKE OF ESSENTIAL AMINO ACIDS

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INTRODUCTION: Ageing is associated with a slow and progressive decline in muscle mass and function, ultimately resulting in a condition referred to as sarcopenia. The etiology of sarcopenia is multifactorial, but a key underlying factor is believed to be the inability of aged muscle to properly respond to growth-promoting stimuli such as intake of essential amino acids (EAA) and resistance exercise. This phenomenon has been termed anabolic resistance and is defined by a dampened protein synthesis response in comparison to young individuals. However, much of the literature supporting the existence of such phenomenon have not used optimal doses of dietary amino acids and/or exercise volume. It is thus possible that optimal doses of EAA and high-volume, high-intensity resistance exercise (RE) may overcome anabolic resistance in older adults.

METHODS: Ten young (22 ± 1 years) and 10 older (70 ± 1 years) lean, healthy and physically active men performed 13 sets of unilateral resistance exercise (RE) at their 10-repetition maximum. Upon exercise completion, participants ingested 240 mg/kg body weight of EAA, a dose previously shown to maximally stimulate the mTORC1-pathway in young males. Muscle biopsies were collected before and immediately after exercise, and at 60 and 180 min after EAA intake in both the rested and the exercised leg. Phosphorylation and content of proteins involved in the regulation of protein synthesis and insulin signalling were measured using immunoblotting. Statistics were performed using mixed model analysis with Bonferroni correction.

RESULTS: Sixty minutes after EAA intake, phosphorylation of S6K1 at Thr389 was increased to the same extent (140-fold, $p<0.05$) in the exercised leg of both groups compared to pre-exercise values. However, in the rested leg, S6K1 at Thr389 phosphorylation was 345% higher ($p<0.05$) in the older group. Phosphorylation of eEF2 at Thr56 was reduced in the exercised leg at both 60 (67%, $p<0.05$) and 180 (40%, $p<0.05$) min compared to baseline with no difference between groups. Total levels of Rheb were 46% higher ($p<0.05$) in the old group compared to young. Phosphorylation of PRAS40 at Thr246 was increased in the exercised leg of both groups but was higher in young than old compared to baseline (81% vs 57%, $p<0.05$).

CONCLUSION: When assessing mTORC1-signalling, skeletal muscle of healthy, lean and physically active older men does not show obvious signs of anabolic resistance following intake of a large dose of EAA and performance of high-volume,

high intensity RE. Older muscle does however show signs of reduced insulin signaling as evidenced by lower PRAS40 phosphorylation. One would therefore expect a lower anabolic response in older individuals, but the lack of such may be explained by higher total levels of the protein Rheb, which is the most proximal upstream activator of mTORC1. This in turn may be a compensatory mechanism to maintain anabolic sensitivity in this population.

EFFECTS OF NUTRITION- AND EXERCISE-BASED PERFORMANCE ENHANCEMENTS IN ROWING: A NETWORT META-ANALYSIS

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INTRODUCTION: Previously rowing performance improvements were elicited via numerous different exercise-based approaches like (i) resistance training [1]; (ii) plyometric training [2]; (iii) high-intensity training [3]; (iv) blood flow restriction methods [4]; and (v) various nutritional supplementation strategies [5]. Therefore, network meta-analytical approach was used to examine all those rowing-specific findings within one analysis. Thereby, this network meta-analysis assessed via direct and indirect comparison the occurrence and magnitude of effects following different nutritional supplementation strategies and exercise interventions on acute and chronic rowing performance and its surrogates.

METHODS: PubMed, WebofScience, PsycNet and SPORTDiscus searches were conducted until march 2022 in order to identify studies with the following inclusion criteria: (a) controlled trials, (b) rowing performance and its surrogate parameters as outcomes (c) peer-reviewed published in English. A Frequentistic network meta-analytical approaches were calculated based on standardized mean differences (SMD) using a random effects model.

RESULTS: 71 studies with 1229 healthy rowers (21.5 ± 3.0 years) were included and two networks (acute and chronic) have been created. Both, networks revealed low heterogeneity and non-significant inconsistency ($I2 \leq 35.0\%$ and Q statistics: $p \geq 0.12$). Based on P-score rankings, caffeine (P-score 84%; SMD = 0.43) revealed relevantly favorable effects in terms of acute rowing performance enhancement, whilst prior weight reduction (P-score 10%; SMD = -0.48) and extensive preload (P-score 18%; SMD = -0.34) impaired acute rowing performance. Chronic blood flow restriction training (P-score 96%; SMD = 1.26) and the combination of β-hydroxy-β-methylbutyrate and creatine (P-score 91%; SMD = 1.04) induced remarkably large positive effects, while chronic spirulina (P-score 7%; SMD = -1.05) and black currant (P-score 9%; SMD = -0.88) supplementations revealed impairment effects.

CONCLUSION: Homogeneous and consistent findings based on numerous studies indicate that choice of the nutritional supplementation strategy and the exercise training regime is vital for acute and chronic performance enhancement in rowing. While caffeine supplementation increases acute rowing time trial performance, prior weight reduction or extensive preload could impair performance. Furthermore, chronic rowing time trial performance was increased via blood flow restriction training and the combination of β-hydroxy-β-methylbutyrate and creatine supplementation. In contrast chronic spirulina and black currant supplementations might impair chronic rowing performance adaptations.

(1) Thiele et al., 2020; (2) Egan-Shuttler et al., 2017; (3) Akca et al., 2015; (4) Held et al., 2020; (5) Grgic et al., 2020

EFFECTS OF PLACEBO PERCEIVED-AS-PARACETAMOL ON CYCLING EXERCISE IN INDIVIDUALS WITH EXPERIMENTALLY INDUCED MUSCLE PAIN

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INTRODUCTION: Endurance exercise performance is related to the ability to tolerate unpleasant sensations such as pain during exercise [1]. Pain is a three-dimensional phenomenon that involves a sensory-discriminatory, affective-motivational, and cognitive-evaluative dimension [2]. The ingestion of paracetamol is well-known to reduce pain and improve exercise performance through its action on the sensory-discriminatory dimension, but the effects of paracetamol-placebo are unknown. We investigated the effects of paracetamol placebo on physical performance, neurophysiological and perceptual responses in endurance cycling exercise in individuals with experimentally induced muscle pain.

METHODS: Twelve males (22.0 ± 3.5 years) sensible to a hypertonic saline solution (2.0 ml, 6% NaCl) performed in a randomized crossover design: 1) VO2MAX cycling test; 2) baseline time-to-exhaustion cycling test (TTE) without induced pain; 4) TTE with induced muscle pain and ingestion of placebo perceived-as-paracetamol (PCT); 4) TTE with induced muscle pain and ingestion of placebo perceived-as-placebo (PLA). A variety of neurophysiological (EEG, EMG and cardiopulmonary) and perceptual (pain sensation, RPE and affect) responses were sampled during exercise, then analyzed and paired at every 25% of the exercise bout (i.e., 25%, 50%, 75% and 100%) for comparisons in a repeated-measures mixed model. Results were reported as mean (SD) and effect size (d-Cohen).

RESULTS: Participants (WPEAK of 245.2 ± 28.4 W and VO2PEAK of 43.9 ± 4.6 mL·kg-1·min–1) improved their time-to-exhaustion ($p = 0.009$, $d = 0.31$) when in PCT (411.8 ± 152.1 s) when compared with PLA trial (356.0 ± 175.8 s). The improved cycling performance was accompanied by increased cardiopulmonary responses ($p = 0.03$, $d = 1.25$ for VO2; $p = 0.002$, $d = 1.75$ for VE and $p = 0.005$, $d = 1.23$ for HR), but lowered activation in vasto lateralis ($p = 0.01$, $d = 1.38$) and biceps femoris muscles ($p = 0.01$, $d = 1.43$). Differences between PCT and PLA trial were observed neither in EEG measures (Cz, F3 and P3 derivations) nor in effect and pain sensation, but participants reported a greater RPE throughout the cycling test after ingesting PCT ($p = 0.04$, $d = 0.87$).

CONCLUSION: Placebo perceived as paracetamol improved exercise performance in participants with prior induced muscle pain. Results of psychophysiological responses may suggest that placebo improved exercise performance by altering the affective-motivational dimension of pain.

A NOVEL CARBOHYDRATE HYDROGEL SYSTEM FOR THE DELIVERY OF SODIUM BICARBONATE MINI-TABLETS INCREASES ACID-BASE BUFFERING AND ALLEVIATES GASTROINTESTINAL DISCOMFORT

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INTRODUCTION: Sodium bicarbonate (SBC) is a popular ergogenic aid to enhance cycling performance, however, the gastrointestinal (GI) discomfort often deters athletes from ingestion. Recently, a novel SBC formulation using a combination of a carbohydrate-rich hydrogel and SBC mini-tablets has been created with the aim to minimise GI discomfort following ingestion. The purpose of this study therefore was to investigate the GI discomfort and acid base balance responses from a novel SBC supplement.

METHODS: Ten trained/well trained cyclists (maximal oxygen uptake (VO2max): 63 ± 5 ml·kg-1·min-1, power at VO2max: 406 ± 35 W) completed this randomised, single-blind, crossover trial consisting of three visits to the laboratory. In the initial visit, a VO2max test was conducted to assess cardiorespiratory fitness. Two separate trials were then completed whereby participants ingested a breakfast consisting of 1.5 g·kg-1 BM carbohydrate (CHO) approximately 2-3 h prior to ingestion of either 0.3 g·kg-1 BM SBC in vegetarian capsules (size 00, Bulk Powders, UK) (SBCCAP) or 0.3 g·kg-1 BM SBC in mini-tablets (Maurten, Sweden) (SBCMT) alongside 40 g of CHO hydrogel mix (Maurten, Sweden). Participants then remained rested for 5 h, whereby 10 blood samples were taken from the fingertip for blood bicarbonate (HCO3-) every 30 min. Symptoms of GI discomfort were also taken every 30 min using a VAS scale to assess frequency and severity of symptoms. Data was analysed using a t test to assess differences between time to peak HCO3-, the change from baseline to peak HCO3- and aggregated overall GI discomfort. Effect sizes (ES) were calculated using Cohen D thresholds with a Hedges g correction. Significance was accepted at $p<0.05$.

RESULTS: The time to peak HCO3- was achieved 39 min faster with SBCMT compared to SBCCAP (120 ± 35 vs. 159 ± 36 min; $p < 0.001$; ES = 1.05). The change from baseline to peak HCO3- was 1.5 mmol·l-1 greater following SBCMT compared to SBCCAP (8.2 ± 0.8 vs. 6.7 ± 1.4 mmol·l-1; $p < 0.001$; ES = 1.26). Higher GI discomfort was observed in the SBCCAP treatment, with 9/10 participants suffering one or more symptoms to at least a moderate level (>5/10 severity), whilst none experienced this with SBCMT (all <4/10 severity). Mean aggregated overall gastrointestinal discomfort (sum of all GI symptoms) was reduced following SBCMT versus SBCCAP (9 ± 9 vs. 85 ± 63 au; $p = 0.003$; ES = 1.62). Specifically, SBCMT reduced stomach cramps (6 vs 164 au), bowel urgency (10 vs 141 au), diarrhoea (0 vs 149 au), belching (6 vs. 46 au), and stomach-ache (14 vs 181 au) over the 5 h period compared to SBCCAP.

CONCLUSION: Based on the findings of this study SBCMT is a more suitable supplement to limit GI discomfort compared to SBCCAP. Moreover, SBCMT has the potential to improve exercise performance to a greater extent due to the larger increases in HCO3- from baseline to peak, which further research should investigate.

THE IMPACT OF ARTIFICIAL SWEETENER CONSUMPTION IN SPORTS DRINKS AND NUTRITION ON CARDIOVASCULAR HEALTH: PRELIMINARY DATA IN RODENTS AND HUMANS VESSELS.

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INTRODUCTION: Sports drinks and nutrition contain many food additives including artificial sweeteners such as sucralose and acesulfame potassium (AceK). If currently the health authorities authorize the use of these sweeteners within the limits of the ADI, many recent studies question their physiological harmlessness, especially regarding the cardiovascular system. These molecules are known to activate the sweet taste receptors (Tas1Rs) in the oral cavity, but recent data, including our work, have also reported their expression in the vascular wall. Therefore, the aims of this study was to investigate the effects of artificial sweeteners, sucralose and AceK, on vasomotor function, used as an early cardiovascular risk marker, and to decipher the underlying mechanisms to understand the role of Tas1Rs.

METHODS: qPCR of Tas1Rs has been performed on mice and rat aortas as well as on human dermal micro-arteries. The direct effects of sucralose and AceK on vasoreactivity ex-vivo have been assessed using isometric tension measurements in organ bath systems in rodents (rats and mice including Tas1R3 KO mice) aortas and human omental arteries.

RESULTS: First, we observed with an ex-vivo approach that sweeteners, AceK and sucralose, induce direct vasoactive effects at high concentrations (around 10mM) in both human arterioles and rodent aortas. These sweeteners have antagonistic effects, which are endothelium-independent; AceK exhibits vasoconstriction while sucralose induces vasorelaxation. We then demonstrated the mRNA expression of Tas1R2 and/or Tas1R3, which form the heterodimer receptor of sweet taste, in the vascular wall and especially in the smooth muscle cells of our three models. Pharmacological inhibition (gurmarin in rodents and lactisol in humans) and the use of Tas1R3 KO mice models revealed that these vasomotor effects do not involve sweet taste receptors. Instead, they are more likely to rely on bitter taste receptors of the Tas2Rs family. To support this, using an analogous approach with different Tas2Rs agonists (quinine, denatomium benzoate, coumarine), we observed the same kind of vascular response as sucralose, suggesting that Tas2Rs isoforms are the most likely involved.

CONCLUSION: This evidence supports the idea that sweeteners can affect vasomotor signaling in vascular smooth muscle cells, thereby challenging the notion that these molecules are neutral. Contrary to our initial hypothesis, these vasomotor effects do not appear to be mediated by sweet taste receptors, but rather by bitter ones. The mechanism of action and the potential pathophysiological consequences of this phenomenon remain to be further explored.

Conventional Print Poster

CP-BM14 Muscle Tendon Function II

THE EFFECTS OF INSTRUMENT ASSISTED SOFT TISSUE MOBILIZATION (IASTM) TECHNIQUE ON MECHANICAL PROPERTIES OF ANKLE MUSCLES AND DORSIFLEXION RANGE OF MOTION IN WRESTLERS

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INTRODUCTION: Instrument-assisted soft tissue mobilization (IASTM) is one of the most popular treatments for myofascial restriction. This technique has been used to increase ankle range of motion with decreasing tightness within the musculotendinous unit. Restricted DF in the ankle joint can cause acute and chronic ankle and knee injuries in elite athletes. It is thought that IASTM treatment stimulates the remodeling of connective tissue and therefore its use in professional athletes is increasing. The aim of this study was to determine the effect of IASTM technique on dorsiflexion ROM and passive mechanical properties (viscoelastic) of the ankle muscles and tendons in wrestlers.

METHODS: 25 wrestlers between the ages of 14-17 who have been licensed for at least 2 years were included in the study. Athletes' left lower extremities were selected for the IASTM application as the intervention group, and the right side was selected as the control group. Each IASTM session was applied for 15 minutes, 3 days a week, for a total of 10 sessions on the left ankle muscles, tendons and plantar fascia during a 3-week period. Passive mechanical properties (tonus, stiffness and elasticity) and lunge bearing dorsiflexion test were measured respectively. The Myoton-3 equipment was used to describe the viscoelastic parameters of the ancle muscles and tendons. Measurements were made a total of 3 times; before the sessions, after the first session and at the end of the10th sessions.

RESULTS: It was found that lunge bearing dorsiflexion test values were significantly increased after both the first and tenth sessions of IASTM application ($p<0,01$). After the first session, the tonus and stiffness of the left gastrocnemius medialis (GM) and gastrocnemius lateralis (GL) muscles decreased, while the elasticity of the left GM muscle increased significantly ($p<0,01$). No significant change was found in the passive mechanical properties of the tendons ($p>0,05$). After 10 sessions, tonus and stiffness of the left GM muscle and left plantar fascia; tonus of the left Achilles tendon and stiffness of the left tibialis anterior (TA) tendon increased significantly ($p<0,01$). In addition, the elasticity of the right GL, left TA tendon, right and left GM and TA muscles increased significantly after 10 sessions ($p<0,05$).

CONCLUSION: A single session of IASTM application can be included in the training programs of wrestlers as a method to decrease muscle tonus and stiffness while increasing ankle mobility and flexibility. After 10 sessions of IASTM application, the increase in elasticity of some ankle muscles and tendons that was observed also with the increase in tonus and stiffness, can be attributed to the strength development caused by the ongoing training programs of the wrestlers. As a result, integrating IASTM applications into the training programs can reduce the risk of injury of the athletes, as well as increase their movement capacity and contribute positively to their performance.

TRAINING EFFECTS OF STRETCHING ON RANGE OF MOTION: A SYSTEMATIC REVIEW WITH META-ANALYSIS

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INTRODUCTION: Previous meta-analyses reported that stretch training can induce prolonged increases in joint range of motion (ROM) (Borges et al. 2018; Medeiros and Martini 2018). However, to date it is unclear which training variables might have greater influences on such improvements in flexibility. Thus, the purpose of this meta-analysis was to investigate the effects of stretch training on ROM in healthy participants by considering potential moderating variables such as stretching technique, intensity, duration, muscles stretched as well as sex-specific, age-specific, and/or trained state specific adaptations to stretch training.

METHODS: We searched through PubMed, Scopus, and Web of Science to find the eligible studies and finally assessed the results from 77 studies and 186 effect sizes by applying a random-effect meta-analysis. Moreover, by applying a mixed-effect model, we performed the respective subgroup analyses. Moreover, to find potential relations between the stretch duration or age to the effect sizes we performed a meta-regression.

RESULTS: We found a significant overall effect, indicating that stretch training can increase ROM with a moderate effect compared to the controls (ES = -1.002; Z = -12.074; CI (95%) -1.165 to -0.84; $p < 0.001$; I2 = 74.97). Subgroup analysis showed a significant difference between the stretching techniques (P=0.01), indicating that proprioceptive neuromuscular facilitation (PNF) and static stretching produced greater ROM changes compared to ballistic/dynamic stretching, respec-

tively. Moreover, there was a significant effect between the sexes (P=0.04), indicating that females showed higher gains in ROM compared to males. However, further moderating analysis showed no significant relation or difference.

CONCLUSION: When the goal is to maximize ROM in the long-term, PNF or static stretching rather than ballistic/dynamic stretching should be applied. Stretching volume and intensity might not play a significant role for the yields in ROM. Potential mechanisms for such an increase in ROM following stretch training are either chronic changes in muscle-tendon unit properties (e.g., a decrease in muscle stiffness (Nakamura et al. 2021) and/or changes in the perception to stretch or stretch tolerance (Freitas et al. 2018).

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TWO-DIMENSIONAL MOTION ESTIMATION FOR MEASURING THE DISPLACEMENT OF THE BICEPS FEMORIS IN PASSIVE AND ACTIVE MOVEMENTS

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INTRODUCTION: The biceps femoris long head (BFlh) is the most involved muscle in hamstring strain injury. The excessive strain of muscle tissue during sprinting is the proposed injury mechanism. However, no studies have measured the displacement of the BFlh during movement in vivo. Speckle-tracking ultrasonography (STU) is a semiauto-tracking method using consecutive ultrasonographs to estimate the displacement in dynamic conditions [1]. The tracking accuracy may be affected by BFlh inhomogeneity and contraction intensity. Therefore, this study aimed to establish a robust methodology with high accuracy and test–retest reliability for STU application in estimating BFlh displacement.

METHODS: STU was performed in 10 men (age: 23.4±0.7 years) twice 1 week apart; the protocol included 20°/s passive knee extension (PASS), knee flexion isometric contraction in 30° knee flexion (ISOM), and 20°/s knee flexion eccentric contraction tests (ECC). Scanning was conducted at the proximal and mid-BFlh, and the participants were tested in maximal and submaximal (85% MVIC) contraction intensities. The axial/lateral normalized cross-correlation (ANCC/LNCC), indicators of tracking accuracy, and intraclass correlation coefficient (ICC) of displacement (DISP) and the displacement angle (ANGL) were collected. These two outcomes were compared between the testing conditions using paired t-test and two-way repeated-measure ANOVA.

RESULTS: The normalized cross-correlation values were higher in the mid-BFlh than in the proximal mid-BFlh in PASS (LNCC: 0.94±0.04 vs. 0.91±0.04, p=0.03), ISOM (ANCC: 0.90±0.03 vs. 0.88±0.05, p=0.03; LNCC: 0.88±0.03 vs. 0.84±0.06, p<0.01), and ECC (ANCC: 0.84±0.03 vs. 0.82±0.04, p<0.01; LNCC: 0.80±0.04 vs. 0.75±0.05, p<0.001). The values were higher in the maximal than in the submaximal contraction intensity in ISOM (ANCC: 0.90±0.03 vs. 0.88±0.04, p=0.01; LNCC: 0.88±0.03 vs. 0.85±0.05, p=0.01); there were no differences in ECC.

The ICC values were higher in the mid-BFlh than in the proximal mid-BFlh in ISOM (DISP: 0.80 vs. 0.78; ANGL: 0.76 vs. 0.73) and lower in the mid-BFlh in PASS (DISP: 0.43 vs. 0.93; ANGL: 0.55 vs. 0.95) and ECC (DISP: 0.45 vs. 0.83; ANGL: 0.69 vs. 0.91).

Although mid-BFlh STU yielded poorer reliability in PASS and ECC, the displacement angle in the mid-BFlh showed the muscle moving toward the knee joint, which was consistent with the findings in the B-mode images. However, the proximal muscle displaced to the hip joint, which might be a sign of false tracking.

CONCLUSION: Mid-BFlh STU in combination with tests under maximal contraction intensity demonstrated better tracking accuracy and thus a potential for studying injury mechanisms. Further research should be implemented to improve the test–retest reliability.

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COMPARISON OF DIFFERENT ULTRASOUND METHODS TO DETERMINE TRICEPS SURAE MUSCLE- AND TENDON DYNAMICS DURING LOCOMOTION

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INTRODUCTION: Since the 1990s ultrasound (US) enables analyzing the dynamics of human muscles and tendons in vivo. This technique showed the independence of the overall muscle-tendon unit (MTU) and muscle length (ML) changes, e.g., during the stance phase of gait when the gastrocnemius medialis (GM) contracts near-isometrically despite eccentric behavior of the MTU (1). In the following years different methods using US were developed to determine ML and tendon lengths (TL) during human locomotion. The aim of this study was to identify and compare the different methods and their respective results.

METHODS: Different methods were identified in the literature and compared qualitatively.

RESULTS: Before determining ML and TL, all identified methods estimate total MTU length with equations based on cadaver measurements (2) or a musculoskeletal model (3). For these approaches, joint angles, e.g., from 3D motion capture, and individual anthropometrics for scaling are used to calculate MTU length. To determine ML and TL separately, Fukunaga et al. (1) were the first to use fascicle lengths and pennation angles from US measurements on the muscle belly. The length of the fascicle projected onto the aponeurosis represents the ML which is then subtracted from the MTU length to receive TL (i.e., serial elastic elements length). Important assumptions of this common method are that the geometry of the muscle is homogenous along its length and that TL represents tendon and aponeurosis lengths. A different approach (4) tracks the GM muscle-tendon junction (MTJ) with US to separate ML and TL during walking. Combined with 3D motion capture, this method allows to determine TL distal from the MTJ and ML by subtracting this value from the MTU length. Recently, a novel approach (5) combined MTJ tracking with direct measurement of the MTU length by placing markers at the origin and insertion of the gastrocnemii. This approach was validated for static measurements with MRI and does not need scaling of the MTU length due to direct individualized measurements, however, assumes that all parts proximal to the MTJ belong to the muscle, ignoring a proximal tendon.

CONCLUSION: ML and TL values from different approaches vary significantly because the underlying assumptions are very dissimilar. When ML is determined from US measurements on the muscle belly, the TL represents the length of all serial elastic elements and ML the length of the fascicle projected on the line of action. However, ML from US measurements on the MTJ represents the muscle belly length and the TL represents the Achilles tendon length only. While the scaling of musculoskeletal models is a valid approach, novel methods using individual landmarks may allow the direct determination of individual MTU lengths.

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INFLUENCE OF TELOMERE LENGTH ON MUSCLE AND TENDON ADAPTATION IN THE ELDERLY FOLLOWING TO A STRENGTH TRAINING PERIOD

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INTRODUCTION: Telomere length (TL) decreases with aging, and contributes to cell senescence [1]. In observational studies, higher levels of physical activity are related to longer TL in various populations. Indeed, age is known to be associated with a marked decrease in muscle-tendon properties for maintaining balance. It has been clearly shown that resistance training (RT) improves muscle-tendon properties with stiffer tendon structures associated with increased balance ability [2]. Nevertheless, the relationship between the TL in older individuals and the response to training intervention remains unknown.

Thus, the aim of this study is to investigate the effect of high RT programs of the Quadriceps Femoris (QF) muscles on mechanical properties of the Patellar tendon (PT) changes in old men and the influence of TL.

METHODS: Healthy old men (OM80, (n=14, age 69.8 ± 4.4yrs) took part in a high training program (12 weeks RT program (3 times/week)) corresponding to 80% 1RM on QF muscle (using: leg press, leg extension). PT were scanned using a 1.5T MRI scanner before and after RT period. PT Cross Sectional Area (CSA) were determined every 10% of tendon length. Mechanical properties of PT were investigated from force and ultrasonographic measurements during maximal isometric ramp contractions. Blood samples were collected 1 week before the beginning of RT. TL was measured using an established quantitative real-time PCR technique. Pearson correlation analyses were conducted with the TL as dependent variable and the muscle-tendon characteristics as independent variables.

RESULTS: After training, QF volume was significantly increased (+4.2%, $p<0.05$). PT CSA was significantly increased in OM80 (+1.7%; P=0.002). An increase in PT force (+14.0%, p=0.008), stiffness (+34.5%, p=0.007) and Young's modulus (YM) (+34.8%, p=0.04) was found after 12-w RT. TL was significantly associated with gain in PT force (CC=0.67; p=0.049) and QF volume (CC=0.82; p=0.048). However, TL was not associated with gain in PT stiffness and YM despite a tendency (CC=0.70; p=0.14) and YM (CC=0.78; p=0.10).

CONCLUSION: The present study shows that the increase in QF volume, PT stiffness and YM following high strength training in old subjects was correlated with telomere length. Thus, the longer the telomere length is, the higher the muscle-tendon structures adaptations are. This may at least partly explain the heterogeneity in subjects' response following to strength training whatever the investigated adult population.

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WRIST EXTENSOR TENDON FORCES DURING TENNIS FOREHAND ARE MODULATED BY PLAYER-SPECIFIC TECHNIQUE

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INTRODUCTION: Lateral epicondylalgia, also known as tennis elbow, is a major health issue among tennis players, affecting hand extensor tendons and resulting in pain and impairments for everyday life. Unfortunately, prevention remains limited by the lack of data regarding biomechanical risk factors, especially hand tendon forces which evaluation remains challenging. Musculoskeletal modelling is a non-invasive method to estimate muscle and joint loading from motion capture data and already provided data for the upper limb joints [1,2] but was less used for the hand [3]. The objective of this study was thus to develop a musculoskeletal model to provide a new insight into hand tendon loadings in tennis players.

METHODS: An Advanced player (ITN 3; grip strength: 653 N; eastern grip) and an Intermediate player (ITN 7; grip strength: 1195 N; semi-western grip) participated in a two-step protocol. First, players performed a series of grip force tasks to establish a relationship between electromyographic (EMG) activities and grip force. Second, players performed forehand drives, aiming a target with a ball at two shot speeds and with three rackets with different inertial properties.

Upper limb kinematics were tracked using reflective markers and a seven-camera motion capture system. EMG activities were synchronously recorded for four forearm muscles, including a finger extensor and a wrist extensor.

An EMG-informed musculoskeletal model was developed to estimate the tendon forces of 42 hand muscles. The model relied on an inverse-dynamics approach [3] with three main inputs: grip force estimated from EMG, wrist net moments deduced from marker data and four muscle forces estimated from EMG using force-length-activation relationships [4]. From the 42 tendon forces, muscle group forces of finger and wrist extensors were calculated by summing the forces of the four finger common extensor bellies and the three wrist extensors, respectively. Forces jut before impact were kept for further analysis.

RESULTS: Finger extensors' forces were close to 50 N and negligible compared to wrist extensors' ones, ranging from 400 N to 750 N. Wrist extensor tendon forces increased with shot speed but were moderately affected by racket properties. After normalizing by grip strength and shot speed, wrist extensors' loading in the Advanced player were up to three times higher than for the Intermediate one, suggesting player-specific biomechanical strategies.

CONCLUSION: The results of this study confirmed wrist extensors are exposed to high mechanical loadings and that player-specific characteristics, e.g., grip position, might modulate this loading. Further studies are required to clarify the individual factors influencing finger and wrist biomechanical loadings during tennis playing.

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BICEPS FEMORIS APONEUROSIS STRUCTURE IS NOT CONTINUOUS BUT SEPARATED BY LOOSE CONNECTIVE TISSUE: A CADAVER STUDY.

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INTRODUCTION: The biceps femoris long head (BFlh) is known to be prone to strain injury, and studies in the last decade suggest a role for its architectural complexity. Several studies on human cadavers have been performed to understand the structure-function relationship, particularly around the proximal region, where most injuries occurs (1). A particular and potentially relevant structure in this region is the intramuscular aponeurosis, e.g. a broad, sheet-like elastic structure, which is loaded both in the longitudinal and transverse axis during muscle contraction. In vivo studies have attempted to delineate the intramuscular aponeurosis using ultrasonography (2). However, this does not allow for studying its detailed anatomical structure. Hence, the aim of this study is to assess the structure of BFlh aponeurosis in detail.

METHODS: Both lower extremities of four embalmed human cadavers (male : female = 2 : 2, mean ± SD 84.5 ± 6.35 years old) were dissected. Morphometric data of the BFlh muscles were collected after separating them into blocks by cross-sectional (CS) cuts of the BFlh every 5% of its length. Care was taken to align the blocks to identify the path of the aponeurosis throughout the BFlh muscle length. Macroscopic analysis of each block surface was performed to differentiate dense connective tissue of the aponeurosis structure from loose connective tissue or adipose tissue based on the appearance and resistance to deformation induced by a forceps. Structures that were not clearly identified with these procedures were further processed for histological analysis.

RESULTS: Intramuscular aponeurosis was identified from 40% ± 5% to 70% ± 5% of BFlh muscle-tendon unit length. Infiltrations of loose connective tissue between the collagen bundles of the aponeurosis in the CS plane were observed in the macroscopic and histological analysis, i.e, there were divisions of aponeurotic continuity by the loose connective tissue. Inter-individual differences of the aponeurosis geometry and disrupted continuity were observed along the BFlh length. Significant changes were observed from 50 to 60% BFlh length, where the aponeurosis transformed its shape in the CS from a flat line to a hook-like or a T-shape.

CONCLUSION: The intramuscular aponeurosis of BFlh does not have a continuous structure transversely. The shape considerably changes along its length and across individuals. These features have implications for the region-specific and individual differences in strain injury proneness.

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RESIDUAL FORCE ENHANCEMENT IN THE DESCENDING LIMB: IS THERE A LIMIT?

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INTRODUCTION: Residual Force Enhancement (rFE) is a property of skeletal muscle, defined as an increase in force during an isometric steady-state contraction after an active stretch compared to the force produced during a pure isometric contraction at the same joint angle and similar muscle activity. RFE has been shown to be present during the entire force-length relationships. In addition, rFE increases with stretch amplitude and muscle length up to a critical point. This study aimed to investigate if rFE keeps increasing with increasing muscle length only in the descending limb and if there is a limit where it does not appear anymore.

METHODS: Eight healthy male participants performed maximal isometric voluntary contractions (MVIC) of the knee extensors during the descending limb of their individual torque-angle relationship, with and without a preceding active stretch. In total three different stretch amplitudes (short = 15°, medium = 25°, long = 40°) where tested. For data analysis, torque, and EMG activity of the quadriceps muscles (rectus femoris, vastus medialis, and vastus lateralis) were tested during the isometric trials, as well as during the trials after an active stretch.

RESULTS: The results showed a significant decrease in torque between the reference MVIC (195.41 □ 46.90 Nm) and stretch-hold contraction (183.17 □ 59.93 Nm) for the short stretch condition, and a significant increase in torque between the reference MVIC (142.92 □ 34.81 Nm) and stretch-hold condition (159.29 □ 37.08 Nm) for the long stretch amplitude. RFE values ranged from 2 – 25%. Fascicle length from the vastus lateralis increased by an average of 1.90mm (4%) for the short stretch, 2,8mm (6%) for the medium stretch, and 3,4mm (6%) for the long stretch amplitude.

CONCLUSION: Although torque values decreased with the increase in fascicle length during the descending limb, the change percentage in torque was higher after the long stretch (20% change) compared to the medium stretch (10%). From these results, we can conclude that force enhancement exists at very long muscle lengths in the quadriceps femoris, that it is higher with higher stretch amplitudes and longer fascicle lengths, and that so far, it does not show a limit or point where it does not increase anymore.

THE CHARACTERISTICS OF LOWER LIMB MUSCLE STRENGTH IN ELITE JAPANESE ATHLETES: FOCUSING ON THE DIFFERENCE IN SPORTS TYPE AND COMPETITION SEASON

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INTRODUCTION: The competition and training environment varies depending on the competition season, i.e., summer or winter, not to mention that it varies depending on sports type. Therefore, physical characteristics of elite athletes are considered to be affected by the competition season as well as the sports. Previous studies have suggested that lower limb muscle strength is an important factor in a variety of sporting activities (1). There have been several reports that have examined lower limb muscle strength for different competitive events, but not in terms of the competition season and sports type. This study aimed at investigating lower limb muscle strength in elite Japanese athletes with a focus on the sports type and competition season.

METHODS: Elite Japanese male athletes of various competition events were involved in this study (N=1364). They were divided into 5 categories of sports type (2, 3) (a. SPRINT/POWER, b. ENDURANCE, c. ARTISTIC, d. BALLGAME, e. OTHER) and also into 2 competition seasons (Summer or Winter). Isokinetic knee extension and flexion strength tests were conducted at the angular velocities of 60 and 180 deg/s. The peak extension and flexion torque (PT) and those normalized to their body weight (PT/BW) were extracted from each velocity condition. Differences in PT and PT/BW of both knee extension and flexion at each angular velocity among the categories were tested by a two-way ANOVA (5 sports types × 2 seasons). Statistical significance was set at $p < 0.05$.

RESULTS: In 60 deg/s knee extension, significant main effects of the sports type and season were found, without any interaction. Winter season athletes showed significantly higher PT/BW than summer season athletes. Post-hoc multiple comparison revealed that PT/BW in SPRINT/POWER was significantly higher than OTHER. On the other hand, significant interactions were found between the sports type and season for PT/BW in 180 deg/s knee extension, and 60 deg/s and 180 deg/s knee flexion. In 180 deg/s knee extension, there were significant differences between Summer (S-) and Winter (W-) in PT/BW of ENDURANCE (S-ENDURANCE < W-ENDURANCE) and OTHER (S-OTHER < W-OTHER). Significant differences were also found between the seasons in PT/BW of 60 deg/s knee flexion for ENDURANCE (S-ENDURANCE < W-ENDURANCE) and BALLGAME (S-BALLGAME > W-BALLGAME) and in PT/BW of 180deg/s knee flexion for SPRINT/POWER (S-SPRINT/POWER > W-SPRINT/POWER), ENDURANCE (S-ENDURANCE < W-ENDURANCE) and BALLGAME (S- BALLGAME > W- BALLGAME).

CONCLUSION: Our results suggest that not simply the sports type but also the season of them affect the lower limb muscle strength of elite athletes substantially. Seasonal differences may be due to the season-specific feature in sporting movement, e.g., forward-bent posture and tonic muscle contraction in skiing and skating.

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UPPER LIMB JOINTS COORDINATION DURING JUMP PULL-UPS IN ROCK CLIMBERS

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INTRODUCTION: The pull-up exercise is a complex motor task involving multiple joints. The jump pull-up (JPU) is representative of climber's skill and is given as a relevant upper-limb power test (1), but JPU's joint coordination is not described in the literature. JPU task can be related to squat or counter-movement jumps where complex motor task rules the activation joint from proximal to distal (2) (3). This study investigates the coordination pattern of the upper limb joints during JPU exercise with or without stretch shortening cycle.

METHODS: Six skilled climbers (over 7c French lead climbing grade.) performed 4 trials of two forms of JPU : counter-movement JPU and stato-dynamic JPU. Climbers were asked to jump in order to ascend their two hands as high as possible. Each participant was equipped with an adapted Qualisys® marker set to measure upper limbs displacements. Two 3-axis force sensors were used to measure each hand reaction force during the JPU. Upper joint angular kinematics and hands maximal height were estimated from Qualisys measurements. The onset times of maximum joint velocities (NT) were normalized to JPU duration. t-test were performed to realize statistical analysis.

RESULTS: Statistical tests realized on NT deviation between the wrist and elbow joints (14.1 ±5.8 % NT of JPU, $p<0.05$) and the elbow and shoulder joints (38.7 ±12.0 % NT of JPU, $p<0.05$) indicate significant differences. The joints were involved from the shoulder to the wrist in a proximal to distal sequence. No significant difference of the height reached by the hands between the two JPU exercises were found.

CONCLUSION: This study demonstrates that the recruitment pattern of the upper limb joints obeys the proximal-distal order when performing JPU. This is consistent with the observations conducted on lower limb squat jumps. However, the comparison of the two JPU forms performed reveals no significant improvement in jump high performance due to the presence of a stretch shortening cycle. Further investigation should be conducted in order to confirm these findings.

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GRANTS:

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UPPER LIMB KINEMATICS OF AN ELITE CLIMBER DURING A POWER SLAP TASK

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INTRODUCTION: Climbing coaches can benefit from quantifying upper limb kinematics during climbing activities to develop training programs. However, kinematic analyses of climbing tasks are rare due to technological limitations, and coaching relies on qualitative observation or video data (2). Inertial measurement units (IMUs) are wearable, portable, and require minimal preparation and can be undertaken in real-world settings. However, prior to their widespread use the validity of these tools for climbing tasks warrants investigation. The study aims to quantify upper limb kinematics of an advanced climber during climbing-specific tasks and compare the accuracy of IMU-derived kinematics to optical motion capture.

METHODS: A male climber (age: 23 years; body mass: 61.1 kg; top boulder grade: V11; climbing experience: 14 years) provided written informed consent to participate in this study. A twelve-camera motion analysis system and five Blue Trident IMUs (Vicon, Motion Systems Ltd) simultaneously acquired kinematic data. Retroreflective markers and IMU sensors were attached to the torso, pelvis, upper arms, and forearms. Following a self-selected warm up the climber performed two repetitions of a power slap test. The test begins with a two-armed hang on a 45mm rung, followed by an

explosive pull-up where one arm slaps the scale board above. Upper limb kinematics were calculated using inverse kinematics following the OpenSense workflow (3) within OpenSim 4.4.

RESULTS: The mean distance attained during the power slap was 1.0 m for both arms. The dominant hand slap showed higher humeral flexion, abduction, and internal rotation (126.2°, 56.8°, and 45.8°) compared to the non-dominant hand slap (120.6°, 43.6° and 41.9°). Whereas torso lateral flexion and rotation were lower in the dominant hand slap. IMU and optical capture kinematic differences ranged from 1.1° to 7.9°, with the largest occurring in humeral internal rotation.

CONCLUSION: This work presents novel insights into the upper limb kinematics of a highly explosive climbing task performed by an elite climber. Despite attaining similar heights between dominant and non-dominant limbs during the power slap the climber exhibited differences in upper limb kinematics suggesting slight alterations in coordination. IMU-derived upper limb kinematics were comparable to the optical capture system during both the two-armed hanging position phase and the single-arm slapping phase of the power slap. Despite these promising results further work is necessary to further evaluate the accuracy of IMUs in quantifying upper limb kinematics in climbers which should include a larger sample size and wider array of climbing tasks. The notable asymmetries in upper limb kinematics may provide coaches with additional cues to observe when developing climbers.

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COMPARISON OF GROUND REACTION FORCES ON FULL AND CONTROLLED DRIVER SHOTS IN MALE PROFESSIONAL GOLFERS

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INTRODUCTION: Shot distance and accuracy in golf are achieved by adjusting club head velocity (CHV). A prior study indicated that the horizontal reaction force of the front leg is diminished when a reduced shot distance is achieved with a 6-iron club [1]. However, the regulation of ground reaction force (GRF) with different CHVs of driver shots has yet to be elucidated. This study aimed to determine how skilled golfers adjust GRF variables during full and controlled driver shots.

METHODS: Eight right-handed male professional golfers (age: 35.7 ± 1.7 years; height: 173.6 ± 7.7 cm; body mass: 75.1 ± 9.4 kg) participated in the study. Each golfer executed a full driver shot (aiming for maximum distance) and a controlled shot (aiming for the center of the fairway). Two Kistler force plates and 12 Vicon cameras were used to record GRF data for each leg and clubhead kinematics data during the swing. The maximum CHV and magnitude and angle of the front and rear leg GRF were calculated for the backswing and downswing phases. A paired t-test using statistical parametric mapping (SPM) was done to compare the GRF magnitude and vector angle of the shots [2].

RESULTS: The full shot had a greater maximum CHV than the controlled shot (51.8 ± 3.7 vs. 49.5 ± 2.2 m/s, respectively, $p < 0.05$). SPM analysis indicated that, for both legs, the GRF magnitude in the backswing phase did not differ between the shots. In contrast, during the downswing phase, only the vertical GRF of the front leg was significantly greater in the full shot than in the controlled shot, in the range of 55%–74%. No difference was observed in the GRF vector angle between shot types.

Our results indicated that skilled golfers increased the front leg vertical GRF in the mid-downswing phase of a full driver shot. This differs from the prior study, which reported a reduction in the horizontal GRF component of the front leg with reducing shot distance using a 6-iron club [1]. This discrepancy may be due to the difference in swing using a driver or an iron. Another study showed that the magnitude of the vertical GRF of the front leg on the downswing is a major predictor of ball velocity [3]. Thus, the skilled golfer may have pushed downwards harder with the front leg during the full shot with the driver. Furthermore, adjusting the GRF magnitude without changing the GRF angle between shots may promote shot distance and accuracy in terms of leg coordination and performance, as shown in a previous study [1].

CONCLUSION: A comparison of full and controlled driver shots of skilled golfers suggested that the full shot had a higher CHV due to a greater vertical GRF of the front leg after the mid-downswing phase.

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PERFORMANCE COMPARISON BETWEEN WATERFOWL AND SYNTHETIC FEATHER SHUTTLECOCKS IN BADMINTON: FOCUSING ON THE SHUTTLECOCK MOVEMENTS IMMEDIATELY AFTER BEING SMASHED

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INTRODUCTION: The Badminton World Federation approved substituting the waterfowl feather shuttlecock (hereinafter "WFS") for synthetic feather shuttlecocks (hereinafter "SFS") at international tournaments from 2021. Thus, players need to adapt to the SFS and play on it. Although the manufacturers reported similar performance between SFS and WFS, no de-

tailed data has been presented. Therefore, we investigated the kinematic characteristics of the WFS and SFS focusing on the shuttlecock movement immediately after being smashed in this study.

METHODS: Twenty collegiate badminton players smashed the shuttlecocks coming out of the knock machine to the target area 12 m far from the hitting location. To record the shuttlecocks' movements immediately after being smashed, a high-speed camera was placed laterally and perpendicular to the shuttlecock's trajectory. The camera was set at a frame rate of 2,000 fps. One of each trial where the racket speed at impact was maximal in WFS (TOURNAMENT, YONEX) and SFS (TECH FEATHER 03, Mizuno) was selected for analysis. The cork head and both ends of the feather tip were manually digitized. Racket speed at impact, initial shuttlecock speed, shuttlecock/racket speed ratio, vertical launch angle, and attitude angle of shuttlecock, which is defined as the angle between the long axis of the shuttlecock and the initial velocity vector, were calculated. To compare these parameters between WFS and SFS, an unpaired t-test was used. The significance level was set at $p<0.05$.

RESULTS: Significant differences were not found for racket speed (WFS: 63.3±9.5 m/s, SFS: 63.8±8.9 m/s, p=0.48), initial shuttlecock speed (WFS: 73.6±8.5 m/s, SFS: 71.8±7.0 m/s, p=0.07), vertical launch angle (WFS: –9.0±2.6 degrees, SFS: –9.2±2.6 degrees, p=0.40). Shuttlecock/racket speed ratio for WFS was larger than that for SFS (WFS: 1.17±0.06, SFS: 1.13±0.07, p=0.03). Maximum attitude angle of shuttlecock for WFS was smaller than that for SFS (WFS: 41.0±4.9 degrees, SFS: 45.4±4.4 degrees, p=0.01).

CONCLUSION: The participants smashed both shuttlecocks at almost the same initial speed and vertical launch angle to hit the same target area; therefore, the difference in flight characteristics between the two shuttlecocks was found to be negligible at a glance. However, the shuttlecock/racket speed ratio for SMS is smaller; thereby, there is a possibility that the participants might have adjusted the racket speed slightly, although no statistical difference were found in racket speed. Moreover, the drag force acting on SFS might be slightly larger because SFS had a larger attitude change. Badminton players have extremely sensitive senses to perform well, especially at the international level. In our future work, it is required to reveal how they adapt to the SFS and the risk of injuries associated with it through the motion analyses. In addition, revealing the aerodynamic characteristics of shuttlecocks is also required through the wind-tunnel experiments.

ACCELEROMETERY VS. VIDEO-DERIVED STROKE PARAMETERS IN HIGH-LEVEL SWIMMERS

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INTRODUCTION: Swimming is a multifaceted sport with nuanced performance parameters that tend to vary according to the swimmer's stroke style [1]. The extraction and analyses of swim parameters, such as lap time (LT), stroke length (SL), stroke rate (SR) and velocity are time-consuming [2]. This may be eased, and to some extent automated, by the use of cost-effective tri-axial accelerometers.

OBJECTIVES:

To determine the validity of tri-axial accelerometers across all four stroke styles, and to investigate kinematic differences in stroke styles using accelerometer-based data.

METHODS: Twelve elite swimmers were recruited for the study. The group consisted of five male (age: 22.2 ± 2.6 years; height: 1.84 ± 0.08 m; weight: 76.2 ± 3.6 kg) and seven female (age: 20.7 ± 2.1 years; height: 1.68 ± 0.08 cm; weight: 62.0 ± 6.3 kg) swimmers. A 4 x 50-m individual medley was completed in a 25-m pool, with tri-axial accelerometers fitted to the swimmer's left wrist and upper-back, sampling at 100Hz. Accelerometer data (reference method) were compared to high-speed video (criterion method) to evaluate the validity of the key stroke parameters.

RESULTS: There was a small but significant bias for accelerometery data compared to video data for most parameters evident from the mean bias differences across all stroke styles for swimming velocity (Mdiff = -0.05m/s, $p<0.019$), SR (Mdiff = -0.02str/sec, $p<0.047$, except freestyle, Mdiff = -0.01str/sec, $p = 0.083$) and lap time (Mdiff = 1.38 sec, $p<0.001$). No statistical differences were evident for SL (Mdiff = 0.01m/str, $p = 0.795$) and stroke count (Mdiff = 0.19, $p = 0.280$). However, the accelerometery-derived SR, SL and velocity can be considered practically useful based on the training requirements of coaches, with a two one-sided t-test indicating that these parameters fell well within their equivalence bounds for all strokes (velocity = ±0.10m/s, SR = ±0.04str/sec, and SL = ±0.02m/str). Parameters derived from video analysis compared to accelerometery were highly correlated ($r > 0.91$) and therefore consistent regardless of the method of analysis.

CONCLUSION: Slight statistical differences were present between the video and accelerometer data, suggesting that the accelerometers may not be a "true" surrogate compared to video data. The accuracy of the results obtained were on par with those of other studies, even though the sample investigated were different [3,4]. Hence, the accelerometers showed potential for monitoring of swimmers in training, with the practical usefulness for coaches. Future research should investigate real-time feature extraction, effects of injury and/or fatigue, and whether training interventions yield detectable changes in stroke mechanics when using accelerometery.

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RELATIONSHIP BETWEEN BATTING VELOCITY AND UPPER EXTREMITIES ISOKINETIC MUSCLE STRENGTH DURING BASE-BALL TEE BATTING

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INTRODUCTION: The increasing swing velocity can help increase decision time, reduce swing time, and increase ball exit velocity. The latter can make the ball fly faster and farther, creating challenges for the opponents' defense (1). Batting velocity affects batted ball distance. To increase ball exit velocity, hitters must increase swing velocity (2), which demonstrates the importance of both swing and batting exit velocities. However, most researchers have focused on lower extremity joint performance (3), with studies lacking on the upper extremity joints that perform movements. Therefore, the purpose of this study was to investigate the relationship between batting exit velocity and isokinetic muscle strength of the upper extremities.

METHODS: Three college baseball players were recruited for this study. The participants used wood bats (850 g; Louisville Slugger) to hit the ball positioned on a tee; they were instructed to hit the ball with full strength into a net (87 cm x 87 cm). The swing velocity parameters of the reflective balls on the bat were obtained using Vicon systems. The Biodex System 4 Pro was used for the isokinetic muscle strength tests of the shoulder, elbow, and wrist joints, collecting peak torque and power parameters at 60, 120, and 180°/s. We used Pearson product difference correlation analysis.

RESULTS: According to the results of the Pearson correlation analysis, the batting exit velocity was significantly positively correlated with the shoulder 60°/s internal rotation PT/BW ($r = 0.997$; $P = 0.047$); no correlation was found with the parameters of the elbow and wrist joints. The swing velocity was significantly positively correlated with the elbow 180°/s extension PT/BW ($r = 0.999$; $P = 0.026$), shoulder 60°/s internal rotation PT ($r = 1$; $P = 0.015$), 120°/s internal rotation PT/BW ($r = 0.999$; $P = 0.032$), and 60°/s internal rotation AVG PT ($r = 0.998$; $P = 0.036$). However, it did not correlate with the wrist joint parameters.

CONCLUSION: The batting exit velocity was significantly positively correlated with the peak torque of the internal rotation of the shoulder joint, indicating that batting is a continuously coordinated action, and the kinetic chain transmits energy from the lower to the upper limb (4). The main energy may come from the rotation of the lower limb and torso. Many factors affect the batting exit velocity, including the launch angle, swing velocity, and pitching velocity, among others. Therefore, the isokinetic muscle strength in the upper limb joints has a low impact on the batting exit velocity. The results of this study showed that shoulder internal rotation and elbow extension are highly correlated with batting. In the future, to improve batting performance, the focus should shift to shoulder and elbow joint strengthening. These results provide a batting training reference for coaches and players.

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EFFECT OF ADJUSTMENT OF SADDLE HEIGHT AND RIDING TIME ON CYCLE PEDALING

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INTRODUCTION: Road cycling is one of the most popular sports not only for professional athletes but also for recreational players around the world. The saddle height of road cycling, which rides more than 100 km a day on average, is a very important factor in increasing cycling efficiency. However, unlike professional athletes with professional trainers, recreational players have limited information on choosing their own optimal saddle height. In addition, since the traditional saddle height chosen by general fitters is calculated for professional players, it is difficult to apply it to recreational players (1-2). Therefore, the purpose of this study was to help the cycling club riders(recreational players) to prevent injuries and improve their athletic performance based on the data from comparison of lower extremity movements according to saddle height and running time during cycling pedaling.

METHODS: Eleven healthy adult males (age: 33.18±7.51 yrs, height: 175.49±6.14 cm, weight: 69±8.72 kg, career: 7±5.53 yrs.), whose dominant foot is right one, and who have been cycling for more than three years with no lower extremity musculoskeletal injury within the past six months participated in this study. Raw data of this study were collected for three days and test protocol was conducted under the same conditions, including hour and time period, except for saddle height. A 3-Dimensional motion analysis with eight infrared cameras(sampling rate: 200 Hz) and five-channel of EMG(sampling rate: 1000 Hz) was performed. A two-way ANOVA with repeated measures was conducted to verify the intervention effect and the statistical significance was set at α=.05.

RESULTS: As saddle height increased, the hip joint revealed the largest ROM followed by knee and ankle joints. For all saddle height, the third phase, where the lower extremity joint was at maximum extension, showd the largest change in joint ROM. Also the joint angular velocity revealed similar to that of the joint ROM. In addition, higher saddle height led to more decrease in angular velocity over time in all joints. Finally, as saddle height increased, it was shown that a tendency of higher muscle activation and greater decline in muscle activity over time.

CONCLUSION: This study quantified the saddle height adjustment method for recreational riders, which was studied only for elite riders regardless of East and West. The results of this study seems to contribute to relieving the discomfort of recreational riders while riding, and to help research on more efficient saddle height adjustment methods in the future.

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DIFFERENCES IN LOWER EXTREMITY BIOMECHANICS BETWEEN PATIENTS WITH PATELLOFEMORAL PAIN SYNDROME AND HEALTHY ADULTS DURING STATIONARY BIKE RIDING

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INTRODUCTION: Cycling is less of a load on the knee joints, but long-term repetitive pedaling may easy to cause knee injury. The most common injury is Patellofemoral Pain Syndrome (PFPS), whose symptoms include anterior knee pain, paresthesias, and functional deficits. Although there is no definite conclusion on the cause of PFPS, most scholars believe that abnormal joint movement, unbalanced muscle contraction and so on are all possible causes. This study wants to know about the activation of lower limb muscles in patients with PFPS during cycling, with different resistances and different seat heights at a fixed riding speed.

METHODS: In this study, the subjects were divided into the PFPS group and the healthy group. Two kinds of seat cushion heights that were commonly used in the past and three different resistances that were often used in the actual riding were used alternately. Use the EMG system to observe the activation of the contraction of the Gluteus Medius (GM), Vastus Medialis (VM), Rectus Femoris (RF), and Vastus Lateralis (VL) while riding. To compare the differences between the two groups and find out which one is more suitable for patients with PFPS.

RESULTS: The VL (β = -0.105, $p < 0.05$) & VM(β = -0.139, $p < 0.05$) activation in the pain group is less than that in the health group. When using the high seat height, the activation of VL is significantly greater than the low seat height.(β = -0.133, $p < 0.05$) Conversely, VM activation was significantly lower with higher seat height (β = 0.129, $p < 0.05$).

In the PFPS group, GM EMG activation was significantly greater than in the healthy group(β = -0.201, $p < 0.001$); and in higher seat height, EMG activation was significantly greater than low seat height(β = 0.161, $p < 0.001$); There was no significant correlation in muscle activation between different resistances.

Different resistances have a significant impact on the activation of RF(β = 0.102, $p < 0.05$). As the resistance increases, the activation of RF increases.

CONCLUSION: Strengthening the GM, VM, and VL muscles in patients with PFPS to reduce muscle compensation when riding a bicycle. In addition, due to the dislocation of the joints of the lower limbs, it is necessary to pay more attention to whether the joint angle is too large, so as to reduce knee varus, thereby reducing joint pain.

THE INFLUENCE OF RACKET SIZE ON SERVE BIOMECHANICS IN YOUNG TENNIS PLAYERS

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INTRODUCTION: Scaling the equipment of young athletes is justified by the constraints-led approach introduced in motor learning. Tennis coaches are encouraged to scale the equipment in children's sport to improve motor patterns acquisition and to favor the emergence of efficient and safe technical skills in a fun and exciting environment. Among all the possible interventions on equipment, scientists encourage coaches to ask young tennis players to play with different racket size in the theoretical hope of facilitating racket handling ability, decreasing upper limb joint loadings, promoting more variability, increasing performance (speed and accuracy), increasing segmental and joint angular velocities. However, the short-term effects of the racket scaling constraint on serving performance, kinematics and joint loadings are unknown. As a consequence, this study aimed to assess the effect of racket size on the serve biomechanics and performance parameters for young tennis players

METHODS: 9 young intermediate competitive tennis players (age: 9.9 ± 1.0 years) performed maximal effort successful flat serves with 3 different rackets (scaled 23 inches, scaled 25 inches and full-size 27 inches) in a randomized order. A radar measured ball speed while shoulder and elbow loadings and upper and lower limb kinematics were calculated with a motion capture system. Repeated measures ANOVAs were used to compare the effect of the three racket sizes.

RESULTS: Ball speed ($P = 0.187$), maximal racket head velocity ($P = 0.368$) and percentage of serve in ($P = 0.713$) were not significantly different between the three rackets. The lowest maximal upper limb loadings (shoulder internal rotation, shoulder abduction and elbow varus torques) and the highest upper limb maximal angular velocities (forearm pronation, elbow extension and wrist flexion) were obtained with the scaled 23 inches racket while the full-size 27 inches racket induced higher maximal angles of front knee ($P = 0.005$) and back ankle flexion ($P = 0.033$), higher maximal extension velocities of the back knee ($P = 0.004$) and back ankle ($P = 0.008$).

CONCLUSION: The current results show that scaling racket from 23 to 27 inches would not have immediate effect on ball speed, maximal racket head velocity and percentage of serves in but would decrease shoulder and elbow loadings. Moreover, the manner in which the body produced joint angular velocities differed between the three racket sizes, with scaled rackets promoting more distal angular velocities and the full-size racket facilitating more proximal angular velocities from the lower limbs. Our results suggest that serving with a full-size racket provides beneficial biomechanical opportunities for the lower limbs but detrimental boundaries for the dominant upper limb in young intermediate tennis players. Finally, our study shows that modifying racket characteristics constitutes a short-term and relevant practical intervention that provides immediate new learning opportunities for young intermediate tennis players.

THE IMPACT OF PHASE DURATION AND ITS VARIABILITY ON ARCHERY SHOOTING PERFORMANCE: A CASE STUDY

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INTRODUCTION: The recurve bow shooting movement could be divided into several phases including set-up, drawing, aiming, clicker reaction time （CRT), and follow through (1). Previous studies have addressed the importance of the aiming duration and CRT; however, the results were inconsistent (1,2,3), and the other phases were not examined. Moreover, most studies used cross-sectional design where participants were required to shoot a limited amount of arrows in one experiment. Therefore, the aim of this study was to systematically investigate the relation between shooting performance and each phase duration as well as its variability with a longitudinal design.

METHODS: We recruited one skilled male archer (19 years) who had 7 years of recurve archery experience. In each experiment, the archer was required to shoot 12 ends of 6 arrows at a 122-cm target face at 70 m outdoors. 10 experiments were conducted, resulting in 720 arrows collected. A customized mechanical switch was attached under the clicker of the participant's bow to record the fall of the clicker in each shot. Moreover, one marker was attached on the participant's wrist and its movement was captured by one video camera (30Hz) and input to Kinovea for digitization. Each shot cycle was then divided into 4 phases with 5 specific movements (i.e., set-up, drawing, anchor, clicker fall, and release to define the phases of set-up, drawing, aiming and CRT). Separate one-way repeated measures ANOVAs were used to compare the difference of the duration and duration variability of each phase under different scores (10, 9, 8, and under 7 points, respectively). The Pearson product-moment correlation coefficient was used to examine the relation between performance and the duration as well as the duration variability in each phase. The level of significance was set to $\alpha = .05$.

RESULTS: The percentage of the shots in 10, 9, 8, and under 7 points were 20±6.4%, 37.9±6.0%, 25.5±3.8%, and 16±6.3%, respectively. The duration of set-up, drawing, aiming, and CRT was 2549±217ms, 1605±187ms, 3488±619ms, and 193±37ms, respectively. The average duration variability of set-up, drawing, aiming, and CRT was 144±29ms, 115±28ms, 647±201ms, and 33±9ms, respectively. Particularly, there was a significant main effect of score in the duration of set-up phase $F(3,27)=3.725$, $p<.05$, $\eta p2=.293$, with the 10-point arrows（2514±177ms）shorter than the 8-point ones（2569±165ms）Furthermore, the duration variability of drawing phase was negatively correlated with scores ($r=-.826$, $p<.05$).

CONCLUSION: Our results revealed that the duration and duration variability in certain phases may crucially impact the shooting performance. On the one hand, these results partially replicated previous findings in literature. On the other hand, the discrepancy of the results from previous studies might highlight the importance of collecting data in a more ecological setting that simulated the competition and in a longitudinal design.

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CP-PN19 Nutrition IV

SERUM CONCENTRATION OF SELENIUM, FOLATE, VITAMIN B12 AND FERRITIN IN FEMALE ELITE FIELD HOCKEY PLAYERS

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INTRODUCTION: Micronutrients play an essential role in maintaining health and performance of athletes. In addition to their role as components and biocatalysts of metabolic processes, micronutrients also function as regulators of the immune system (1). The serum concentrations of the micronutrients selenium, folic acid, vitamin B12 (Vit B12) and ferritin in female elite hockey players have either not been investigated in depth so far (e.g. selenium, folic acid and Vit B12) or are still of interest due to poor implementation of substitution recommendations. The aim of this study was to analyse the serum concentrations of these micronutrients in the players of the German field hockey national team in order to detect possible deficits and develop sport- and gender-specific recommendations for micronutrient substitution.

METHODS: 33 German female hockey players (age: 23.9 ± 3.5 years; weight: 65.4 ± 6.7 kg; height: 170.4 ± 5.6 cm) playing in the first German national league and in the German national team were included. Venous blood sampling was done in the morning in a fasting state during the days of the yearly sport medical health examination. Whole blood was analysed for the concentrations of selenium and folic acid, and serum was analysed for Vit B12 and ferritin. The analyses were done by Ganzimmun Diagnostics GmbH, Mainz and their specific reference values (RV) were used. Results were corrected for haematocrit concentration. Descriptive statistics are presented as mean ± standard deviation (range, RV).

RESULTS: The mean concentrations of the four micronutrients were: selenium 122.0 ± 23.9 ng/ml (90-181 ng/ml, 101-170 ng/ml); folic acid: 220.0 ± 88.8 (112-570 ng/ml, 126-651 ng/ml); Vit B12: 318.0 ± 80.0 (168-493 ng/ml, 211-911 ng/ml; ferritin: 65.0 ± 39.4 (16-163 ng/ml, 35 (stage 1 iron deficiency)-150 ng/ml). The following number of athletes had values below the respective RV: selenium: n=5; folic acid: n=2; Vit B12: n=4; ferritin: n=10.

CONCLUSION: Mean concentrations of selenium, folic acid, vitamin B12 and ferritin were within the reference ranges. A relevant number of athletes, however, had values below the respective lower limit. This was especially true for selenium. A deficiency in the selenium supply might lead to weakness of the immune system or impaired antioxidant capacity in

situations of high training or competition loads (1). Some athletes were stage-1 iron deficient which might sooner or later lead to anaemia and reduced endurance capacity if the stores are not filled properly (2). Folic acid and Vit B12 were only reduced in a few athletes and might lead to anaemia when not substituted properly (1). Reduced selenium blood values are justifying a general supply of female athletes with selenium supplements. Ferritin should be checked on a regular basis in this population and iron substitution should be provided based on the individual value.

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EFFECT OF ARGININE-CITRULLINE SUPPLEMENT ON SKIN-GAS ACETONE CONCENTRATION FOLLOWING MAXIMAL RUNNING EXERCISE

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INTRODUCTION: Ketones (β-hydroxybutyrate, acetoacetate and acetone) are generated in mitochondria of the liver, mainly from the oxidation of fatty acids, and are exported to peripheral tissues, such as the brain, heart, kidney, and skeletal muscle for use as energy fuels (1). We previously demonstrated that exercise increased skin-gas acetone concentration (2,3). Recent studies reported the combination of oral L-arginine and L-citrulline immediately and synergistically increases plasma arginine and nitrite/nitrate (NOx) concentrations (4), therefore, during exercise arginine-citrulline supplement improved blood flow in muscle tissues, muscle energy metabolism, mitochondrial respiration, and exercise performance due to increased nitric oxide (NO) bioavailability (4). However, no one has confirmed the effect of arginine-citrulline supplement on skin-gas acetone concentration during exercise. The present study demonstrated the effect of arginine-citrulline supplement on skin-gas acetone concentration and performance following maximal running exercise.

METHODS: A double-blind randomized placebo-controlled 2-way crossover study was employed. Ten healthy male students (23.0 ± 1.5 years; mean ± SD) consumed arginine-citrulline supplement (VELOX Charge: Kyowa Kirin Co., Ltd., Japan) or placebo orally 1 h before incremental maximal running exercise exhausting within 30 min. The skin-gas samples were obtained from the dominant hand by covering with a polyethylene bag in which pure nitrogen gas (250mL) was introduced for 100 sec, and collected in a sampling bag at rest and 0, 5, 10, 15, 30 min recovery of the exercise. Acetone concentration was analyzed by gas chromatography. Blood flow measured using a laser tissue blood flow meter (Omegaflo, Omega Wave, Japan). Blood samples were obtained from fingertip to measure lactate concentrations using Lactate Pro (arkley, Co., Ltd., Japan).

RESULTS: The arginine-citrulline supplement significantly ($p<0.05$) increased running time and distance compared to the placebo. Significant higher levels were observed in skin-gas acetone concentration ($p<0.001$) and blood flow ($p<0.001$) following the maximal exercise, thus there was a significant interaction in skin-gas acetone concentration ($p<0.05$) and blood flow ($p<0.001$) between the arginine-citrulline supplement and the placebo.

CONCLUSION: Significantly higher levels of skin-gas acetone concentration have indicated that the arginine-citrulline supplement increased acetone production in mitochondria of the liver and efluxed into skin-gas during the maximal exercise. These results suggest that increased NO bioavailability by the arginine-citrulline supplement improved not only blood flow in muscle tissues, muscle energy metabolism, and mitochondrial respiration, but also acetone production in the liver.

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METABOLIC EFFECTS OF HIGH-INTENSITY INTERVAL TRAINING WITH PROBIOTICS SUPPLEMENTATION IN OBESE WOMEN

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INTRODUCTION: The rising of cardiovascular disease and obesity is a pandemic issue over the past years. High-intensity interval training (HIIT) has been shown to improve aerobic capacity, increase metabolic rate, and improve obesity. Lactobacillus plantarum TWK10, a type of probiotics isolated from Taiwan pickled vegetables, was also found to provide similar performance and metabolic outcome. However, the additive effects of probiotics with HIIT are unclear. Therefore, the purpose of this study was to investigate the additive effects of probiotics supplementation in combination with HIIT on cardiopulmonary fitness, anthropometry and metabolic syndrome blood biomarkers.

METHODS: The placebo-controlled, double blinded study recruited obese women (n = 23, age = 45.8 ± 6.4 y, height = 159.2 ± 4.9 cm, weight = 62.9 ± 9.2 kg, body fat % = 39.3 ± 3.8 %) and assigned into two groups: probiotics group (TWK10) and placebo group (PLA). Participants in both groups consumed supplements daily before breakfast and participated in a self-monitored HIIT training (treadmill running 7 x 2 minutes at 85-90 % VO2max with 1-minute resting interval)

for 3 sessions per week for 8 weeks. Cardiopulmonary fitness - VO2max and time to exhaustion, anthropometry - body weight, waist and hip circumferences, and blood sugar and lipid profile - fasting blood glucose (FBG), triglyceride (TG), and high-density lipoprotein (HDL) were measured at baseline and after the exercise intervention. Data was analyzed using paired t-test and ANCOVA.

RESULTS: Time to exhaustion significantly increased in both TWK10 (+ 11.4 %, p = .008) and PLA (+ 8.8 %, p = .004). Hip circumference reduced significantly only in TWK10 group (- 2.1 %, p = .018) and waist circumference increased significantly only in PLA group (+ 1.7%, p = .008). No significant group effects were found in waist and hip circumference respectively. FBG increased significantly in PLA group (+ 4.5 %, p = .027) but no significance was found in TWK10 group and between both groups. No significant time and group effects were found in VO2max, body weight, TG, and HDL.

CONCLUSION: Probiotics supplement in combination with HIIT may only control body circumferences and stabilize FBG over time, but does not have additive benefits in overall cardiopulmonary fitness and metabolic biomarkers.

FREE, BIOAVAILABLE 25-(OH)D, 1,25-(OH)2D AND SKINFOLD THICKNESS IN INDOOR AND OUTDOOR ATHLETES

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INTRODUCTION: There has been suggested that some functions of vitamin D may be more closely related to the free or bioavailable fraction of vitamin D than to total serum 25-(OH)D concentrations [1]. Current studies strongly support the significant impact of vitamin D on multiple aspects of adipose tissue biology [2]. Body composition/size is overlooked predictor of vitamin D status in athletes. It is still unknown whether adiposity should be taken into consideration while assessing vitamin D requirements in athletes. The aim of our study was to determine the relationship between free, bioavailable 25-(OH)D, 1,25-(OH)2D and skinfold thickness in indoor and outdoor athletes.

METHODS: Forty athletes (16 judoists – indoor, 24 football players – outdoor) participated in the study. Free (25-(OH)DF), bioavailable 25-(OH)D (25-(OH)DB) concentration were evaluated by calculation, using serum albumin and vitamin D binding protein levels. Total 25-(OH)D (25-(OH)DT), 1,25-(OH)2D were assessed using LM-MS/MS. Skinfold thickness was measured with a Harpenden skinfold calliper and percentage body fat was assessed using seven site method. Multiple regression was performed to analyse association between 25-(OH)DF, 25-(OH)DB, 25-(OH)DT, 1,25-(OH)2D levels and skinfold thickness. A statistical level of $p<0.05$ was accepted.

RESULTS: We found that 42.5% (n = 17) of the athletes had 25-(OH)DT concentration <20 ng/ml, which is defined as vitamin D deficiency. In group of indoor players there was no statistical association between 25-(OH)DF, 25-(OH)DB, 25-(OH)DT, 1,25-(OH)2D and skinfold thickness. In group of outdoor players was a significant correlation between serum 25-(OH)DF and midaxillary ($p<0.051$), biceps ($p<0.007$), subscapular ($p<0.08$) skinfold thickness. There was association between serum 25-(OH)DB and biceps ($p<0.008$) skinfold thickness in football players. 25-(OH)DT levels was correlated with midaxillary ($p<0.010$), biceps ($p<0.027$) skinfold thickness in outdoor players.

CONCLUSION: Based on the result of our study, we concluded that 25-(OH)DF, 25-(OH)DB levels are linked with skinfold thickness in football players. The different relationship between 25-(OH)DF, 25-(OH)DB and skinfold thickness in indoor and outdoor athletes might be related with lifestyle physical activity and behaviour of their training.

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PLASMA-INDUCED CHANGES IN THE METABOLOME FOLLOWING POLYPHENOL CONSUMPTION.

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INTRODUCTION: There is increasing evidence to suggest tart cherry (TC) supplementation has beneficial effects on health indices and recovery following strenuous exercise. However, little is know about the mechanisms and how TC might modulate the human metabolome. The aim of this study was to evaluate the influence of an acute high- and low-dose of Vistula TC supplementation on the metabolomic profile in humans.

METHODS: In a randomised, double-blind, placebo controlled, cross-over design, 12 healthy participants (nine male and three female, mean ± SD age, stature and mass were 29 ± 7.46 years old, 174.75 ± 9.30 cm and 77.29 ± 10.52 kg, respectively) visited the lab on three separate occasions (high dose; HI, low dose; LO, or control; CON), separated by at least seven days. After an overnight fast a baseline venous blood sample was taken. Participants consumed a standardised breakfast followed by dose conditions (HI, LO, or CON). Subsequent blood draws were taken 1, 2, 3, 5 and 8 h post consumption. Following sample preparation, an untargeted metabolomics approach was adopted and ran through LCMS/MS.

RESULTS: When all time points were collated, principal component analysis showed a significant difference between conditions, such that the CON trial had homogeneity and HI showed greater heterogeneity. In addition, when conditions were examined at each time point, this same trend was evident up to 5 h, but was reduced by 8 h post supplementation ($P < 0.05$).

CONCLUSION: The doses induced different kinetics. The LO dose provided an initial up regulation at 1 and 2 h (2 h peak) but was reduced thereafter. The HI dose provided a slower up-regulation of global metabolites, however this up regulation is maintained for longer (3 h peak) and can still be observed at 8 h. These data provide new information on the dose-response of Vistula TC following HI and LO doses. This information can be used to inform future intervention studies where changes physiological outcomes could be influenced by metabolomic shifts following acute supplementation.

INTEREST IN VEGAN DIET TARGETING FEMALE ATHLETE STUDENTS

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【introduction】 It is well known that a balance between training, rest, and exercise is important for athletes to improve their performance, but recently the quality of each has been emphasised. Many athletes who switch from a normal diet to a vegan diet experience better physical condition, lighter weight, less fatigue, and fewer injuries compared to before switching to a vegan diet. Thus. this study aimed to investigate the differences in interest in vegan diets depending on the purpose of sport among female athlete students.

【Method】 The participants were 306 female physical education students enrolled in a sports nutrition course. There were 161 valid responses, corresponding to a response rate of 52.6%. A questionnaire survey was conducted using Google Forms. Survey items included the current diet and knowledge of veganism. In this study, questions were asked regarding grades, departments, and club activities. Regarding knowledge of veganism, we asked about awareness of veganism and the current status of the vegan diet. For the analysis, the subjects were divided into two groups, the competition group (CG, n=76) and the healthy group (HG, n=85), according to the purpose of the exercise, and cross-tabulation was performed. The chi-square test was used for the two groups and question items. Differences were considered statistically significant at $p<0.05$.

【Result】Regarding knowledge of veganism, 29% of the CG and 32% of the HG were unaware of veganism. Those who were aware composed of 69% in the CG and 68% in the HG, with no significant difference observed. Further, 79% of the CG and 81% of the HG had no previous experience with a vegan diet, whereas 18% of the CG and 19% of the HG had at least one experience, with no significant difference observed. Regarding whether they followed a vegan diet in their daily lives, 77% of the CG and 72% of the HG did not follow it at all. Additionally, 20% of the CG and 25% of the HG had eaten a vegan meal. Four participants from each group did not answer the questions. In the CG, there were two participants whose almost every meal was vegan and one whose every meal was vegan. In HG, one participant's every meal was vegan. When asked whether they wanted to adopt a vegan diet, 57% of the CG and 46% of the HG did not. In addition, 42% of the CG and 51% of the HG wanted to adopt the diet, with no significant difference observed.

【Conclusion】 This study aimed to clarify the differences in interest in vegan diets depending on the purpose of sport. There was no significant difference in interest in vegan diets for any of the questions. Athletes in previous research improved their performance by changing to a vegan diet, but only a few of the target female physical education students had accurate knowledge of veganism. Therefore, it is important to educate people in order to experience vegan diets close to them, acquire accurate knowledge, and subsequently select foods that suit their current situation.

THE EFFECT OF C8 MEDIUM CHAIN TRIGLYCERIDE SUPPLEMENTATION ON THE COGNITIVE PERFORMANCE OF YOUNG AND HEALTHY ADULTS.

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INTRODUCTION: Medium chain triglycerides (MCTs) supply the brain with an alternative energy source than glucose via both direct (medium chain fatty acids) and indirect (ketone bodies) pathways, meanwhile causing chronic physical adaptations to the brain. Research has unveiled that MCT supplementation leads to cognitive improvements in diseased and/or elderly individuals, and our previous work using MCTs with a C8:C10 ratio of 30:70 discovered that these cognitive improvements also apply to young and healthy adults. The aim of the present study is to see if these results will be replicated using MCT gels that are comprised of 100% C8.

METHODS: 30 participants were randomly divided into three groups of ten: 10g MCT/day, 20g MCT/day and Placebo (carbohydrate gel) and were all provided with three weeks' worth of gels. The 10g MCT/day and Placebo groups were instructed to take 1 gel per day 30 minutes prior to breakfast. The 20g MCT/day group's dosage was increased incrementally to reduce the risk of gastronomical side effects. They were instructed to take 1 gel per day 30 minutes prior to breakfast for the first week, then to take an additional gel 30 minutes prior to their evening meal for the final two weeks. Participants visited the laboratory for approximately 45 minutes once a week for 4 consecutive weeks (baseline, test weeks 1-3) where they underwent a battery of cognitive tests; Trail Making, Digit Span and Spatial Span. Fingertip blood capillary samples were also taken each week to assess blood ketone levels.

RESULTS: After 1 week of supplementation, the two MCT groups exhibited enhanced performances in cognitive tasks, including Trail Making A (-1.42 ± 0.96 secs), Trail Making B (-6.86 ± 4.67 secs) and Digit Span Backwards (1.25 ± 0.97 points) compared to baseline, before performance plateaued in weeks 2 and 3 (ps> 0.05). In Digit Span Forwards, there was a significant main effect of time ($p< 0.001$). In all cognitive measures, there were no significant differences between the two MCT groups (ps> 0.05) nor any effect of treatment or learning in the carbohydrate placebo group (ps> 0.05).

CONCLUSION: MCT supplementation improved some aspects of cognitive function after just 1 week, with there being no differences between ingesting 10g and 20g MCT/day. This raises the possibility of the cognitive improvements being attributed to an acute effect of the C8 gels (i.e. via immediate availability of medium chain fatty acids and/or ketone bodies), rather than the physical adaptations linked with high C10 MCTs.

THE EFFECTS OF A VEGAN MULTI-INGREDIENT PRE-WORKOUT SUPPLEMENT IN BODY COMPOSITION, RESTING METABOLIC RATE AND PERFORMANCE IN MIDDLE-AGED PERI- AND POST-MENOPAUSAL WOMEN

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INTRODUCTION: Pre-workout multi-ingredient (PMTN) supplements are specialised dietary supplements widely used to increase willingness to train and maximise exercise performance outcomes. In the last years, there has been an increased interest in plant-based protein multi-ingredients among vegan athletes and physically active middle-aged and older adults. The aim of the present study was to compare the effects of ingesting a vegan protein-based PMTN vs an isocaloric-only carbohydrate (CHO) supplement comparator on body composition, training volume, and muscular endurance performance over a 6-week training period in recreationally trained peri- and post-menopausal women (n=24, 53±4.3 y.o.)

METHODS: Following a double-blinded randomised parallel design, thirty women were initially assigned to either a PMTN (n=15) or a CHO (n=15) group. Both groups followed an 8-exercise resistance training protocol (3 days/week) for 6 weeks (18 workouts). Supplements were administered 15 minutes before each workout session. The following dependent variables were assessed at pre- and post-intervention: (i) relative volume (total kilograms lifted divided by body mass) lifted per workout (ii) muscle thickness from the vastus lateralis of the quadriceps, and elbow flexors using ultrasonography, (iii) waist and hip circumferences and (iv) fat mass, and fat-free mass via air displacement plethysmography.

RESULTS: No significant differences were observed between groups at baseline for any of the analysed variables. Both groups significantly increased relative workout volume, vastus lateralis and elbow flexors muscular thickness, and fat-free mass. However, only the PMTN group showed a significant post-intervention reduction of fat mass (26.02±6 vs 25.13±6; p=0.029, d=1.33) and waist circumference (79.5±6 vs 77.9±6; p=0.007, d=0.62). No further differences or interaction effects were identified between groups post-intervention.

CONCLUSION: Compared to the ingestion of carbohydrates alone, a pre-workout vegan protein-based multi-ingredient including caffeine and amino acids promoted fat mass and waist circumference reduction after a 6-week resistance training programme in women over 45 years old. Nonetheless, both supplements were similarly effective to influence resistance training volume and promoting fat-free mass gain and exercise-induced hypertrophy. The current findings suggest that ingesting a pre-workout plant-based protein multi-ingredient with caffeine may maximise fat reduction but not fat-free mass gain or higher training volume in middle-aged peri-menopausal and postmenopausal women.

VOLUNTARY REHYDRATION AT A POST-EXERCISE MEAL IS INADEQUATE TO REPLACE FLUID LOST AFTER EXERCISE-INDUCED DEHYDRATION: A BLINDED STUDY

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INTRODUCTION: Starting exercise dehydrated can impair exercise performance, but athletes regularly present at training with raised urine osmolality/specific gravity (indicating dehydration). Better understanding of post-exercise rehydration strategies is thus warranted. Most hydration studies do not blind participants to their hydration status which may influence behaviour and confound outcomes. The aim of this study was to assess short-term (single post-exercise meal) rehydration with participants blinded to their hydration status.

METHODS: 7 healthy males (age 25 ± 2 y; V̇O2max 48 ± 7 mL·kg-1·min-1) completed blinded euhydrated (EU) and dehydrated (DH) trials, with the primary outcomes (performance/physiology responses) published previously[1]. Participants completed a preload (8x15 min cycling at 50% PPO, 5 min rest) and a 15-min performance test in the heat (34°C, 50% RH), with water or dummy infusions delivered to the stomach via a gastric tube in the preload to replace sweat loss (EU) or induce dehydration (DH). 20 min post-exercise, participants were provided a standard ad-libitum buffet meal (food and drink) and were instructed to eat/drink until fully recovered. Body mass, blood-based (serum osmolality, AVP, plasma volume) and perceptual (thirst, hunger, fullness) responses were determined throughout trials. Energy and macronutrient intake were determined by weighing buffet items pre/post.

RESULTS: Post-exercise body mass loss (DH -3.0±0.3%, EU -0.7±0.1%, P=0.002), plasma volume loss, serum osmolality (DH 299±3 mosmol/kg, EU 290±2 mosmol/kg), thirst (DH 85±8 mm, EU 65±15 mm) and AVP were all greater in DH (P≤0.038). Hunger, fullness and core temperature were not different between trials (P>0.05), and neither was post-meal thirst. Total (DH 1695±437 g, EU 1233±370 g, P=0.002) and drink (DH 1474±409 g, EU 943±283 g, P=0.002) water intake were greater, but food water was less (DH 221±108 g, EU 289±119 g, P=0.026) in DH. Energy (DH 5780±1303 kcal, EU 4951±1016 kcal, P=0.106) and carbohydrate (DH 154±60 g, EU 125±31 g, P=0.133) intake were not different between trials, but protein intake was less in DH (DH 53±17 g, EU 44±15 g, P=0.008). Total water intake showed moderate/strong association with serum osmolality (r=0.525, P=0.054), plasma AVP (r=0.746, P=0.002) and thirst (r=0.670, P=0.009). Water intake replaced 73±17% (DH) and 235±77% (EU) of fluid losses (P<0.001).

CONCLUSION: These data show that voluntary fluid intake at a single post-exercise meal only replaces ~73% of fluid loss after exercise dehydration of ~3%, which only increased by ~460 mL compared to a euhydrated trial. This suggests, in situations where a subsequent exercise bout occurs in close proximity to dehydrating exercise, voluntary rehydration may not ensure the athlete is euhydrated at the start of the next bout.

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IMPACT OF LOW FLUID INTAKE ON HUMAN ADIPOSE TISSUE GENE EXPRESSION IN LEAN, ACTIVE MEN

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INTRODUCTION: Water is essential for life, and without it, humans can only survive for a few days. Accumulating evidence suggests that insufficient water intake may increase the risk of developing cardio-metabolic diseases if sustained for long enough. Some observational studies indicated that inadequate water intake might play a role in developing cardio-metabolic diseases, such as Type II Diabetes (T2D). Carrol et al. (2015) reported a negative correlation between plain water intake and T2D risk score. In contrast, Roussel et al. (2011) found self-reported water intake to be inversely associated with the risk of developing hyperglycemia.

METHODS: We assessed differences in gene expression and changes in plasma levels of several metabolic parameters in response to suboptimal hydration practices. Nine lean, healthy and active young males were instructed to follow either 48h of a low fluid intake (LF; 1.1 ± 0.2 L/d) or adequate fluid intake (AF; 2.9 ± 0.5 L/d), followed by a lab visit for urine, blood, and adipose tissue collection to assess hydration biomarkers, appetite-related hormones, inflammation and glycemic control, and global gene expression.

RESULTS: The LF protocol resulted in mild dehydration (-1.23 ± 0.64 %; $p > 0.05$). Despite no significant changes in differential gene expression at an individual level (FDR > 5% for all genes), gene set enrichment analysis yielded 15 gene sets that were differentially expressed (FDR < 10%), with up-regulation of categories related to coagulation, oxidative stress, immune response and glucose metabolism, and a paradoxical downregulation of the inflammation response category. In addition, glucagon was significantly elevated in the LF condition (AF 44.6 ± 20.8 vs LF 63.0 ± 27.6, $p < 0.05$), while changes in c-peptide were negatively associated with changes in urine osmolality ($r = -0.70$, $p < 0.05$).

CONCLUSION: Overall, these results suggest that two days of a low fluid intake regimen might be enough to influence the expression of genetic pathways implicated in the physiological consequences of acute to chronic dehydration and alter glycemic regulation. However, further research is needed, potentially using a more ample sample and a more prolonged protocol (i.e., 3 to 5 days in a row or 1-2 days repeated for several weeks) to confirm and expand the results of this study.

Conventional Print Poster

CP-MH28 Sports Medicine II

PARALYMPIC SPORT AND SPORT-RELATED CONCUSSION: A SINGLE CASE STUDY

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INTRODUCTION: Sport-related concussions are common in para sport and are associated with short-term effects on cognitive functions. Due to the heterogeneous impairments in para-sport, the circumstances of handling sport-related concussion are difficult to assess. We therefore investigated in a single-case study of a Paralympic swimmer several motoric, behavioral, and neuro-cognitive parameters (before and after head collisions) that have been previously reported to be of diagnostic value in the assessment of post-concussion deficits.

METHODS: We investigated a nineteen-year-old Paralympic swimmer with dysmelia (resulting in pronounced deformities of the hands, arms, and legs). The investigations were conducted before and after four head collisions against the wall in a swimming pool (identical collisions as the swimmer regularly performs to end competitions). Head acceleration was recorded during each collision by an accelerometer and video analyses. Before and after the collision we assessed post-concussion symptoms, the positive and negative affect schedule (PANAS), cognitive functions (working memory (wm), King Devick), nonverbal hand movement behavior and brain oxygenation (by applying functional Near InfraRed Spectroscopy (fNIRS) above precentral cortices of both hemispheres during rest (for connectivity analyses) and during the working memory task).

RESULTS: The average head acceleration during the four head collisions was 15 g ± 5.5. Preliminary results showed that post-concussion symptoms increased from before to after the four head collisions. The positive affect scores decreased. There were no differences in the King Devick. The athlete performed less nonverbal hand movements after the collision when compared to before the intervention. Working memory scores showed 22 percent less correct answers and 195 milliseconds longer reaction times for after the fours head collisions than before. Functional brain oxygenation during the

wm task was reduced from before to after head collision. Brain connectivity was reduced from before to after the head collision.

CONCLUSION: The present findings indicate that repeated head collisions in swimming are related to increased post-concussion symptoms that are accompanied by reduced cognitive and brain functions. Thus, Paralympic swimming with dysmelia may be affected from an increased risk of long-term effects similar to those of repeated concussive incidents. Although it is a challenge to manage sport-related concussions in paralympic disciplines because of the heterogeneous impairments, this issue ought to be considered in future research and the implementation of actual preventive actions.

PRELIMINARY EVALUATION OF A PROPOSAL OF AN INCREMENTAL TESTING PROTOCOL FOR INDIVIDUALS WITH SPINAL CORD INJURY

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INTRODUCTION: Exercise testing is a relevant issue in training and rehabilitation monitoring. Nevertheless, results may be influenced by the test selected [1], especially when specific populations (e.g., with spinal cord injury) with high inter-individual variability are assessed. In the population with spinal cord injury exist a diversity in the tests conducted in the studies [1], making difficult the comparison of their results. Therefore, it is necessary to develop a standardized test which allows the adjustment of people with spinal cord injury and guarantees similar physiological stress.

METHODS: 13 physically active participants were included in the study, and they were divided in three groups: Control [n = 8 (6 male; 2 female); age: 29 ± 5 years; body mass: 75.3 ± 14.4 kg; height 176 ± 9 cm]; Paraplegia (PP) [n = 3 (2 male; 1 female); level of lesion: D7-L1; completeness: complete; age: 37 ± 15 years; body mass: 71.0 ± 19.8 kg; height 170 ± 14 cm] and Tetraplegia (TP) [n = 2 (1 male; 1 female); level of lesion: C5-C7; completeness: complete and incomplete; age: 45 ± 3 years; body mass: 65.0 ± 21.2 kg; height 175 ± 7 cm].

They visited the laboratory one time and completed an incremental test on an arm crank ergometer. Control and PP started with 30W and TP with 15W and increasing steps every three minutes of 5W, 10W and 15W, respectively. Lactate samples were collected at rest and after each interval (Lactate Plus, Waltham, USA) and the second lactate threshold (LT2) was calculated by the ModDmax model using the "lactater" package in RStudio. The rate of perceived exertion (RPE) was asked after each interval using a BORG scale (6-20). Heart rate (HR%) was monitored during all the test employing a Polar V800 (Polar Electro Oy, Finland), and normalized respect maximum heart rate of the test.

RESULTS: All the groups completed 6 ± 1 stages in the incremental test. LT2 was determined between two steps in all the participants [72 ± 19W (Control), 70 ± 27W (PP) and 50 ± 28W (TP)]. For this reason, the difference between the next and the previous step of LT2 in all the variables was calculated to normalise the data. Despite the differences observed in absolute power output at LT2 between Control/PP and TP, the difference between stages of internal load variables presented similar values between groups: RPE [2 ± 2 (Control), 2 ± 0 (PP), 3 ± 1 (TP)] and the HR% [9.5 ± 0.1% (Control), 10.9 ± 0.1% (PP), 8.8 ± 0.0% (TP)].

CONCLUSION: An incremental arm test with different power output in the start step and the increments of each group produced similar physiological responses between groups. Therefore, it could be suggested that this test is valid for those studies which compare different grades of spinal cord injury and people without it.

[1] S. Eerden et al., Disabil. Rehabil. 40 (2018) 497–521.

CHARACTERISTICS OF HEART RATE RESPONSE IN ELITE JAPANESE PARALYMPIC ATHLETES WITH AND WITHOUT SPINAL CORD INJURY DURING ARM CRANK ERGOMETER TEST

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INTRODUCTION: It is well documented that heart rate (HR) is a useful tool for determining training prescription in able-bodied participants. However, limited HR-based training prescription or assessment is available for Paralympic sitting sports athletes who depend mainly on upper body work. In addition, their HR response could be different for their disabilities, e.g., with/without spinal cord injury. Previous research indicates that a slightly lower HR max is generally obtained during arm than during leg exercise testing [1]. Thus, this study aimed to compare the HR response of elite Japanese Paralympic athletes with spinal cord injuries to those without them during an arm crank ergometer incremental test.

METHODS: The participants were 20 Paralympic athletes. They were divided into two groups: athletes with spinal cord injuries (SCI: n=10) or athletes without them (Others: n=10, leg amputation, etc.). HR and Blood lactate concentration (BLa) were measured during the arm crack ergometer incremental test. Protocols of the incremental test were tailored to individual athletes according to their disabilities: one typical example, for male wheelchair tennis players, was that the load was started at 40W and was increased by 20 W in every 3 minutes stage, with 1-minute rest between stages. The athletes were asked to maintain a cranking speed of 60 rpm until BLa exceeded 4 mmol/L. The HR and workload equivalent to 2 mmol/L and 4 mmol/L of BLa were calculated. Also, body weight, lean body mass (LBM), and body fat percentage were assessed by means of the air displacement plethysmography method. Mann-Whitney U tests were applied for examining the difference in those indices between SCI and Others.

RESULTS: No statistically significant difference was found in HR at 2 mmol/L (118 ± 10 bpm vs 118 ± 12 bpm) and in HR at 4 mmol/L (147 ± 9 bpm vs 148 ± 15 bpm) between SCI and Others. The workload for the arm crank incremental load test at these intensities was comparable (at 2 mmol/L: 52.0 ± 15.8 W vs 52.5 ± 19.8 W, at 4 mmol/L: 81.5 ± 20.3 W vs 79.3 ± 26.3 W, respectively). Body composition indices were also comparable (body weight: 61.6 ± 11.9 kg vs 54.4 ± 12.4 kg, LBM: 44.2 ± 7.1 kg vs 41.5 ± 10.4, body fat percentage: 27.2 ± 7.5% vs 24.0 ± 3.6%, respectively).

CONCLUSION: The current results suggest that the HR responses of SCI showed similar responses to Others. Previous studies reported that athletes with spinal cord injuries were not sufficiently able to increase their HR compared to able-bodied athletes [2], implying that they have a disadvantage in aerobic work. However, our results showed that SCI was very well trained, and their HR responses were comparable to those of other Paralympic athletes without spinal cord injuries. It is important to keep in mind that HR-based training prescription for athletes with spinal cord injuries could be the same with other disability athletes.

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THE ASSOCIATION BETWEEN PA STATUS AND THE PREVALENCE OF ALCOHOL USE DISORDER IN KOREA

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INTRODUCTION: Previous studies have suggested that physical activity (PA) can prevent or delay the onset of different mental disorders. However, substance use disorders such as alcohol use disorders (AUD) have so far less frequently been a matter of investigation.[1] Some evidence indicates a positive relationship between alcohol use and physical activity in the general population [2], while there are contradictions that a physically active lifestyle increases drinking consumption [3]. This study aims to investigate the association between PA status and the prevalence of alcohol use disorder in Korea.

METHODS: 5,511 participants aged 18 ~ 79 in the National Mental Health Survey of Korea 2021 (NMHSK 2021) were included in this study. The Korean version of the Composite International Diagnostic Interview 2.1 (K-CIDI) was used in this survey. PA status was defined by The International Physical Activity Questionnaire (IPAQ). Participants were categorized into three PA groups: high(n=1,150), moderate(n=2,654), and low(n=1,636). Logistic regression analysis was used to estimate the odds ratios (ORs) and 95% confidence intervals (CIs) of the prevalence of alcohol use disorder according to the PA group.

RESULTS: After adjusting for age and sex, alcohol use disorder and PA had associations in the high PA group in lifetime prevalence (OR 1.12; 95% CI 1.03-1.23), likewise in 1-year prevalence (OR 1.07; 95% CI 1.03-1.23). Alcohol dependence disorder also had associations in the high PA group in lifetime prevalence (OR 1.05; 95% CI 1.01-1.08) and in 1-year prevalence (OR 1.08; 95% CI 1.00-1.15). However, alcohol abuse disorder had no significant association with PA.

CONCLUSION: The prevalence of alcohol use disorder and alcohol dependence disorder had an association with high PA levels, and alcohol abuse disorder had no association. This study does not support a common alcohol–physical activity relationship. However, a cause-and-effect relationship cannot be convinced due to the limitation of a cross-sectional study. Future research, including personal history, the severity of the disorder and the PA domain, is needed to identify precise correlation and effect of PA.

LAMP : NEW DNA AMPLIFICATION TECHNOLOGY AS A POINT OF CARE TOOL TO AVOID PROPAGATION OF EHV-1 AND EHV-4 PATHOGENS BETWEEN HORSES DURING HORSE RACE

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ENALEES

INTRODUCTION: LAMP technology (Loop mediated isothermal AMPlification) is a NAAT technology (Nucleic Acid Amplification test) which can occur at constant temperature, unlike PCR which need thermal cycles. This allow the use of this technology near a sick animal and the obtention of the result in only 30 min. This technology can be really useful to detect highly contagious pathogens during a sportive event, ie : detection of EHV-1 or EHV-4 in horses during a horse competition to allow the isolation of a contaminated horse to avoid a pandemic.

METHODS: Specific LAMP primers for EHV-1 and EHV-4 were designed and LAMP reactions were performed on viral genome and on nasopharyngeal swab samples extracted by our own specific quick extraction. Performances of these tests were evaluated in our lab and compared to PCR performed in an external lab.

RESULTS: LAMP tests have a limit of detection for amplification between 3-40 copies/reaction dependant of the test. The limit of detection of all method (quick extraction and LAMP test) is similar or better of the limit of detection of all method (extraction on column and PCR test) obtained in a conventional analysis laboratory. LAMP test which was designed are really specific for the target (>95% specificity) and are really sensitive for the target (>90% sensibility).This technology is really fast (<30 min) and can be performed near a sick animal.

CONCLUSION: LAMP tests are a new generation of DNA/RNA amplification test, really specific, really sensitive which can be performed near a sick animal and can give a result in only 30 min. These parameters allow the consideration to use this technology in sportive events to analyse quickly potential pathogens holder and realize quickly a diagnostic to avoid an pandemic.

EFFECTS OF LUMBR EXTENSION-BASED TRUNK CONTROL EXERCISE ON PHYSIOLOGICAL AND CLINICAL PARAMETERS OF MUSCLES IN PATIENTS WITH FLAT BACK SYNDROME

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INTRODUCTION: Flat back syndrome (FBS) is a type of sagittal imbalance in the spine, and it is characterized by loss of the lordotic curve (Harrison & Oakley, 2018). Trunk control exercise can be altered by changing trunk muscle activities or lengths and improve of proprioceptive (Kavcic et al., 2004). The purpose of this study was to test the hypothesis that lumbar extension-based trunk control exercise would be a positive effect on physiological and clinical parameters of muscles compared to stretching exercise.

METHODS: A total of 35 FBS with lumbar lordosis angle of less than 30° were randomly divided to lumbarextension-based trunk control exercise group (EEG, n=12), stretching exercise group (SEG, n=11) and control group (CON, n=12). EEG and SEG were performed for 40 minutes, three times a week and for 8 weeks. Physiological [muscle activity (PHE), muscle tone (GM, BF,ES)] and clinical parameters [trunk control (JPS, SFL, SKE, BKFO, LL), lumbar lordosis angle and lower back pain (ODI)] were measured before and after 8 weeks each exercises.

RESULTS: The results revealed that muscle activity of GM during PHE significantly increased after exercise in the EEG compared to SEG and CON ($p<.05$). Muscle activity of ES during PHE significantly decreased after exercise in the EEG compared to CON ($p<.05$). Muscle tone of GM significantly increased after exercise in EEG compared to CON ($p<.05$). Muscle tone of BF significantly decreased after the exercise in SEG compared to CON ($p<.05$). Muscle tone of ES significantly decreased after exercise in EEG compared to CON ($p<.05$). Trunk control of JPS, SFL, and LL significantly decreased after exercise in EEG compared to SEG and CON ($p<.05$). SKE significantly decreased after exercise in SEG compared to CON ($p<.05$). ODI significantly decreased after exercise in EEG compared to CON ($p<.05$).

CONCLUSION: These results indicate that lumbar extension-based trunk control exercise reduces lower back pain by improving muscle activity, muscle tone, and trunk control in patients with flat back syndrome. In particular, lumbar extension-based trunk control exercise partially improved muscle physiological and clinical parameters of muscles compared with stretching exercise.

Conventional Print Poster

CP-MH29 Physiotherapy Knee/Shoulder

THE EFFECTS OF ECCENTRIC-FOCUSED EXERCISE ON SHOULDER MOBILITY, STRENGTH, PAIN, SCAPULAR KINEMATICS AND MUSCLE ACTIVATION IN SYMPTOMATIC OVERHEAD ATHLETES WITH POSTERIOR SHOULDER TIGHTNESS

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INTRODUCTION: Posterior Shoulder Tightness (PST) is a common pathology in overhead athletes due to repeated high tensile loading during overhead throwing. PST is highly related to glenohumeral internal rotation deficit and scapular dyskinesis, leading to an increased risk of subacromial impingement syndrome (SIS). Eccentric exercises that improve the eccentric strength and neuromuscular control of posterior shoulder muscles have the potential to enhance the ability to withstand repetitive eccentric loading. Despite the limited intervention studies focusing on PST in individuals with shoulder pain, no previous research has investigated the impact of shoulder eccentric exercises on PST in overhead athletes. Thus, the purpose of this study was to investigate the effects of additional shoulder eccentric exercise training on PST in overhead athletes with SIS.

METHODS: This single-blind randomized controlled trial (RCT) has recruited ten amateur baseball athletes with PST and SIS. The athletes were randomly assigned to one of two groups: the eccentric-focused (EF) group or the general treatment (GT) group. The GT group received a four-week intervention program that included hot pack application on the shoulder region and stretching exercises, while the EF group received additional eccentric exercises. The study assessed various outcome measures including the range of motion (ROM) of shoulder external rotation (ER), internal rotation (IR), horizontal adduction (HAD), total ROM (TROM), isokinetic rotator cuff functional strength ratio, visual analogue scale (VAS), Disability of Arm, Shoulder and Hand (DASH) questionnaire, shoulder endurance test (SET), scapular kinematics, and muscle activation.

RESULTS: There was no significant difference in demographic data between two groups. Repeated measures ANOVA showed a significant time by group interaction for the rotator cuff functional strength ratio ($p=0.031$). There were also time effects for the VAS score ($p=0.001$). Both groups improved their TROM ($p=0.043$ and 0.043) and DASH scores ($p=0.043$ and 0.042), while only the EF group showed improvement in HAD ROM ($p=0.042$) and the SET ($p=0.043$) after the four-week intervention.

CONCLUSION: This is the first RCT to compare the effects of additional eccentric shoulder exercises and general treatment in symptomatic overhead athletes with PST. After the four-week intervention, both groups demonstrated equal effectiveness in improving shoulder TROM, DASH, and reducing VAS score. The EF group exhibited a greater improvement in the isokinetic functional strength ratio of the rotator cuff and SET, which is reasonable because only the EF group received the strengthening exercise program. However, the enhancement in rotator cuff strength was found to be only associated with

an increase in shoulder HAD ROM but not TROM. The studys small sample size of ten athletes limits the validity of the results, and further recruitment is underway to ensure the findings.

RADIOGRAPHIC ASSESSMENT OF SCAPULAR ROTATION AND TILT IN SUBACROMIAL IMPINGEMENT SYNDROME

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INTRODUCTION: People with subacromial impingement syndrome (SIS) present differences in movements of the scapula when compared with asymptomatic individuals. Some authors have studied scapular position and motion in SIS using three-dimensional motion capture system, and identified reduced posterior tilting and external rotation in the subjects with SIS. The method adopted in their reports was regarded as highly reliable, but it is not thought to be always accurate in determining the same points on the scapula while the arm is being raised. We used a simple and accurate method of evaluating both scapular upward and axial rotational tilts by using plain antero-posterior (AP) radiography. The purpose of this study was to identify the types of scapular rotational tilt disorders that affect shoulder impingement.

METHODS: A total of 75 subjects completed the study, 50 patients in the SIS group and 25 healthy volunteers in the healthy group. Three parameters of scapular rotation and tilt were measured by shoulder antero-posterior (AP) radiography at 0 °, 60 ° and 90 ° of shoulder abduction in SIS patients and healthy volunteers: the scapular upward rotation angle (SURA), which was adopted as the parameter of the upward rotational tilt ;the coracoid upward shift distance (CUSD), which evaluate the axial rotation tilt of the scapula; the length of the scapular spine line (LSS), which corresponds to the parameter of the protraction- retraction tilt of the scapula. The results of the two groups of subjects were compared.

RESULTS: At 0°and 90°shoulder abduction, the SURA in the two groups was not significantly different（P＞0.05）; At 60°, however, the SURA was 21.1±6.3° for SIS group and 25.1±8.1° for healthy group , showing a significant difference (P=0.022)。The standardized CUSD at 0° shoulder abduction has no significant difference (P =0.058); For 60°shoulder abduction, the standardized CUSD were 3.1±2.5 mm for SIS group and 6.0±4.0 mm for healthy group , showing a significant difference (P =0.003). At 90°shoulder abduction, the standardized CUSD was 7.4±2.8mm for SIS group and 10.2±5.0mm for healthy group , for an even more significant difference (P = 0.016). No significant differences were observed between the standardized LSS at each of the abduction angles in the two groups.

CONCLUSION: Our study confirms that a wide supraspinatus outlet may be created by scapular posterior tilting and upward rotations, so that subacromial impingement can be avoided in normal shoulder elevation. For the assessment of SIS, early evaluation of scapular functional tilt is important. It is necessary to classify the patients with subacromial impingement syndrome to determine the specific classification of scapular movements abnormalities, which is conducive to targeted rehabilitation training.

EFFECTS OF AN 8-WEEK OF THERMAL AQUATIC EXERCISE ON KNEE STRENGTH, ROM, AND WOMAC INDEX IN FEMALE PATIENTS OVER 50 YEARS OLD WITH KNEE OSTEOARTHRITIS

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INTRODUCTION: According to the 2019 Global Burden of Disease, approximately 1.71 billion people are in a condition related to musculoskeletal disorders, 528 million people have osteoarthritis (OA) and 19 million of them lived with disability worldwide (1,2), OA affects more women than men, especially women over 50 (3). Pain-free weight-bearing exercises, weight control, and knee pain reduction are essential elements of a rehabilitation program for knee OA patients. Many OA patients, especially obese individuals, are precluded from a land-based exercise. Aquatic exercise minimizes the risk of injury by reducing joint stress than a land-based exercise and warm water lowers pain perception and knee stiffness. The purpose of this study was to investigate the effects of 8 weeks weight-bearing isotonic and ROM exercises in a spa pool at 32-34°C for female knee OA patients aged 50 years or older.

METHODS: Twenty-six female knee OA patients over 50 years old volunteered. Subjects were randomly assigned to either thermal aquatic exercise (TAE: n=10, 60.3±4.6 yrs, 158.6±6.8 cm, 59.1±9.1 kg, 33.2±6.3 BFP) or control (C: n=16, 52.2±8.5 yrs, 158.4±5.7 cm, 58.4±8.6 kg, 32.6±5.9 BFP) groups. The TAE group visited the aquatic center twice a week for 8 weeks to perform isotonic (concentric and eccentric) and ROM exercises using own body weight and water resistance for the ankle, knee, and hip joints in a spa pool at 32-34°C. Exercise duration was 90 minutes per visit and exercise intensity was set between Borg RPE 12-16. All subjects' height, body mass, muscle mass, fat mass, body fat percentage, BMI, isokinetic knee strength, knee flexion ROM, and WOMAC Index were measured before and after 8-week of the intervention. Two-way mixed-design ANOVAs were used for statistical analyses.

RESULTS: The TAE group showed significant improvements in muscle strength (60°/sec peak torque: knee extension, p=0.025; knee flexion, p=0.006), muscle power (60°/sec average torque: knee extension, p=0.041; knee flexion, p=0.041), muscle endurance (180°/sec total work: knee extension, p=0.040; knee flexion, p=0.003), knee flexion ROM (p=0.014), and WOMAC Index (p=0.010) when compared to the C group. After the intervention, no significant differences were observed between groups on weight (p=0.988), muscle mass (p=0.478), fat mass (p=0.707), body fat percentage (p=0.293), and BMI (p=0.947).

CONCLUSION: A 8-week thermal aquatic exercise protocol in a spa pool at 32-34°C with full weight-bearing isotonic strengthening and full ROM exercises in the lower extremity helps to increase muscle strength, muscle power and muscular endurance of the knee, and improve knee pain, stiffness, and joint dysfunction for female OA patients 50 years and older.

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HOW LONG DOES IT TAKE TO PHYSICALLY AND PSYCHOLOGICALLY RECOVER AFTER AN INJURY IN FOOTBALL?

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INTRODUCTION: When football players sustain an injury, they generally have to recover, both physically and psychologically. The process of recovery after an adversity such as an injury can be defined as resilience. (1) Despite its importance, individual resilience after a time-loss injury has never been quantified before. Therefore, this study aimed to quantify resilience in terms of both physical and psychological variables after time-loss injury in individual football players.

METHODS: We included 21 football players who sustained time-loss injuries during the 2021/2022 season. For each individual, we monitored the training load, perceived recovery, motivation, self-efficacy, mood, and enjoyment for every training and match day. We quantified resilience using these variables following injury by fitting multiple growth models. Next, we identified the best one using the Bayesian information criterion. (2) Then we used the predicted values from the selected model to identify the time point at which the physical and psychological variables should return to baseline levels.

RESULTS: Eight of the 21 football players experienced a significant drop in physical or psychological variables following an injury. For three football players, the psychological variables self-efficacy and mood did not return to baseline levels even though these players resumed training. Accordingly, the average duration between the day of the injury and the predicted day of return to baseline was lower for the physical variables (training load = 20.5 days and recovery = 73.5 days) than for the psychological variables (motivation = 358 days, self-efficacy = 114.8 days, mood = 104.4, and enjoyment = 70.25 days). However, these trajectories were highly individual-specific.

CONCLUSION: Injuries often lead to a significant decrease in the physical and psychological variables of football players. Although the recovery trajectory after an injury is highly individual-specific, the recovery of psychological variables often requires more time than the recovery of physical variables. Practitioners can use these findings during the multidisciplinary and personalized rehabilitation of injured players.

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EFFECTS OF 8-WEEK PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION STRETCHING AND STATIC STRETCHING ON MUSCLE-TENDON PROPERTIES, MUSCLE STRENGTH, AND JOINT FUNCTION IN CHILDREN WITH SPASTIC CEREBRAL PALSY

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INTRODUCTION: Based on animal studies, stretching or orthoses are usually applied to induce longitudinal muscle growth to prevent and/or counteract muscle contractures in individuals with spastic cerebral palsy (SCP). However, while the effect of static stretching (SS) as treatment in individuals with SCP is questionable [1,2], recent results suggest that a combination with activation might be promising to cause positive effects on muscle-tendon level [3]. Therefore, the study aim was to investigate the effects of an 8-week PNF stretching intervention on the gastrocnemius medialis (GM) muscle-tendon properties, muscle strength, and joint function in children with SCP in comparison to SS.

METHODS: Twenty-four children were randomly assigned to a PNF stretching or SS group stretching their calf muscles four times a week for eight weeks at home. In the SS group, the ankle joint was moved into maximal dorsiflexion and held for 30s. The PNF group additionally performed an isometric contraction [4] for 3-5s before placing the joint in greater dorsiflexion for the remaining ~25s. Either ten static or PNF stretches were applied on both legs alternating the knee joint position (extended/flexed). Pre- and post-assessments of GM muscle-tendon properties, isometric muscle strength, and ankle joint function were performed using 3D motion capture, 2D ultrasound, dynamometry, and electromyography. Data was tested for normal distribution and analyzed by use of a mixed ANOVA.

RESULTS: Despite high training adherence in both stretching groups (PNF: 93.1%; SS: 94.4%), no significant changes ($p>0.05$) were observed in the mechano-morphological muscle-tendon properties, muscle strength, and ankle joint parameters after the interventions. Moreover, no differences ($p>0.05$) were found between the stretching techniques.

CONCLUSION: This is the first study investigating the effects of 8-week PNF stretching in comparison to SS on GM muscle-tendon properties, muscle strength, and joint function in children with SCP. Our findings support the idea of other authors

that manual stretching (PNF or SS) performed in isolation for eight weeks may not be appropriate to evoke significant changes on muscle-tendon and joint level in this population. Shifting our focus and looking for other/new efficient treatment strategies is needed.

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ARE THE SHOULDER JOINT FUNCTION, STABILITY, AND FLEXIBILITY TESTS PREDICTIVE OF HANDSTAND EXECUTION?

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INTRODUCTION: Handstand is unstable element used across multiple gymnastic disciplines (1). The quality of any element's execution plays an important role, which is evaluated accordingly. Multiple strategies are used to maintain a handstand (2–4), where the shoulder joints seem to play an essential role (5, 6). The function of the shoulder joint is affected by its stability and mobility (7). The purpose of this study is to examine the relationship between shoulder joint function (flexibility and stability) and the quality of handstand execution.

METHODS: The handstand execution of university students (n = 111) was evaluated using two qualitative scales, 'Assessment of the Quality Value" (AQV) and E score. The stability and mobility of the shoulder joint were assessed by two standardized field tests: Upper Quarter Y Balance Test (UQYBT) and the Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST). We also evaluated the active range of motion (aROM) in flexion using a specific Sit Position Test (SPT). In two ordinal logistic regression models, we evaluated the relationship between the quality of handstand execution (UQYBT, CKCUEST, and SPT) and the AQV and E-score.

RESULTS: In the first model (AQV), the proportional odds ratio (POR) of the UQYBT (1.06 [0.98, 1.14]), CKCUEST (0.99 [0.89, 1.09]), and SPT (1.43 [0.76, 2.74]) were not statistically significant contributors to the handstand execution quality. Similar results were observed in the second model (E score), where the POR of the UQYBT (0.97 [0.91, 1.03]), CKCUEST (1.00 [0.91, 1.09]) and SPT (1.16 [0.64, 2.07]) also did not show a statistically significant contribution to the execution of the handstand.

CONCLUSION: In our sample, we did not observe any relationship between the shoulder function tests (UQYBT, CKCUEST, and SPT) and measures of handstand execution quality. This pattern of results may be caused mainly due our sample's limited ability to perform the handstand sufficiently well.

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PROGRESSIVE USE OF A PASSIVE SHOULDER-EXOSKELETON IN MANUAL MATERIALS HANDLING

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INTRODUCTION: Occupational exoskeletons are seen as attractive solutions to lower the physical load of workers conducting manual handling tasks, since reduced muscle activities during exoskeleton-use has been reported [1]. However, literature is still lacking field studies reflecting real-life settings [2]. Additionally, companies start implementing exoskeletons without considering a familiarization process, which increases the risk of failure of integration [3]. This study aimed to investigate in-field changes in muscle activity and acceptance when using a passive shoulder-exoskeleton pre and post a 5-week familiarization period.

METHODS: Ten workers from a Danish logistics company (INT) underwent a 5-week familiarization period of progressive use of a passive shoulder-exoskeleton (from 7.5 h/week to 37 h/week), while ten other workers acted as controls throughout the period (CON). Test sessions pre and post the familiarization involved four typical work tasks based on observations of their daily work. All four tasks included lifting merchandise from a shelf to a truck in a rotational movement

with the exoskeleton (EXO) and without (NoEXO). Surface electromyography (sEMG) of erector spinae, deltoideus anterior, and upper trapezius was recorded bilaterally. Additionally, perceived effort and perception of acceptance (usefulness, ease of use, emotions, attitude, and comfort) of the exoskeleton was assessed using a Borg CR10 scale and a questionnaire. The sEMG amplitude was normalized to maximal voluntary contractions, and the 10th and 90th percentiles were calculated. Two-way RM-ANOVAs were conducted to assess the effects of the exoskeleton and familiarization.

RESULTS: No effects of familiarization were revealed in sEMG amplitude nor in perceived effort. Perceived usefulness ($p<.001$), emotions ($p<.001$), attitude ($p<.001$), and comfort ($p=.005$) of the exoskeleton decreased in both INT and CON group after the 5-week period. The use of EXO resulted in significant decreases of the 10th and 90th percentile of sEMG amplitude of the anterior deltoid muscles and of the 10th percentile of the upper trapezius muscles across all lifting conditions ($p<.05$). Additionally, decreases were revealed in perceived effort ratings in lifts conducted above shoulder height ($p=.003$).

CONCLUSION: The exoskeleton reduced the muscle activity of the neck-shoulder musculature and perceived effort as earlier reported in the literature. On the other hand, the perception of acceptance of the exoskeleton also decreased during the familiarization period. This illustrates a challenge for this company for a sustainable implementation of a shoulder exoskeleton in their business. This work also showcases the importance of a holistic approach when trying to implement exoskeletons in real working situations.

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EFFECTIVENESS OF TELEHEALTH PROGRAM ON SELF-REPORTED FUNCTION, FUNCTIONAL PERFORMANCE, AND PHYSICAL ACTIVITIES IN PATIENTS WITH KNEE OSTEOARTHRITIS: A SYSTEMATIC REVIEW AND META-ANALYSIS.

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INTRODUCTION: Knee Osteoarthritis (OA) is the most common chronic degenerative bone and joint disease in the middle-aged and elderly worldwide. It is characterized by cartilage deterioration, joint space narrowing, osteophyte formation, and sclerosis of the subchondral bone. Digital technologies may be a feasible solution given that people with knee OA have limited access to hospital and physiotherapy clinic. The objective of this systematic review and meta-analysis was to evaluate the telehealth program on self-reported function, functional performance, and physical activities in the treatment of patients with knee osteoarthritis (KOA).

METHODS: A systematic review was conducted by searching six electronic databases, namely MEDLINE (PubMed), Cochrane, EMBASE, Web of Science, SPORTDiscus (EBSCO), PEDro Six electronic databases were searched to identify trials comparing telehealth program and conventional intervention in a population with KOA. Studies were selected according to the inclusion and exclusion criteria. Outcome measureswere compared by standardized mean differences (SMDs) or mean difference (MD) with 95% confidence intervals (CIs). The Higgins's (I2) statistic was calculated to evaluate heterogeneity. The methodological quality of selected studies and the quality of evidence were evaluated for included studies.

RESULTS: Of 3687 articles identified, a total of nine studies were included in this meta-analysis, with very low to moderate risk of bias. The pooled results showed telehealth program group have greater improvement on Timed-up and go test (MD = -0.90 [95%CI: -1.59, -0.20], P = 0.01, I2 = 17%) than control group. However, no significant difference between telehealth program group compared to control group for KOA, including self-reported function (SMD = -0.05 [95%CI: -0.17, 0.26], P = 0.66 I2 = 77%), 30-s chair stands (MD = 1.43 [95%CI: -0.34, 3.20], P = 0.11, I2 = 89%), physical activity levels (MD = -8.65 [95%CI: -17.92, 0.63], P = 0.07, I2 = 20%).

CONCLUSION: Data from pooled studies showed telehealth program may have greater improvement for treating patients with KOA on Timed-up and go test. However, no evidence showed telehealth program is beneficial to self-reported function and physical activities More evidence with high quality is needed in further research for its effectiveness and feasibility.

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ACTIVE VERSUS PASSIVE PHYSIOTHERAPY FOR SHOULDER PAIN: A SYSTEMATIC REVIEW AND META-ANALYSIS.

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INTRODUCTION: Shoulder pain, second only to back and neck pain, is one of the most prevalent musculoskeletal pain in primary care. Epidemiology shows that the lifetime prevalence of shoulder pain in adults worldwide ranges from 7% to 67%. Treatment of shoulder pain poses tremendous economical pressure on patients. A study in the Netherlands showed

that the average total cost per patient for shoulder pain in primary care was estimated to be $689 within six months since the first consultation.

Physiotherapy is normally the preferred intervention for shoulder pain in the absence of evidence for its standard treatment. David A in 2021 proposed the "active" and "passive" of physiotherapy, as well as the dispute between them and their future development. According to existing studies, active physiotherapy (AP) includes therapeutic active activities carried out by patients during the intervention process, while passive physiotherapy (PP) is mainly done by the therapist or equipment. Recently, the effect of traditional PP was questioned and labeled as "low-value care". Jeremy Lewis also suggested that the physical therapy profession was embracing an inflection point where active therapies and more patient self-reliance will move physical therapy away from an overreliance on passive therapies of the past.

Therefore, this review aims to compare the effects of AP and PP on pain intensity and function in patients with shoulder pain in the hope of providing reference value in future clinical practice of physiotherapy.

METHODS: Two independent researchers searched PubMed, Cochrane library, Embase, Web of science, CINAHL and PEDro from the beginning to September 7, 2022. All included studies were evaluated for risk of bias by the Cochrane risk-of-bias tool and the certainty of results was rated using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach. Randomized controlled trials (RCTs) involving patients with shoulder pain were included. The treatment must be AP versus PP.

RESULTS: Altogether 21 studies, including 1011 patients, were included. The primary result: Compared with passive manipulation, AP was superior in the pressure pain threshold (PPT) of shoulder (SMD-0.09, 95%CI: -0.42 to 0.24, P=0.59), pain intensity (SMD-0.37, 95%CI: -0.71 to -0.03, P=0.03) and function (SMD-0.22, 95%CI: -0.43 to -0.01, P=0.04). AP had an advantage over physical factor therapy in terms of pain intensity (SMD-1.32, 95%CI: -2.34 to -0.29, P=0.01) and function (SMD-0.64, 95%CI: -1.15 to -0.14, P=0.01). The secondary result: AP was superior to PP at short-term and medium-term follow-up, with no difference at long-term follow-up.

CONCLUSION: Evidence with moderate to very low certainty suggests AP was superior to PP in pain and functional improvement in patients with shoulder pain at short-term and medium-term follow-up, but this advantage was not observed in the long-term follow-up.

ISOKINETIC STRENGTH PROFILE OF THE ROTATOR MUSCLES OF HIGH-LEVEL TABLE TENNIS PLAYERS

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INSEP

INTRODUCTION: The practice of high-level table tennis require high muscular strength in the shoulders and the intensity of the strokes associated with a lot of repetitions can lead to overload particular joints [1]. However, few studies have explored the isokinetic profile of the rotator muscles of the table tennis players. Our objective was to describe and compare isokinetic muscle profiles of the shoulders of high-level table tennis players by laterality and gender.

METHODS: 8 male (22 ± 4.6 years old; 181 ± 3.9 cm, 71 ± 7 kg) and 4 female (23 ± 8.2 years old; 168 ± 7.2 cm, 59 ± 10 kg) of the Table Tennis French Team were enrolled in this cross-sectional study. A clinical examination and a bilateral shoulder isokinetic test were carried out for all the athletes of the Table Tennis French Team as part of the annual medical check-up. The muscle strength of the internal rotators (IR) and external rotators (ER) of the shoulder were measured on an isokinetic dynamometer (Biodex system 4, Biodex Medical Systems, New York, USA) in the concentric mode at 60°/s and 180°/s, and the eccentric mode at 60°/s. The conventional ratio (ER : IR at 60°/s concentric mode) and the mixed ratios (ER in the eccentric mode at 60°/s to IR in the concentric mode at 180°/s for the throwing movement ; IR in the eccentric mode at 60°/s to ER in the concentric mode at 180°/s for the arming movement) were also calculated.

RESULTS: The statistical analysis of the data in males shows only difference between the dominant arm and the non-dominant arm on the internal rotators in the concentric mode at 180°/s (0.66 ± 0.16 vs. 0.55 ± 0.11, P = .008). No difference was found in females between the two shoulders in any mode for the IR and the ER peak torque. There was no significant difference between sides for each of the ratios, in males and females.

CONCLUSION: The isokinetic profile of high-level table tennis players, men and women, appears to be symmetrical between the racket arm (considered as the dominant one) and the non-dominant arm, with the possible exception of the internal rotators peak force in a high velocity condition (concentric mode at 180°/s), which is higher on the dominant side in males. Thus, it would be interesting to research in our high-level table tennis players suffering from pathology of the shoulder, if there is an imbalance of the muscular profile of the dominant side compare to those results.

Conventional Print Poster

CP-PN20 Cardiovascular Physiology II

EVALUATION OF TWO METABOLIC CARTS FOR CARDIOPULMONARY EXERCISE TESTING (CORTEX METALYZER 3B AND JAEGER OXYCON PRO) IN DIFFERENT ENVIRONMENTAL CONDITIONS

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INTRODUCTION: To evaluate the measurement accuracy and consistency of two metabolic gas analyzers, using breath-by-breath technology, for cardiopulmonary exercise (CPX) testing in different environmental conditions (ambient temperature and relative humidity) with a metabolic simulator (MS) as verification procedure.

METHODS: In a climatic chamber, six different combinations of ambient temperature (18, 27 and 36°C) and relative humidity (45% and 75%) were set to test two regularly maintained metabolic carts, i.e, Metalyzer 3B (Cortex Biophysik GmbH, Germany) and Jaeger Oxycon Pro (Viasys Healthcare GmbH, Germany). Calibration procedures according to the manufacturers recommendations were performed in each environmental condition before testing with the MS (Relitech Systems BV, The Netherlands). The CPX mode of the MS was applied to simulate metabolic gas exchange by controlled pure gas (N2 and CO2) input at 4 different respiratory exchange ratios (RER; 0.75, 0.85, 0.95 and 1.05), with according respiratory rates (RR; 10, 20, 40 and 60 b/min) and a fixed tidal volume of 2 L. Primary outcome parameters were oxygen consumption (VO2), carbon dioxide production (VCO2), and ventilation (VE). Acceptable difference was set within 3%, based on the precision/specified accuracy of the metabolic carts and MS combined.

RESULTS: The overall differences, irrespective of environmental condition or metabolic intensity, were -3.7, -1.0 and -2.2% (Metalyzer 3B), and 4.3, 6.0 and 2.6% (Jaeger Oxycon Pro), respectively for VO2, VCO2 and VE. For the Metalyzer 3B, there was no change in VO2 difference across the three ambient temperatures, while the lowest metabolic intensity (i.e., RER = 0.75), had the largest difference (-9.7%). The largest underestimation of VE (-4.2%) occurred at the highest ambient temperature. Overall difference of VCO2 was -1.0%, although, the range varied between -8.2 and 7.7%. For the Jaeger Oxycon Pro, overestimation of VO2 values increased with increasing intensity (respectively 2.6, 4.2, 6.9 and 7.3%). VE was within acceptable range except for the lowest intensity (7.3%). Only 4/24 VCO2 measurements were within acceptable range, with the smallest difference at the highest ambient temperature (3.4%).

CONCLUSION: For the Metalyzer 3B, 39/72 obtained values were whitin 3% difference compared to MS, while this was only 29/72 for the Jaeger Oxycon Pro. There was no clear influence of environmental conditions on the detected errors. Although, trends regarding the influence of temperature, humidity and intensity on outcome parameters (VO2, VCO2 and VE) can provide a better understanding of the operational functioning of metabolic carts in general. Maintenance of measurement systems and components, together with regular verification of pulmonary gas exchange variables obtained during CPX testing using a MS, is necessary to ensure quality of testing for adequate guidance of athletes and patients in sports and rehabilitation.

DEVELOPMENT OF EQUATION PREDICTING STROKE VOLUME TO ASSESS CARDIOVASCULAR STRAIN.

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INTRODUCTION: The advances in wearable technology have been popularized for monitoring individuals heart rate during recreational activities of the general population or the athletes, but there are also wearables that have been used to monitor occupational heat stress. Some of them are based on core and skin temperature and some others based on heart rate. To our knowledge, there are no devices that estimate the cardiovascular strain based on stroke volume or cardiac output. One of the problems is the lack of suitable algorithms that would provide such an index on the basis of relevant physiological responses. Cardiac strain reflects heat strain and can be estimated by cardiac index, which is derived from the ratio of cardiac output (the product of stroke volume and heart rate) to the body surface area. The main hurdle in determining the cardiac index is the determination of cardiac output, particularly the determination of stroke volume, which normally requires complex clinical methods. The present study aimed to develop and validate a formula for predicting stroke volume from measurements of blood pressure

METHODS: Fourteen individuals participated in the study. During each trial we monitored their cardiovascular response in four positions: sitting, standing, supine and 60° head up title. During the test we measured arterial blood pressure with a sphygmomanometer. Blood pressure was also measured with finger photoplethysmography which also provided beat-by-beat measures of stroke volume and cardiac output.

RESULTS: A multiple linear regression analysis was performed to develop the predictive formula for stroke volume.

CONCLUSION: The present study developed an equation predicting stroke volume with a regression of R2=0.704.

RUNNING STYLE AND PERFORMANCE: PERCEPTION OF EFFORT OR CARDIOMETABOLIC FITNESS?

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INTRODUCTION: Based on various parameters (vertical oscillation of the head, arms movement, pelvis position at ground contact, foot position at ground contact, and strike pattern) runners can be classified as having an aerial or a terrestrial style. The main aim of this causal-comparative study was to investigate the physiological and perceptual effects of running style in a group of competitive runners.

METHODS: Thirty athletes competing in distance running were recruited. Two or three experienced coaches classified each participants running style using the Volodalen method [1]. Participants were then matched for gender for a final grouping of 12 aerial runners (AER; 10 males and 2 females) and 12 terrestrial runners (TER). During the first visit, maximal oxygen consumption (VO2 max), peak treadmill speed (PTS) and ventilatory thresholds (VTs) were measured. During the second visit, participants performed two 10-min runs on a treadmill at a constant speed corresponding to the first VT (low-intensity run, LI) and the second VT (high-intensity run, HI) followed by a 3k time trial (TT). During all three runs, heart rate (HR), rating of perceived exertion (RPE), and blood lactate (La) were measured. During LI and HI, gas exchange and gait parameters were also measured.

RESULTS: Volodalen score was higher in AER (17 ± 1) than in TER (12 ± 2; $p < 0.001$). The duty factor (a global gait parameter) [2] was lower in AER (0.746 ± 0.049) than in TER (0.833 ± 0.051; $p < 0.001$). The 5-km personal best time was better in AER (1007 ± 93 s) than in TER (1081 ± 98 s; $p = 0.018$). AER (20.5 ± 1.6 km/h) achieved a higher PTS than TER (19.6 ± 1.1 km/h; $p = 0.039$) despite no significant differences in VO2 max (AER: 62.2 ± 7.3 ml/kg/min; TER: 64.9 ± 6.0 ml/kg/min). During LI, no significant differences were found for cost of transport (CT), running economy (RE), HR, La, RPE:speed, and RPE:HR. During HI, RPE:HR was lower in AER than in TER ($p = 0.034$), and a trend ($p = 0.057$) was found for lower RPE:speed in AER than in TER. No significant differences were found for CT, RE, HR and La. During the TT, AER ran 0.82 km/h faster than TER ($p = 0.050$). HR in AER was 10 bpm higher than in TER ($p = 0.028$). RPE:HR was lower in AER than in TER ($p = 0.050$), and a trend ($p = 0.052$) was found for lower RPE:speed in AER than in TER. No significant differences were found for La.

CONCLUSION: Our study confirms previous findings that running style does not affect CT and RE at moderate intensity [3] and extends them to high-intensity running. Furthermore, we found that, despite no significant metabolic differences, AER ran faster than TER during both the incremental running test and the TT. These significant differences in performance may be explained by lower perception of effort at high running speeds.

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CARDIOVASCULAR RESPONSES AND METABOREFLEX ACTIVATION FOLLOWING EXERCISE-INDUCED MUSCLE DAMAGE.

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INTRODUCTION: The aim of the present study was to investigate whether exercise-induced muscle damage (EIMD) influences cardiovascular responses to isometric exercise and isolated metaboreflex activation. We hypothesized that EIMD would lead to muscle afferent sensitisation and altered blood pressure responses to exercise and isolated muscle metaboreflex activation using post-exercise cuff occlusion (PECO).

METHODS: Twenty subjects performed unilateral isometric knee extension at 30% of maximal voluntary contraction (MVC) for 3-minutes, followed by 2-minutes of PECO and 3min recovery pre- and 48 h post-EIMD while recording cardiovascular response (CV) with a beat-by-beat blood pressure monitoring device. EIMD protocol consisted of 200-250 maximum eccentric knee-extension contractions on the same leg performing the cardiovascular assessment.

RESULTS: EIMD elicit a significant decrease in MVC from 634.6 ± 229.3 to 504.0 ± 160, and an increase in perceived soreness (VASSQ) from 2.3 ± 1.5 to 39.5 ± 27.3 mm (all $p < 0.001$). CV response to exercise and PECO were not different from pre- to post-EIMD (all $p > 0.05$), however increases in mean arterial pressure (MAP) were found during recovery phase (Delta-Rec) post-EIMD ($p < 0.05$). Moreover, significant associations were found between increases in MAP during contraction (Delta-Con) and VASSQ, Rate of Perceived Exertion (RPE) and Pain only post-EIMD (all $p < 0.05$).

CONCLUSION: These results indicate that EIMD does not influence cardiovascular responses to isometric exercise and isolated metaboreflex activation, suggesting that metaboreflex is not increased post-EIMD. Results from single correlations analysis may advance the hypothesis of an altered cardiovascular responses to exercise linked to pain, soreness, and exertion through mechanisms other than metaboreflex.

EXERCISE TRAINING INDUCES BENIGN RIGHT VENTRICULAR HYPERTROPHY ALONG WITH FUNCTIONAL IMPROVEMENT AND WITHOUT PATHOLOGICAL PROCESSES OR ARRHYTHMOGENICITY IN A RODENT MODEL OF ATHLETE'S HEART

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INTRODUCTION: Regular sport activity leads to the adaptation of cardiac structure and function, the so-called athlete's heart. Research projects over the last years have focused on exercise-induced adaptation of the right ventricle (RV), because the disproportionate load on the RV - when compared with the left ventricle - might lead to pathological consequences, such as myocardial interstital fibrosis or chamber dilation. We aimed at investigating RV alterations induced by regular aerobic exercise training in a rat model of athletes heart.

METHODS: Young, adult rats were divided into control (Co) and exercised (Ex) groups (n=12-12). Exercised rats underwent a 12-week-long swim training program. In vivo electrophysiological study and in vitro cellular force assessments on isolated cardiomyocytes were carried out to investigate electrical and functional RV alterations, respectively. Molecular biological (qRT-PCR, Western-blot) and histological investigations were applied to reveal underlying mechanisms.

RESULTS: Exercise training was associated with increased RV cardiomyocyte diameter (12.5±0.1 μm Co vs. 13.8±0.2 μm Ex, $p<0.05$), that was associated with hyperphosphorylation of protein kinase B (Akt). RV cardiomyocytes from exercised animals showed improved calcium sensitivity and increased maximal force development. We found increased length of repolarization as reflected by prolonged QT interval and ventricular effective refracter period (VERP: 44.0±1.6 ms Co vs. 52.8±2.1 ms Ex, $p<0.05$) along with decreased gene expression of potassium channels (Kcnd2, Kcnj2). Picrosirius staining did not reveal fibrosis, that was associated with unchanged protein expression of connective tissue growth factor (CTGF) and gene expression of profibrotic markers (such as TGF-β). Gene expression of apoptotic markers (Bax, Bcl-2) and fetal gene program (such as β-MHC) did not differ between groups.

CONCLUSION: According to our data, regular swim training induced RV hypertrophy, that was associated with functional improvement (improved calcium sensitivity and maximal force) and prolonged repolarization without characteristic pathological alterations in myocardial tissue.

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LOCAL MUSCLE CONTRACTIONS SUPPRESSE DECLINE IN METABOLIC CAPACITY CAUSED BY INACTIVITY

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INTRODUCTION: Physical inactivity due to aging, bed rest after injury, spinal cord injury, etc. is a risk factor of chronic diseases such as skeletal muscle wasting and obesity. On the other hand, it is well known that physical activity (exercise) can improve body composition and prevent diseases associated with physical inactivity. Although regular exercise training is one of the most effective ways to combat physical inactivity, its application to people with exercise difficulties is not possible. To address this issue, we have focused on "muscle contraction" from the complex components of exercise. Indeed, it has been reported that an electrical stimulation (ES) model to induce local muscle contraction in the mouse lower leg activates representative molecular signals that are activated during exercise (Tanimura et al., 2022). In this study, we aimed to investigate the effects of ES on the metabolic capacity of skeletal muscle and adipose tissue during inactivity.

METHODS: All the experimental procedures performed in this study were approved by the Institutional Animal Experiment Committee of the University of Tsukuba, Tsukuba, Japan (22-397). Male ICR mice aged 7 weeks were used in this study. After one week of acclimation, mice were underwent sciatic nerve transection surgery (denervation: DEN) or performed sham operation. Two weeks after surgery, the gastrocnemius muscles were stimulated percutaneously (30V, 100Hz) with an electrode (ES) or left sedentary (CON) for 4weeks. Mice were divided into four groups: Sham + CON group (n = 6), Sham + ES group (n = 5), DEN + CON group (n = 6), DEN + ES group (n = 6).

RESULTS: The weight of the gastrocnemius muscle was lower in the denervated limb than in the sham-operated limb and it showed a tendency to increase by ES. Thus, we observed collateral evidence of ES and DEN. The wet weight of inguinal white adipose tissue (iWAT) was significantly lower in ES and ES+DEN groups than non-ES groups. Furthermore, DEN induced reductions of mitochondria related proteins in gastrocnemius and iWAT, which were partially suppressed by 4-weeks of ES. Based on several results such as the expression of IL-6 receptor in iWAT and plasma IL-6 immediately after acute ES, interleukin-6 (IL-6), one of the muscle-derived secreted proteins, could be involved in metabolic remodeling of adipose tissue.

CONCLUSION: Local muscle contraction by electrical stimulation could suppress the decline in metabolic capacity of skeletal muscle and adipose tissue during inactivity. In addition, contractile muscle-derived IL-6 might be involved in this mechanism in iWAT.

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THE POTENTIAL HARMS OF SEDENTARY BEHAVIOUR ON CARDIOMETABOLIC HEALTH ARE MITIGATED IN HIGHLY ACTIVE ADULTS - A COMPOSITIONAL DATA ANALYSIS

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INTRODUCTION: Insufficient physical activity and sedentary behaviour (SB) are important factors that determine cardiometabolic health and the development of non-communicable diseases. The aim of this study was to investigate the modifying effects of moderate-to-vigorous physical activity (MVPA) on the association between SB and cardiometabolic health within highly active adults.

METHODS: In a cross-sectional design, 61 (male/female: 41/20) highly trained adults (age: 33.6 ± 10.7 years; BMI: 22.4 ± 2.3 kg/m2) performed a maximal cardiopulmonary exercise test from which indicators for peak performance were determined. Physical activity and SB were assessed using the activPAL3™ accelerometer. In addition, anthropometrics, blood pressure, plasma lipids and insulin sensitivity were assessed. These cross-sectional associations between a daily movement behaviour composition and cardiometabolic health parameters were investigated using a compositional data analysis approach.

RESULTS: Participants spent 600 ± 86 min/day in SB and engaged in almost 1.5 hours per day of MVPA. No association was found between SB and cardiometabolic health related variables, whereas MVPA (β = 8.07 ± 2.18; r2 = 0.544; $p < 0.001$) was only significantly associated with oxygen uptake, relative to all other remaining behaviours.

CONCLUSION: No associations were found between the time spent in SB and cardiometabolic health related outcomes, possibly due to the high amount of time spent in MVPA within highly active adults.

Conventional Print Poster

CP-BM16 Motor control and Athletic Performance

VERBAL OUTCOME PREDICTION IN BASKETBALL – A BEHAVIORAL STUDY

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INTRODUCTION: Professional basketball players like to show off that they can predict the outcome of their throws. Studies confirm a high perceptual sensitivity in experienced players to discriminate hits from misses (Cañal-Bruland et al., 2015; Maglott et al., 2019). The present study shows that this perceptual sensitivity is related to verbal prediction accuracy. Herein, this measure of verbal prediction accuracy controls for strategic response patterns and individual throwing performance.

METHODS: 19 participants (6w, 13m; 23.7 ± 4.8 years; average basketball experience of 11.2 ± 4.9 years) performed 500 free throws, in which they verbally predicted the outcome (hit/miss) of every second trial. Visual and auditory feedback was withdrawn for 2.5 seconds after ball release using liquid crystal glass goggles and in-ear headphones. Individual, strategy-controlled, prediction accuracy was calculated based on Maurer et al. (2022). In addition, d' was computed to detect the players' sensitivity to discriminate hits and misses.

RESULTS: On average, participants could predict significantly above their individual chance level with a mean accuracy of 12.97 % and a standard deviation of 9.00 % ($t(18) = 6.28$, $p < 0.001$, $d = 1.44$). The according d' value reached an average of 0.36 and a standard deviation of 0.26 ($t(18) = 6.10$, $p < 0.001$, $d = 1.40$) and an average response bias λ of -0.14 with a standard deviation of 0.40. The two parameters prediction accuracy and d' show a high correlation ($r(17) = 0.99$, $p < 0.001$).

CONCLUSION: To be able to predict the result of one's own basketball free throws, participants have to rely on prerelease kinesthetic and efferent information. Although this perceptual information is noisy, and decisions have to be made under time constraints, expert players are able to discriminate and verbally predict their own throwing outcomes above an individual level of chance. The high correlation between the verbal prediction accuracy and the d' values underlines the assumption that the players have conscious access to the online predictions of their sensorimotor system.

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RECRUITMENT PROPERTIES OF SPINAL REFLEX OF THE THIGH MUSCLE IN ELITE SPRINTERS

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INTRODUCTION: Activation timing of thigh muscles is important in high-performance of sprint running. Especially, sharpness of switch from onset to offset of thigh muscle activation during sprint running is superior in top sprinters (Kakehata et al. 2021). These characteristics of activation pattern of thigh muscles in sprinters could be produced by specific function of central nervous system, especially neural circuits including motoneurons. The purpose of this study was to examine the recruitment properties of spinal reflex in sprinters.

METHODS: Ten sprinters and ten control subjects participated in this experiment. We used transcutaneous spinal cord stimulation (tSCS) to evoke posterior root-muscle reflex from lower limb muscles (Courtine et al. 2007). Stimulation electrodes were attached at abdomen (anode) and the midline of the back between L1 and L2 (cathode). tSCS was applied with various stimulation intensities from subthreshold to the above intensity inducing the plateau amplitude of spinal reflex. We evaluated the recruitment curves of the reflex amplitudes in the bicep femoris and soleus muscle. From the recruitment curves, we calculated the maximal slope, plateau amplitude, and threshold (Higashihara et al. 2022).

RESULTS: The maximal slope of the recruitment curve of the spinal reflex of the biceps femoris was significantly higher in sprinters than control subjects ($P < 0.05$). Meanwhile, there was no significant group-differences in the maximal slope of the soleus. Furthermore, the plateau amplitude and threshold did not differ between the group irrespective of muscles.

CONCLUSION: The observed sharper slope of the recruitment curve of spinal reflex in sprinters without differences in plateau amplitudes would mean that higher motor output induced by reflex can be delivered with small changes in sensory input in sprinters. This specific recruitment property of spinal reflex of the biceps femoris in sprinter could reflect plastic change of spinal neural circuits by long-term sprint training. In conclusion, elite sprinters show the muscle-specific recruitment pattern of spinal reflex.

THE IMPACT OF VOLLEYBALL SPIKE AND DEFENSE TRAINING ON DEFENSE ANTICIPATION ABILITY

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INTRODUCTION: In volleyball, the defense is extremely important as it can avoid losing points at first. Moreover, a successful defense can further create the opportunity to organize the latter attack (1). The ability to anticipate the attack correctly allows players to better prepare the defense (2,3). Perceptual and motor experiences of the observed action (e.g., attack) have been shown to enhance the ability to anticipate its results in athletes (2, 3). However, studies with perceptual or motor training intervention remained limited (4-6). Moreover, the action anticipation ability is often tested with the temporal or spatial occlusion paradigms and did not require participant to respond with the actual movement involved (but only with a key press) which might decrease the perception and action coupling (4). Therefore, in this study we investigated how perceptual and motor training of volleyball attacks would influence players' anticipation of the attacks, and the action anticipation ability was tested in a reaction time paradigm in which players had to anticipate the direction of the attack by performing a defense movement.

METHODS: Eighteen male collegiate volleyball players were recruited. We filmed 4 volleyball players spike action on a real indoor volleyball court from the perspective of the player ready to defend at the position #6. Each video clip was occluded 1 frame (33ms) before the ball left the scene. During the experiment, the video clips were projected on a 1.56 m × 1.59 m projection screen. Participants were required to present the real defense reaction. The control group accepted regular practice, and the spike group accepted more spike practice and less defense practice. Both training last for 5 weeks with the frequency of 2 days per week. After the intervention training session, participants took the anticipation and spike post-test. The retention test was performed 7 days after post-test. A 2 (Group) × 3 (Test) ANOVA repeated measurement was used to examine the anticipation and spike performance.

RESULTS: There was no significant difference in anticipation accuracy, reaction time, and spike accuracy between groups and tests. The anticipation consistency of the retention test of each group was significantly higher than the pre-test(PREcontrol = 78.22 ± 4.52, REcontrol = 81 ± 3.50, PREspike = 79.33 ± 4.27, REspike = 82.44 ± 4.07, $F(1, 16) = 4.985$, $p = .013$, $\eta p2 = .238$, $p = .037$)

CONCLUSION: Apparently, anticipation capacity, especially accuracy and reaction time, would not be enhanced after 5 weeks spike training intervention that did not improve motor skill. It appears that the spike training intervention should be more directly related to the aspect of technique, rather than merely accumulating experience. In addition, the examination of spike ability should consider not only accuracy but also technical parts. By doing so, we can not only monitor training effectiveness, but also explore the relationship between motor skill improvement and anticipation performance.

ATTENTIONAL FOCUS EFFECTS ON LOWER LIMB MUSCULAR STRENGTH IN ATHLETES: A SYSTEMATIC REVIEW

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INTRODUCTION: Evidence suggests that the attentional focus contributes to enhancing strength performance [1]. However, additional research is needed to investigate the applicability of these studies beyond the tasks and population currently

examined. This study aimed to systematically review studies about attentional focus effects on strength characteristics during lower-limb exercise tasks in athletes

METHODS: Scopus, web of Science, and EBSCO databases were searched using Prisma PERSIST [2] guidelines and keywords related to the focus of attention, force production processes, and athletes. Inclusion criteria required an age ≥16 years and to be a healthy competitive athlete. Exclusion criteria were applied for research about technical skills, postural control, and asymmetry comparisons. Based on the literature [3], athletes were categorized in four tiers or a 'mixed group': World-class (Tier 5); Elite (Tier 4); Highly trained (Tier 3); Trained /Developmental (Tier 2); and Tier mixed (different levels). Information used from each eligible study were the aims and design, participants characteristics, strength task, attentional focus conditions, outcome measures, findings, risk of bias calculation, and assessment of certainty against several established methodological issues identified within the literature.

RESULTS: 15 out of 296 studies were initially found, met inclusion criteria. The study aims addressed the focus of attention on performance (n=6), between skill level (n=2), for learning (n=5), as a preference on performance (n=1) and one study did not state the aim. Studies used either a cross-over within-subjects (n=9) or RCT (n=6) design. Participants (n=440 males vs. n=96 females) consisted of one elite, four highly-trained, eight developmental, and two mixed group samples. Studies mainly used single tasks: jump (n=8), running acceleration (n=3), isokinetic knee extension (n=1), and isometric lift (n=1), performed with pretension mechanisms (n=6), influenced by stretch-shortening cycle reflex (n=5), isometric (n=1), isokinetic (n=2) muscle action. Outcomes measured were kinetics (n=13) or combined with EMG (n=2). Few studies reported an advantage for the external focus of attention across conditions (n=2; g=0.13-0.419) performing CMJ and IMTP tasks with Tier 2 and Tier mixed athletes, with an average risk of bias score of Excellent. However, findings suffered in the assessment of certainty when reviewed against key criteria identified by authors in the field.

CONCLUSION: Research does not address the needs of elite athletes and there is limited evidence on each type of strength characteristics and muscle action. There is also a need to incorporate methodological steps to ensure fair comparisons between attentional foci conditions. Research should focus on contextualized information within the professional practice to offer stronger translational implications for athletes and coaches

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TACTILE SENSORY FUNCTION IN ATHLETIC POPULATIONS: A COMPARISON OF TWO POINT DISCRIMINATION THRESHOLDS

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INTRODUCTION: Two Point Discrimination (TPD) test is a widely used method for assessing the ability of the skin to discriminate between two distinct points of pressure. Although it has been previously used to evaluate sensory loss in conditions such as nerve injuries and peripheral neuropathy (1), its use in athletic populations as an indicator of proficiency level has not been well established (2). The purpose of this study was to compare TPD sensation in professional soccer players, amateur soccer players, physically active people, and sedentary individuals.

METHODS: A total of 105 participants were recruited, including 25 SoccerPro, 24 SoccerAmateur, 31 ActiveSport, and 25 Sedentary. TPD tests were performed on the inside and outside of the dominant foot using a calibrated calliper. The selected areas have dual significance as they are commonly used in soccer practice and innervated by different dermatomes (inside: Saphenous Nerve, outside: Superficial Peroneal Nerve). The distance between two points was reduced until the participant couldnt differentiate, and the resulting threshold distance was recorded. The length (FL) and width (FW) of the foot were also measured. For statistical analysis a more useful index is defined: Touch Sensor Density Index (TSDI) was used from the formula TSDI=(FL.FW)/TPD. Logically it is useful for the body/foot/etc. normalization (if area is high TPD is high and vice versa). Some of the variables were not normally distributed so Kruskall-Wallis (nonparametric version of ANOVA) with Dunn's multiple comparisons tests were used for comparisons.

RESULTS: For the inside region, group medians were statistically different ($p<0.001$). The median TSDI of SoccerPro ($p<0.002$) and SoccerAmateur ($p<0.009$) were both significantly higher than that of Sedentary. But there was no difference between SoccerPro and SoccerAmateur median TSDI values ($p>0.9$). For the outside region, group medians were also different ($p<0.0004$). The median TSDI of SoccerPro ($p<0.0002$) and SoccerAmateur ($p<0.04$) were both significantly higher than that of Sedentary. But there was no difference between SoccerPro and SoccerAmateur median TSDI values ($p=0.071$).

CONCLUSION: The results of this study suggest that professional soccer players have a greater sensor density per area to discriminate between two distinct points of pressure compared to sedentary individuals. This finding may be attributed to the repeated tactile stimulation associated with soccer-related practice over the years. The TPD-based TSDI could be a useful method for assessing sensory function in athletic populations, particularly in sports that require significant tactile stimulation. Further research is needed to determine the effects of training (i.e. field training vs VR training) and other factors such as haptic feedback (3) on TPD sensation in athletic populations.

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THE COMPARISON OF EEG SIGNALS OF REAL PERFORMANCE AND MOTOR IMAGERY IN THE BADMINTON

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INTRODUCTION: Examining sensory information in sports and the study of its neurological views provides a perspective for studying performance, where both cognitive and physical demands are high. In the past decades, psychological research in sports has mainly focused on the decision-making and one of the studied areas is brain activity during real performance and motor imagery. In the sports domain, motor imagery can improve cognitive and motor functions. However, this may be varying with their abilities to perform of an action. Therefore, the main purpose of the project is to comparison of EEG signals of real performance and motor imagery in the badminton.

METHODS: In this causal-comparative research study, the statistical population includes 9 skilled badminton players in the youth age group. Badminton players performed a reaction test in response to monosensory (visual, auditory) and multisensory (audio-visual) in four modes (1. visual, 2. auditory, 3. visual-auditory congruent and 4. visual-auditory incongruence) stimuli. Overall, 96 reaction trials conduct (24 per condition). Also, this study was conducted in 2 conditions (1. during real performance and 2. during motor imagery). Badminton players, based on their position and based on the information they received, had to make the best decision and execute the correct answer with their hand and racket movements. In the second condition, the subject imagery the same movements related to the task for 40 seconds. This task took about 30 minutes for one participant. PsychoPy software was used to design the task. While performing this task, a 32-channel electroencephalogram (EEG) was used to identify the neural activation pattern corresponding to mono and multisensory stimulation. Finally, brain waves were analyzed in EEGLab and Matlab software. Repeated Measures ANOVA was used with a significance level of 0.05 in SPSS23.

RESULTS: Results of the repeated measures ANOVA 2(real performance and motor imagery) ×15 (waves and areas) showed that main effect of performance (motor and imagery) ($F=5.91$, $p=0.04$), main effect of waves ($F=20.03$, $p=0.001$) and the interactive effects of performance*waves were significant ($F=24.54$, $p=0.0001$). Further, the results indicated that there is significant difference in frontal, central, parietal, temporal and occipital areas of theta, alpha and beta waves.

CONCLUSION: So that the alpha wave was higher at the imagery condition in the temporal, central and frontal area and specially with more rate in parietal and occipital area than real performance. In addition, it was showed that beta wave was higher parietal, occipital and frontal and also theta wave was higher in the parietal and frontal area in the real performance than motor imagery condition. The high amount of alpha wave during imaging was consistent with the function of this wave. Also, more activity of frontal and parietal regions is justified in their performance in the field of sensory-motor functions and decision-making.

TRAIN BRAIN INSTEAD OF MUSCLE: IMMEDIATE EFFECT OF NEURO-ATHLETIC TRAINING ON FLEXIBILITY, SERVICE AND UPPER EXTREMITY PERFORMANCE IN ELITE VOLLEYBALL PLAYERS - A RANDOMIZED CONTROLLED TRIAL.

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INTRODUCTION: The aim of this study was to evaluate the immediate effects of neuro-athletic training on flexibility, service, and upper extremity performance in elite volleyball players.

METHODS: A total of 20 young healthy elite male volleyball players aged 18-25 years were included in the study. Participants were randomized evenly into one of two groups; the control group (CG) and the neuro-athletic training (NAT) group. The flexibility was assessed by using the sit and reach test; A pocket radar ball coach speed gun was used to measure the serve speed, and upper extremity performance was measured by the Closed Kinetic Chain Upper Extremity Stability Test pre-and post-treatment. Neuro-athletic training included visual reset drills, vestibulo ocular reflex drills, optokinetic training, brock string drills, and convergence and divergence drills. Control participants received no intervention.

RESULTS: Significant improvements were observed in flexibility ($p<0.01$; effect size: 0.91), serves speed performance ($p<0.01$; effect size: 0.93), and upper limb performance ($p<0.01$; effect size: 0.90) in the neuro-athletic group, while all parameters in the control group were similar to before the training.

CONCLUSION: The results of this study showed that neuro-athletic training acutely increased flexibility, serve speed, and upper limb performance. The beneficial outcomes seen in the current study imply that these neuro-athletic training approaches might be used in addition to routine training programs.

ARE YOUR HURDLES REAL, OR JUST IN YOUR MIND? DIFFERENTIATING HURDLING MOVEMENT PATTERNS USING POINT LIGHT DISPLAYS

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INTRODUCTION: Hurdlers develop specific hurdling coordination from practicing jumping over hurdles. Hurdlers have also participated in shadow practice: hurdling without hurdles. The constraints model proposes that the coordination patterns of human movement result from organismic, environmental, and task constraints (1). Shadow practice changes the task constraint in producing the movement coordination. Point light display has been used to identify characteristics of coordination patterns. Therefore, the purpose of the study was to examine if the hurdlers could differentiate hurdling movement patterns with or without hurdles using point light displays.

METHODS: Participants included 24 collegiate hurdlers, 25 collegiate non-hurdler athletes, and 25 young adults without sport training. Eight videos, shot from 4 hurdlers practicing with and without a hurdle, were digitized to make the point light display testing videos. As the duration of the original video (normal speed) was too short (~ 0.8 s), we edited the videos to half the original speed to make a set of slow speed videos. A pair of 2 hurdling videos from the same hurdler, one with and one without hurdle, were presented consecutively to the participants who were then asked to identify which video was with hurdle. Two copies of each videos were used in the test for the consistency check. A one sample t test was used to compare the correct rates and the consistent rate to 0.5 and 0.7, respectively. The correct rate was examined using the background (3) by playback speed (2) mixed design ANOVA, with the playback speed as the repeated factor.

RESULTS: The result of the one sample t test on the correct rate for the slow/hurdler group was significantly higher than 0.5 ($p<.05$). The consistent rates of the slow/hurdler and normal/hurdler group were not different from 0.7, while all other groups were lower than 0.7. The ANOVA result showed a significant interaction effect, $F(2,71)=5.48$, $p<.01$. The post hoc simple main effect of experience showed a significantly higher correct rate for hurdlers versus the other 2 groups for the slow speed ($ps<.05$). For the simple main effect of playback speed, only the hurdlers showed significant superior performance on the slow speed than the normal speed ($p<.01$).

CONCLUSION: Hurdlers were able to differentiate hurdling with and without hurdles through the point light display of the joint movement. The superior performance from the hurdlers, especially at the slow speed condition, suggests that perception of biological motion is influenced by the action experience of the observers. The results provide evidence that task constraints influence the movement coordination patterns and shadow practicing hurdling may not facilitate the development of hurdling movement coordination.

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HUMANS CAN PREPARE TO MOVE FOR DIFFERENT PURPOSES IN PARALLEL: INFORMATION AND DYNAMICAL SYSTEMS IN DYNAMIC DECISION-MAKING

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INTRODUCTION: In sports, there are often situations where one must respond appropriately to multiple possibilities under strict time constraints. For example, a baseball batter waits for a fastball; however, when the time comes, batters are able to handle a slow ball like changeup. The batter's swing is not a predetermined swing, which means that the batter has two possibilities, a fastball and a slow ball, and tries to respond to each. In perceptual information processing, just as Rubins vase can appear to be a vase or two faces, multiple perceptual states can be present on a single time axis. However, it is difficult to understand how this theoretical concept can be applied to physical movements that eventually converge to a single state. Then, we focused on the change in motion in mid-air from shooting to passing during a basketball jump shot and examined how far the shooter can respond to the change when the purpose, which was initially uncertain, is suddenly clarified. Furthermore, the final goal of this study is to graphically explain the interaction of information and dynamical systems under uncertain and strict time constrained situations.

METHODS: Ten basketball players performed jump shots with the possibility of the purpose being changed to a pass. The timing of the visual stimuli presentation, which signifies the change in purpose to a pass, was determined and set from the premeasured hangtime of each participant. The light timing was divided into eight conditions (0, 10, 20, 30, 40, 50, 60, and 70%) in increments of 10% from 0% to 70% when the time was normalized to 0% at the take-off time and 100% at the landing time for a total of nine conditions, including the before-jump condition in which the lights were turned on when both feet touched the ground. The success rate of shooting and passing in each condition and the time series coordinate data related to the elbow joint were obtained.

RESULTS: The shots maintained a high success rate regardless of the time at which the visual stimuli were turned on; furthermore, the success rate of the pass did not reach 0% until just before the ball was released (at least approximately 50 ms ago). Furthermore, when analyzing the movements during a possible change in purpose, strategies were observed in which individuals paused the elbow joint angle in mid-air and delayed the timing of the ball release.

CONCLUSION: The most important result, in which the success rate did not reach 0% after the minimum reaction time required to make a choice during the execution of the movement, suggests that the shooters can prepare to shoot and pass in parallel rather than in series. Then, the uncertain state in the information system is reflected in the "pausing" of the

movement (extension of the elbow joint) in the dynamical system. This is an example of how humans prepare to make multiple movements with different purposes in parallel, which can be transferred to either pattern if the movement is analogous to common motions.

TIMING TO PASS THE CENTER OF A DISCRETE MOVEMENT IS MORE ACCURATE THAN FOR STOPPING AT THE END OF A DISCRETE MOVEMENT

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INTRODUCTION: Many superb human performances are time related acts such as the spike from a volleyball attacker and the swing of the bat to hit a home run in baseball. However, the focus of the majority of discrete aiming movement studies has been on spatial accuracy. The impulse variability model of motor control assumes a strong relation between the variability of impulse and the variability of movement in space and time. One of the assumptions from the impulse variability model is symmetry between the acceleration and deceleration profiles. Studies of rapid timing tasks where the goal of the task was passing through a spatial location with a specified target time were mainly based on this assumption (1). The purpose of the study was to examine if movement time was more accurate at the middle of the discrete movement where the peak velocity occurred than at the end of the discrete movement.

METHODS: Twenty-two participants were randomly assigned to a passing through or stopping group. The task was to draw a horizontal line of 30cm on a digital tablet with the target time of 300ms. The participants in the passing-through group were required to pass a vertical line located at the 15cm position 300ms after the start of the task whereas those assigned to the stopping group were to stop at the end of the 30cm line in 300ms. All participants performed 100 trials with the latter 80 trials analyzed. Independent t tests were used to examine the mean movement time (MT), absolute error (AE) of MT and the variable error (VE) of MT between groups.

RESULTS: The passing-through group showed significantly shorter mean MT (316 vs. 372ms), $t(20) = 2.76$, $p = .012$, lower AE (30 vs. 77ms), $t(20) = 2.57$, $p = .018$, and lower VE (35 vs. 51ms), $t(20) = -2.30$, $p = .032$, than the stopping group.

CONCLUSION: With the same goal MT of 300ms, the passing through group was more temporally accurate and less variable than the stopping group. The average velocity of the passing through condition was lower than that of the stopping condition. This was not consistent with the literature where temporal variability tends to decrease with increasing average movement velocity. The instantaneous velocity at the midline is close to the peak velocity of the trajectory whereas the instantaneous velocity drops to zero on stopping. A more comprehensive examination of the temporal accuracy when aiming for passing at different locations of the movement trajectory may provide a better understanding of the control mechanism of temporal performance.

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ABNORMAL MOTOR UNIT FIRING PATTERNS AND A STEPPING AGILITY SKILL IN OLDER ADULTS

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INTRODUCTION: Normally, low-threshold motor units discharge at high frequency, whereas high-threshold motor units discharge at low frequency during submaximal contractions. This is well-known as 'onion skin phenomenon'. However, the onion skin phenomenon is often negated in older adults [1]. In older adults, many motor skills, such as an agility, are often impaired. Since the agility skill could be influenced by both neural input to the muscles and muscular functions, we hypothesized that stepping skill would be impaired in older adults with abnormal motor unit firing patterns. We aimed to investigate the difference in the stepping agility skill between older adults with normal or abnormal motor unit firing patterns.

METHODS: Forty-eight community dwelling older adults aged 65 years or older (mean age: 73.6±4.3 years) participated in this study. They performed maximum voluntary isometric contraction (MVC) in knee extensors. High-density surface electromyography was recorded from vastus lateralis muscle during submaximal ramp-up contraction to 50% of MVC. After individual motor units were decomposed, recruitment threshold and firing rate at 40-50% of MVC were calculated. To assess the motor unit firing patterns, participants whose data showed 5 or more motor units could be detected were included in the further analysis. The older adults with normal or abnormal motor unit firing patterns were divided based on the p-values of regression analysis between recruitment threshold and firing rate of individual motor units within individual participants. For stepping test, they were seated in a chair and were instructed to open and close their legs to step across two parallel lines (30 cm apart) as fast as possible for 20 s. The interval times between each step were recorded and the mean and coefficient of variation (CV) of each stepping time were calculated during the whole duration and every 5-s interval.

RESULTS: Thirty-eight older adults were analyzed based on the criteria. The participants were divided into two groups, 15 older adults with normal motor unit firing patterns (N group) with $p < 0.05$ calculated by regression analysis between recruitment threshold and firing rate of individual motor units, and 23 older adults with abnormal motor unit firing patterns (AN group). Mean time and CV of stepping time during the whole duration were not different between two groups ($p = 0.687$, $p = 0.066$, respectively), but the peak CV among every 5-s interval was significantly higher in AN group than N group ($p = 0.044$).

CONCLUSION: Older adults with abnormal motor unit firing patterns would have the impaired ability to perform rapid and regular stepping, which would rely on neural control. The findings suggest the importance of normal motor unit firing patterns for maintaining motor functions in older adults.

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IN HEALTHY YOUNG ADULTS, MAT PILATES INDUCES NEUROMUSCULAR FACILITATION OF MAXIMAL ISOMETRIC FORCES DURING KNEE FLEXION AND EXTENSION MOVEMENT

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INTRODUCTION: Pilates exercise has become popular for strengthening trunk muscle and increasing flexibility. Recent research found that mat Pilates induced improved multiple isokinetic torque parameters (1) (2) and maximal isometric forces from knee extension and flexion (3) in elderly women. However, limited studies have been conducted to validate the effects of Pilates on isometric muscular strength in young adults. This study aimed to investigate whether mat Pilates training improved maximal isometric forces during knee extension and flexion movements in healthy young adults.

METHODS: The study included 23 college students (aged 21.0 ± 1.0 years) divided into two groups: Pilates group (PG; n = 11) and control group (CG; n = 12). Participants in PG performed a 60-minute mat Pilates exercise once a week for 12 weeks under the supervision of a licensed instructor. CG received no Pilates intervention and was instructed to spend as much of their daily life as possible without physical activity. The maximal isometric forces during knee extension and flexion movements were measured in both PG and CG before and after the intervention.

RESULTS: Height and bodyweight did not differ significantly different between groups. When comparing the pre- (203.96 ± 6.5 Nm) and post 12-week intervention (224.77 ± 14.2 Nm), the PG demonstrated a significant improvement in peak torque of knee extensor muscles during maximal isometric knee extension movement ($p < 0.01$). Furthermore, there was a significant improvement in peak torque of knee flexor muscles during maximal isometric knee flexion movement ($p < 0.05$), when comparing pre- (88.18 ± 7.2 Nm) and post-intervention (96.46 ± 7.7 Nm). Conversely, there were no significant differences for the CG in any of the analyzed variables in the intra-group comparison, pre- and post-intervention.

CONCLUSION: Mat Pilates improves maximal isometric forces during knee flexion and extension movements. These findings imply that Pilates exercise aids in the neuromuscular facilitation of the lower limbs as well as improvement of knee flexor and extensor muscular function in young adults.

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THE EFFECTS OF TACTILE STIMULUS ON BIPEDAL POSTURAL SWAY IN EARLY ADOLESCENTS

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INTRODUCTION: The purpose of this study was to investigate the effects of painful and indolent tactile stimulus which was applied through the skin of calf area over bipedal postural sway in early adolescents.

METHODS: 156 adolescents volunteered in the study (n girls=82, n boys=74). They were divided randomly into 3 groups as Painful Stimulus Group (PS) (n=47), Indolent Stimulus Group (IS) (n=55) and the Control Group (C) (n=54). GYKO inertial sensor was used for bipedal postural sway measurements. The data considered from sway measurements were Elliptical Area (EA), Length (L), Mean Distance (MD), Velocity (V) on Medio-Lateral (ML) and Antero-Posterior (AP) directions. PS and IS groups were respectively asked for bipedal postural sway measurement, prone position for 1-minute bilateral calf stimulus and bipedal postural sway measurement again. C group distinctly just lied down for 1-minute without stimulation between the tests. One way ANOVA was used for intergroup comparison and paired sample t-test was used for intragroup comparison.

RESULTS: There was no significant difference between the groups in pre and post-tests. All three groups showed significant increases between the tests in V, AP-L, AP-V. In addition, the PS group showed statistically significant difference in L, ML-L and ML-V. Although there were significant differences, the effect sizes were determined as trivial or small, and the bipedal postural sway responses of girls and boys to tactile stimuli differs.

CONCLUSION: In conclusion investigating the effects of sensory manipulations on bipedal postural sway, we should notice the quality of the stimulus matters. The application area and the quality of the tactile stimuli can affect the bipedal

postural sway parameters differently. This study should be applied for investigating the age and gender effects in different age and gender groups and for customizing the effects of the stimuli characteristics the stimuli should be applied on different body parts.

EFFECTS OF PULSE DURATION AND FREQUENCY ON ELECTROSTIMULATION-EVOKED FORCE: COMPARISON BETWEEN THREE MUSCLE GROUPS

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INTRODUCTION: Neuromuscular electrical stimulation (NMES) consists in the application of transcutaneous stimuli to superficial muscles with the goal to evoke visible contractions. The technique is commonly used to improve muscle function but has inherent limitations such incomplete motor unit recruitment and discomfort. Over the recent years, the so-called wide-pulse high-frequency (WPHF) NMES has been introduced to partially overcome these limitations. It has indeed been shown that low-intensity NMES delivered with a pulse duration of 1 ms and a frequency of 100 Hz can generate a progressive increase in plantar flexor tetanic force through central recruitment of motor units called extra force (EF) (Collins, 2007; Wegrzyk, 2015). However, the combination of stimulation parameters other than 1 ms-100 Hz to maximize EF has not been investigated and it is currently unknown if the EF response differs between muscle groups with different composition, architecture or function. The aim of the present study was to assess the impact of the stimulation parameters on the NMES evoked force profile in plantar flexors, knee extensors and elbow flexors of the same participants.

METHODS: Sixteen volunteers, 14 men and 2 women (29±6 yrs, 177±6 cm, 74±11 kg) participated in a familiarization session followed by 3 experimental sessions (one per muscle group), which included twelve 10-s NMES trains separated by at least 2 min of rest and delivered at an intensity set initially to evoke 10% of the maximal voluntary contraction force. Stimulation trains were randomly delivered with a combination of frequencies (20, 50, 100 and 147 Hz) and pulse durations (0.2, 1 and 2 ms). The development of EF was calculated as the relative percent increase in force between the last and the 2nd second of the stimulation.

RESULTS: For the plantar flexors, greater EFs were generated with frequencies of 100 and 147 Hz (80±77%) compared to 20 and 50 Hz (51±57%, $p<0.001$) and with durations of 1 and 2 ms (74±71%) compared to 0.2 ms (48±51%, $p<0.001$). For the knee extensors and the elbow flexors, no difference in EF was observed between any parameter (respectively 51±109% and 26±74%). Higher EFs were generated for plantar flexors (92±76%) compared to elbow flexors (14±39%, $p=0.005$) using the standard WPHF stimulation parameters (100 Hz, 1 ms) but EFs were not significantly different between knee extensors and the two other muscle groups with this frequency and pulse duration.

CONCLUSION: Despite individual variability in the generation of EF depending on the parameters, the wider pulses (1 and 2 ms) and higher frequencies (100 and 147 Hz) induced greater EFs than the other tested parameters for the plantar flexors. The composition, architecture and function of the stimulated muscle seem to influence the generation of EF, which was the highest for the plantar flexors and the lowest for the elbow flexors.

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EFFECT OF LEGS STARTING BLOCK POSITION ON KINETICS AND KINEMATICS OF AN HEMIPLEGIC/BRAIN IMPAIREMENT T37 ELITE SPRINTER

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INTRODUCTION: Brain impairment (BI) significantly slows down the movement and leads to a reduction of the range of motion of the movement (ROM) and forces (Bezodis et al., 2020; Connick et al., 2015). Specifically, for hemiplegic, this loss of force is not the same in the right or the left side (Beckman et al., 2016). Thus, in starting block sprint phase, the force developed by the right and left leg should be different and the ability of the sprinter to have a balance of force between the right and left could be a strategy to improve sprint performance. The purpose of this study was to compare legs starting block position on kinetics and kinematics of a hemiplegic elite sprinter

METHODS: An elite sprinter (T37) performed 6 maximal 40-m sprints from starting blocks. The athlete realised three sprints with the paretic side in the front position (PSF) in the starting block and three sprints with the paretic side in the rear position (PSR). Average forces, impulses, were measured from the start to the 4th step using force plate (Kisler ; 1000 Hz). During the entire race, instantaneous velocity, maximal velocity, time contact, time flight, steps rate and lenght (V, Vmax,Tc, Tv, SR and SL) were measured using radar (Stalker Pro II; 48 Hz) and an optojump (Microgate, Bolzano). Using the velocity time curve and the model proposed by Samozino et al. (2016), the theoretical force (F0), velocity (V0) and maximal power (Pmax) were calculated.

RESULTS: The results demonstrated that lateral force and impulse were lower in the PSF condition (84 ± 75 vs 70 ± 46 N and 29 ± 41 vs 20 ± 23 N.s-1). Tc, Tv, SR and SL, averaged on the entire sprint, were not different between PSF and PSR, respectively for Tc, 0.142 ± 0.018 vs 0.145 ± 0.022 s for Tv, 0.103 ± 0.021 vs 0.102 ± 0.02 s, for SR 4.1 ± 0.1 vs 4.1 ± 0.4 Hz and for SL 168.5 ± 36.7 vs 168.4 ± 37.1 cm. Concerning the force velocity profile, F0 and Pmax

were greater for PSF condition (respectively for F0 373 ± 25 vs 358 ± 1 N and for Pmax 795 ± 49 vs 766 ± 8 W).

CONCLUSION: For this elite athlete used to start with both feet in front or in a rear position, starting in the PSF condition was the best option. Indeed, less lateral force and impulse are created and a lesser variability in Tc, Tf and SR from the 1st to the 12th step for PSR condition was observed. In addition, F0, Pmax, forces and impulses were greater in PSF compared to PSR (around 4%). The PSF departure may allow a more favourable force transmission during the first step that lead to an improvement of the acceleration phase.

EFFECT OF DIFFERENCES IN TORQUE AND ANGULAR VELOCITY DURING ECCENTRIC MUSCLE CONTRACTION ON SUBSEQUENT REACTIVE STRENGTH

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INTRODUCTION: eactive-strength qualities have important roles in athletic movements and sports performance. Very little research has investigated the motor control of the reactive strength. The effects of differences in muscle strength and angular velocity during movement in the opposite direction on muscle force have not been clarified. The aim of this study was to investigate the effect of differences in torque and angular velocity during eccentric contraction on subsequent reactive muscle strength.

METHODS: Thirteen male subjects (21±1 yrs) with no injury to the knee joint were performed maximum isometric strength after eccentric contraction at maximum and submaximum (about 50%) with different angular velocity (30°, 90°/sec). The maximum isometric torque, the rate of torque development (RTD), and the muscle activity of the vastus lateralis (VL) by using electromyography (EMG) were measured. In the sitting position, the range of motion of the knee joint was 60 degrees (eccentric contraction from 30° to 90°), and the knee joint was flexed at 90 degrees as the switching point for the measurement of maximum isometric torque.

RESULTS: Maximum isometric torque and its RTD significantly decreased when eccentric muscle contraction was performed at a high angular velocity (90°/sec) and submaximum contraction. However, the EMG of VL was no different between slow and fast angular velocity and eccentric contraction at maximum and submaximum effort.

CONCLUSION: To obtain strong reactive strength and high RTD, it is considered effective to have large muscle strength and slow velocity, and suggesting that it is important not to create slack in the muscle-tendon unit before exerting muscle strength. In conclusion, torque and angular velocity during eccentric contraction affect subsequent reactive muscle strength.

BOY-MAN DIFFERENCES IN THE NEURAL STRATEGY USED TO DEVELOP TORQUE DURING FAST HIGH-INTENSITY CONTRACTIONS

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INTRODUCTION: It has been demonstrated that, during maximal contractions, children have a lower rate of torque development than adults (1,2). It has been suggested that this age-related difference in explosive capacity may be due to children's lesser ability to activate their higher-threshold, type-II motor units (MUs)(3). No studies have examined whether MU activation differs between children and adults during contractions performed at high rates. Therefore, this study aimed to examine age-related differences in discrete-MU activation during high-intensity contractions performed at high rates.

METHODS: Nineteen boys and 17 men completed two laboratory sessions. Following a habituation session, maximal knee extension torque (MVC) was determined before completing trapezoidal contractions at 70% MVC at 35%MVC/s (2s to 70%MVC). Trapezoidal contractions were then sustained at the target torque for 12s before being released back to baseline. Surface electromyography of the vastus lateralis was captured by a Delsys Trigno Galileo sensor and mathematically decomposed into individual MU action-potential trains. Average MUAP amplitude (MUAPamp), recruitment threshold (RT), and MU firing rates (FR) at recruitment were then calculated. To characterize the size of MUs recruited with each contraction, MUAPamp was expressed relative to its RT. Group differences in FR at recruitment and the MUAPamp-RT relationship were assessed using ANOVA and linear regression, respectively.

RESULTS: The rate of torque development achieved was not different between boys (30.4±3.2%MVC/s) and men (31.5±2.7%MVC/s)($p=0.32$). The y-intercept, but not the slope of the MUAPamp–RT relationship was significantly ($p=0.008$) greater in men (0.044mV) compared with boys (0.021mV). Additionally, FR at recruitment was significantly greater in men (4.94±1.58pps) compared with boys (4.16±1.58pps) ($p<0.001$; $d=0.42$).

CONCLUSION: During high-intensity contractions at high rates, boys recruited smaller MUs, with lower FR at recruitment compared with men. Moreover, the significantly higher y-intercept of the MUAPamp–RT relationship in men compared with boys suggests that men recruit their larger MUs earlier than boys. Unexpectedly, the MUAPamp–RT slope was not different between groups. This may reflect the need for boys to recruit more MUs compared with men to compensate for their lower FR at recruitment. Overall, our results suggest that boys and men utilize different neural strategies to generate torque at high contraction rates.

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TRICEPS SURAE HYPERTROPHY AFTER STANDING VERSUS SEATED CALF-RAISE TRAINING

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INTRODUCTION: The triceps surae consists of the medial gastrocnemius (MG), lateral gastrocnemius (LG), and soleus (SOL). They all cross the ankle joint and function as the main planter flexors. Among them, MG and LG are biarticular muscles crossing the knee joint, and lengthened more in the knee-extended than knee-flexed position. Previous studies have shown that muscle hypertrophy is greater after training at long muscle lengths than training at short muscle lengths, by manipulating a joint angle of the two joints the target biarticular muscles cross (e.g. seated > prone leg curl for the hamstrings, [Maeo et al., 2021] and overhead > push down cable elbow extension for the triceps brachii [Maeo et al., 2022]). Based on these findings, this study examined the effectiveness of calf-raise exercise training performed in a standing position (long muscle lengths) versus seated position (short muscle lengths) for triceps surae hypertrophy.

METHODS: Fourteen untrained healthy young adults participated in this study. They performed calf-raise exercise with one leg in a standing/knee-extended position (Standing-Leg) and the other leg in a seated/knee 90°-flexed position (Seated-Leg) at 70% of one repetition maximum of the corresponding task. Each leg performed 5 sets of 10 repetitions per session (2 s for each of the concentric/eccentric phases), 2 session per week for 12 weeks. Before and after the intervention, T1-weighted axial 3-T MRI scans (FOV: 200*200 mm, slice thickness & gap: 5 mm) were obtained to assess muscle volume of the MG, LG, SOL, and the whole triceps surae.

RESULTS: After the intervention, muscle volume significantly increased in all three muscles and the whole triceps surae for both legs, except for the MG and LG of the Seated-Leg. The changes in muscle volume were significantly greater for the Standing-Leg than Seated-Leg in the MG (9.2% vs 0.6%), LG (12.4% vs 1.7%) and whole triceps surae (5.6% vs 2.1%) ($P \leq 0.011$), but similar in the SOL between Standing-Leg and Seated-Leg (2.1% vs 2.9%, $P = 0.410$).

CONCLUSION: Standing calf-raise is more effective than seated calf-raise for muscle hypertrophy of the triceps surae, especially the MG and LG. However, seated calf-raise is also recommended when one attempts to selectively target the SOL.

EXPLORING MOVEMENT-RELATED CORTICAL POTENTIALS, REACTION TIME AND FORCE PRODUCTION DURING THE SPRINT BLOCK START OF EXPERT AND NOVICE SPRINTERS: A CASE SERIES

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INTRODUCTION: Research have identified reaction time and force production as the most important factors for a successful sprint start, which accounts for 5% of the 100 m running time. Additionally, executive functions, sensory integration and motor programming are required to carry out the actions of the sprint start. Relating to cognitive processes, the neural efficiency hypothesis states that those with more experience require less cortical activation to execute a well-trained skill, when compared to someone with less experience. This hypothesis has been extended to athletes, but these brain-body connections have not been investigated in sprinters. This pilot study set out to describe MRCP (movement-related cortical potentials) of novice and expert sprinters before and during the sprint block start to understand movement-related brain activity changes during the movement preparation stage of the sprint block start. Secondary aims were to describe the reaction time, relative force production, speed and acceleration of multiple novice and expert sprint cases during a sprint block start.

METHODS: A case series design was used and four cases (two novice and two expert sprinters) were recruited. Cases completed ten sprint block start trials on an indoor track, while MRCP were recorded via 64-channel EEG. Additionally, reaction time, relative force, speed and acceleration were measured by the FAST start blocks.

RESULTS: The prefrontal cortex and the parietal lobe were identified as hubs of brain activity during the sprint block start, with statistically significant differences found across conditions in the parietal lobe. Lower prefrontal theta, alpha 1, alpha 2 and beta power were observed for the expert sprinter case. Parietal theta, alpha 1, alpha 2 and beta power of all cases appear to be quite similar, but this is inconclusive.

CONCLUSION: The statistically significant differences in parietal alpha and theta power, found across conditions, possibly indicate an increase in working memory and focused attention from the initial rest period until the response to the starting signal. Whereas the lower prefrontal power of the expert sprinter case potentially reflects a decrease in the reliance on executive functions and supports the neural efficiency hypothesis. The similar parietal power of the four cases may be because, regardless of skill level, all cases still had to anticipate the starting signal, integrate the sensory information and prepare the appropriate motor response.

These observations show that MRCP recording during the sprint block start is possible, and contributes new information to the novel field of applied mobile-EEG in cue-based closed-skill sport performance. Currently EEG cannot be used as a tool in the everyday sprint training setup due to the many factors affecting the EEG response and the expertise required to process and interpret the data. In future, with development, EEG may possibly be used as a load monitoring tool to screen for fatigue and impaired performance.

RELATIONSHIP BETWEEN MUSCLE ACTIVITY AND SINGLE-LEG STANDING PERFORMANCE ON A SLACKLINE: A PRELIMINARY STUDY OF NOVICE PLAYERS

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INTRODUCTION: This study aimed to shed light on the skill of slacklining, which is a balance sport that requires players to maintain their body balance dynamically and flexibly. Researchers have investigated the effect of slackline training on balance ability. However, knowledge on the skill of slacklining remains scarce.

In slacklining practice, experienced instructors teach learners ways to maintain balance on a swinging flat belt—a slackline—such as by moving both hands in parallel and concentrating on the perception of the self–environment relationship, while relaxing all body muscles.

Previous studies have shown differences between novices' and experts' skills in terms of upper body coordination, exploratory behavior in lower limbs, and perception (e.g., proprioception, interoception). However, muscle activity during slacklining has not been investigated. We hypothesized that single-leg standing on a slackline is a fundamental slacklining skill and that reducing muscle activity of lower limbs may contribute to whole-body dynamic balancing on a slackline.

METHODS: Six novice (five women, mean ± SD, 21.0 ± 2.0 years old) players who had no slacklining experience participated in our experiment. They were required to perform a single-leg standing task on a slackline that included four 3-minute sessions with 2-minute intervals.

To measure participants' muscle activity during slacklining, we attached an electromyogram sensor on the tibialis anterior (TA), lateral gastrocnemius (LG), vastus lateralis (VL), and biceps femoris (BF). We evaluated the slackline performance by persistence time (PT), which represents the duration for which participants can maintain a single-leg standing on a slackline. Additionally, the average muscle activity during the task was assessed. After choosing the top three trials of PT for each participant, correlations between persistence time and muscle activity were also calcul

RESULTS: As a result of analyzing slackline performance, we identified two different skill groups: novice (n=4, mean PT = 14.1 seconds) and intermediate (n=2, mean PT = 76.0 seconds) levels. By analyzing the correlation between the novice level group's PT and muscle activity, negative correlations were observed for TA (r = -0.46), LG (r = -0.56), and VL (r = -0.66), whereas no correlation was observed for BF (r = -0.14).

CONCLUSION: Reducing muscle activity may boost the slackline performance (i.e., PT) of novice players. Comparisons of lower limb muscle activity indicated that TA, LG, and VL activities increased when postural stability became unstable. Therefore, these muscle activities were correlated with PT. However, no significant correlation with PT was found for BF, probably because relaxing the VL causes flexion of the knee joint.

Further investigations should compare novice players with intermediate and expert players using larger samples. Understanding slackline skills can contribute to the practical application of balance training for sports athletes and facilitate rehabilitation.

Conventional Print Poster

CP-PN21 Cardiovascular Physiology III

COMPARING THE EFFECTS OF A HYPOXIC REPEATED SPRINT TRAINING ON PERFORMANCE IN NORMOXIA BETWEEN MALES AND FEMALES

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INTRODUCTION: Males and females exhibit gender-specific characteristics and they therefore respond differently to physical exercise. Yet, females are under-represented in sports and exercise physiology research when compared to males. Due to this gap in research, women are currently given the same training recommendations as men, which may potentially lead them to suboptimal performance. Repeated sprint ability (RSA) is important for sport performance, as it is a key factor in most team and racket sports. Repeated sprint training in hypoxia (RSH) has demonstrated greater improvements in sea-level repeated sprint performance than similar training in normoxia (RSN) in male athletes but has never been investigated in women. This study is therefore investigating the effects of hypoxic repeated sprint training on repeated sprint performance in normoxia in females compared with males.

METHODS: Thirteen male and five female recreational athletes (24.7 ± 0.6 y, practicing a team/racket sport 4.8 ± 1.6 h/week) completed 7 weeks of cycling in normoxia (RSN, FiO2: 0.209, males: n=7, females: n=2) or hypoxia (RSH, FiO2: 0.143, males: n=6, females: n=5). The training consisted of three sets of five 10-s sprints with a recovery of 20 s between sprints and 5 min between sets, twice per week. Before (Pre-) and after (Post-) training, anaerobic performance was evaluated in normoxia by a RSA test and a 30-s Wingate test on the cycle ergometer.

RESULTS: From Pre- to Post- training, the number of sprints during the RSA test increased by 1 repetition in males (11 vs 12) and females (9 vs 10) in RSN. In RSH, the number of sprints increased by 10 (13 vs 23) in males and by 3 (7 vs 10) in females. The average power output of all sprints in males increased by 2% in RSN (623 ± 77 vs 634 ± 91 W) and by 5% in RSH (608

± 61 vs 639 ± 50 W). Similarly in females, power output increased by 1% in RSN (444 ± 56 vs 450 ± 50 W) and by 7% in RSH (451 ±58 vs 485 ± 58 W). In RSN, average power output during the Wingate test increased by 4% in males (653 ± 75 vs 679 ± 58 W) and by 2% in females (450 ± 28 vs 460 ± 1). In RSH, average power output increased by 6% in males (636 ± 51 vs 678 ± 57) and by 8% in females (441 ± 59 vs 478 ± 57).

CONCLUSION: Those preliminary results show that a 7-week hypoxic repeated sprint training improved repeated sprint ability in females in a similar way than in males, through an increase in the number of sprints and in the average power output during the sprints. With the increased participation of women in sport, it is essential to further study their physiology and consequently help them improve exercise performance.

CHANGES IN THE PREFRONTAL CORTEX OXYGENATION LEVELS AFTER 4 AND 8 WEEKS HIGH INTENSITY EXERCISE TRAINING

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INTRODUCTION: The near-infrared spectroscopy (NIRS) can evaluate haemodynamic in prefrontal cortex during maximal exercise, and propose to the aerobic fitness influences cerebral oxygenation during exercise [1,2]. Polarized training (POL), and high interval intensity training (HIIT) have been proposed to improve aerobic endurance performance [3]. The impact of these training on cerebral oxygenation levels of changing metabolic demand is less clear. The purpose of this study was to observe which of these two training concepts provides the greatest response on cerebral oxygenation of endurance performance.

METHODS: Twenty-one male college students (age, 19.4 yrs; height, 1.74 m; weight, 67.6 kg) were randomly assigned to receive 8 weeks of either the POL group [zone (Zn) 1, 75%; Zn3, 25%], HIIT group (Zn3, 100%), and control (CON) group. Data were collected from the tests before training (pre-test), after 4 weeks training (mid-test) and after 8 weeks training (post-test), as regards the cerebral oxygenation in prefrontal cortex were continuously monitored, including total hemoglobin (tHb), oxygenated hemoglobin (O2Hb), deoxygenated hemoglobin (HHb), and tissue saturation index (TSI), when performed the Bruce protocol treadmill tests. The maximal oxygen uptake (VO2max) was evaluated during the tests.

RESULTS: The change of VO2max was significantly increasing in POL after 4 weeks (+ 8.4 %) and 8 weeks (+ 12.5 %) than that in CON ($p < .05$). In addition, HIIT was significantly increasing the change of VO2max after 8 weeks (+ 14.0 %) than that in CON ($p < .05$); however, no significant differences after 4 weeks ($p > .05$). During the tests, the O2Hb of prefrontal cortex were significantly higher in POL at mid- and post-tests than at pre-test. Besides, the O2Hb in HIIT at post-test was higher than at pre-test ($p < .05$). No significant differences in tHb, HHb, and TSI were found between groups.

CONCLUSION: After 8 weeks of the differences of high intensity exercise training, both POL and HIIT can improve aerobic capacity. The POL has an earlier physiological effect in healthy college students. These results demonstrated that the improvement of aerobic fitness may relate to improve prefrontal O2 for supplying.

EFFECTS OF EIGHT WEEKS OF ALTITUDE TRAINING ON THE ERYTHROPOIESIS, IRON METABOLISM AND AEROBIC CAPACITY

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INTRODUCTION: This research was conducted to evaluate the effects of eight weeks of altitude training on erythropoiesis, iron metabolism and aerobic capacity in trained rowers.

METHODS: Twenty-eight trained rowers were divided into altitude training group (AG) or sea-level training group (SG). During the eight-week training camp, the training plan and the training load were almost the same in both groups. VO2peak, the level of red blood cell count (RBC), reticulocyte% (RET%), reticulocyte production index (RPI), high fluorescent reticulocyte(HFR), medium fluorescent reticulocyte(MFR), low fluorescent reticulocyte(LFR) and hemoglobin (Hgb), and the concentration of serum erythroferrone (ERFE), ferritin (FER) and soluble transferrin receptor (sTfR) were measured before and after the eight weeks training camp.

RESULTS: (1) Compared with the pre-value, the VO2peak and the VO2peak to body mass (RVO2peak) increased significantly after eight weeks of training in AG. And no obvious difference of VO2peak and RVO2peak were observed in SG. The change of VO2peak and RVO2peak between AG and SG were significant (+9.41% vs +3.03%, $P=0.038$; +12.83% vs +0.80%, $P<0.01$). (2) After eight weeks of training, the RBC, Hgb and hematocrit (HCT) increased obviously in AG but no statistical difference in SG. The change of Hgb and HCT between AG and SG were significantly (+4.95% vs -3.21%, $P=0.003$; +6.48% vs -1.57%, $P=0.002$). A significant trend of RBC change between the two groups was observed (AG vs SG, +3.19% vs -3.61%, $P=0.061$). Compared with pre-value, no significant change of RET% and RET-He were founded in both groups after eight-week of training. In AG, it exhibited significant elevation of LFR and reticulocyte production index (RPI) while significant decrease of MFR and HFR. There were no group difference in the change of RET%、RET-He、LFR、MFR、HFR and IRF. However, the change of RPI after the training camp between AG and SG was significant（+30.60% vs -4.52%, $P=0.020$）. (3) In AG, no remarkable change of serum ERFE, a significant decrease of serum FER and obvious increase of serum sTfR and sTfR/logFER were observed after eight weeks of training. No statistical change of serum FER, sTfR and sTfR/logFER while a significant increase of serum ERFE were exhibited in SG. The change of serum FER, ERFE, sTfR and sTfR/logFER differed significantly between AG and SG (+17.99% vs +121.31%, $P=0.013$; -36.16% vs -2.96%, $P=0.040$; +82.77% vs -8.87%, $P=0.025$; +108.40% vs -6.96%, $P=0.011$). (4) There was a positive

and significant association between the change of VO2peak and serum sTfR, and the ratio of sTfR to logFER after eight weeks of training.

CONCLUSION: Eight weeks of altitude training appears more effective than sea-level training for improvement of oxygen delivery capacity of the blood and aerobic capacity in trained rowers. Serum sTfR may play an important role in improving the maximal aerobic performance. In the later stage of eight weeks of altitude training, the erythropoiesis is still active.

RELIABILITY OF MUSCLE OXYGEN SATURATION MEASURED WITH A NIRS DEVICE AT VENTILATORY THRESHOLDS DURING INCREMENTAL EXERCISE TESTING ON A BICYCLE ERGOMETER

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INTRODUCTION: Measuring muscle oxygen saturation (SmO2) during exercise by Near InfraRed Spectrometry (NIRS) is a non-invasive method to determine muscle oxygen usage. Some studies investigated reliability of this method under steady-state conditions, at different intensities during ramp protocols and maximum load [1] but not at certain intensities as the ventilatory thresholds (VT) during an incremental exercise test typically used for characterization of submaximal exercise capacity. This study intended to evaluate the reliability of SmO2, measured by the PortaMon device at rest, warm-up, VT1, VT2, peak oxygen consumption (VO2peak), and recovery phase in healthy athletes during an incremental exercise test.

METHODS: Twenty-three healthy athletes participated in this investigation. Each subject underwent two cardiopulmonary exercise tests with the same ramp protocol at the same time of day, separated by 7 days. VT1 and VT2 were determined in Test1 and SmO2 was measured with a portable NIRS device (PortaMon, Artinis Medical Systems, Amsterdam, Netherlands). Parameters for Test2 were measured at the same power as the ventilatory thresholds in Test1 to ensure comparability of parameters between both tests. Intraclass correlation coefficients (ICC) were examined for all parameters.

RESULTS: All participants completed two ramp tests with measurement of gas exchange and NIRS. For men, mean VO2peak was 59.2±4.9 mL/kg/min and SmO2 decreased from 66.5±3.3% at rest to 49.9±6.2% at VO2peak and for women, mean VO2peak was 54.0±3.4 mL/kg/min and SmO2 decreased from 67.6±3.3% at rest to 59.9±3.51% at VO2peak.

For rest, warm-up, VT1, VT2 and VO2peak, the ICCs of SmO2 between Test1 and Test2 were r=0.74 (CI95%: 0.48, 0.88), r=0.75 (CI95%: 0.50, 0.89), r=0.86 (CI95%: 0.70, 0.94), r=0.90 (CI95%: 0.79, 0.96), and r=0.77 (CI95%: 0.53,0.90), respectively.

For recovery phase, the ICCs of SmO2 was r=0.41 (CI95%: 0.01, 0.70).

CONCLUSION: The results indicate that the PortaMon device reliably measures SmO2 in healthy athletes during an incremental exercise test on a bicycle ergometer. Test-retest reliability was acceptable for rest, warm-up and VO2peak, good to excellent for VT1 and VT2 and poor for recovery phase. Since ventilatory thresholds are important for evaluating functional capacity in a clinical setting and for prescribing exercise at certain intensities [2], PortaMon may provide useful information on muscle oxygen consumption at these intensities.

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COMBINING NEAR-INFRARED SPECTROSCOPY AND HEART RATE VARIABILITY DERIVED THRESHOLDS TO ESTIMATE THE CRITICAL INTENSITY OF EXERCISE

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INTRODUCTION: Establishing the critical intensity of exercise often requires costly tools and/or several testing sessions. Noninvasive approaches such as the muscle deoxyhemoglobin concentration breakpoint ([HHb]BP) and the heart rate variability threshold (HRVT2) determined during ramp incremental (RI) test generally show good group agreement but can display relatively large individual variation. Since these modalities depend on different physiologic subsystems, combining these approaches could decrease that variability. Therefore, this study evaluated whether averaging the heart rate (HR) and oxygen uptake (VO2) responses associated with the [HHb]BP and the HRVT2 improved the accuracy of identifying the HR and VO2 at the respiratory compensation point (RCP).

METHODS: Ten recreationally trained females and eleven males (age range 18-50), performed a 6 min cycling within the moderate intensity domain (60-80 W to calculate VO2 mean response time) prior to a 15 W/min RI test until task failure. Gas exchange, near infrared spectroscopy (NIRS) and, RR interval data recorded during the RI test were used to assess the RCP [1], [HHb]BP [2], and HRVT2 [3] as previously described. Data were reported as means ± standard deviation (SD). The Pearson's r coefficient and the intraclass correlation coefficient (ICC) were calculated for all measurements. The agreement was assessed by Bland Altman plots with limits of agreement (LOA) (±2SD). Comparisons between variables were made using paired t-test accepting a $p \leq 0.05$ as statistically significant.

RESULTS: The HR (158±14, 156±13, 160±14 and, 158±12 bpm) and VO2 (3.08±0.69, 2.98±0.58, 3.06±0.65, and 3.02±0.60 L/min) at the RCP, [HHb]BP, HRVT2, and the combined HRVT2&[HHb]BP (H&HAv), respectively were not significantly different (p>0.05). The mean bias and LOA for VO2 and HR were not significantly different when comparing the RCP vs [HHb]BP (0.10±0.52 L/min; 2±20 bpm), the RCP vs HRVT2 (0.02±0.59 L/min; -2±18 bpm), and the RCP vs H&HAv (0.06±0.47 L/min; 0±15 bpm). The Pearson's r coefficient between H&HAv vs RCP was higher compared to the coefficient between [HHb]BP vs RCP and HRVT2 vs RCP for both, HR (r= 0.85; r= 0.73; r= 0.79, p>0.05) and VO2 (r= 0.94; r= 0.93; r= 0.91, p>0.05). ICC between RCP, [HHb]BP, HRVT2 and H&HAv was 0.93 for VO2 and 0.79 for HR.

CONCLUSION: This study demonstrated that both, the [HHb]BP and the HRVT2 independently provided VO2 and HR responses that strongly agreed with those at the RCP. More importantly, combining [HHb]BP and the HRVT2 (i.e., H&HAv) resulted in estimations of the VO2 and HR at the RCP that displayed smaller variability compared to each modality alone. Thus, the information presented supports the use of the [HHb]BP and the HRVT2 as valuable tools for approximating the VO2 and HR responses at the critical intensity within practical settings.

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BLOOD PRESSURE AND SKELETAL MUSCLE OXYGENATION DURING EXERCISE IN HEALTHY YOUNG SUBJECTS

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INTRODUCTION: A large differences is obvious in systolic blood pressure at the same relative exercise intensity in young healthy subjects. Near-infrared spectroscopy (NIRS) techniques measures oxyhemoglobin, deoxyhemoglobin, total hemoglobin, and tissue saturation index (TSI) as a markers of skeletal muscle oxygenation, expressed as surrogates of microcirculation and mitochondrial function, during exercise. We hypothesized that skeletal muscle oxygenation, measured by NIRS technology, is associated with systolic blood pressure and rate pressure product (heart rate x systolic blood pressure) responses at the same submaximal exercise intensity in healthy young subjects.

METHODS: Female (n=8, 29±8 years) and male (n=10, 25±6 years) subjects performed maximal exercise test starting from 0 W (5 min), following incremental protocol starting from 40 W and, increasing load at every 2 min (15 W for females and 20 W for males) until exhaustion. Breath-by-breath gas exchanges and ventilation (Vyaire Medical) was measured continuously to analyze oxygen uptake and respiratory compensatory point (RCP). Heart rate was measured continuously (Polar H10) and blood pressure at every load (Schiller BP 200-plus). NIRS signals were measured from vastus lateralis (Artinis Oxymon Mk III). Baseline blood pressure and heart rate were measured in sitting position before exercise test. The association between systolic blood pressure, rate pressure product and TSI was analyzed at the intensity of RCP.

RESULTS: Maximal oxygen uptake was 42±6 (range 35-50) and 50±7 (range 40-60) ml/kg/min for female and male, respectively. At the intensity of RCP, oxygen uptake was 80±8 % of maximal oxygen uptake, heart rate 88±9 % of maximal heart rate, respiratory exchange ratio 1.00±0.05, systolic blood pressure 185±22 (range 145-230) mmHg and rate pressure product 30159±4877 (range 24000-42550). The change in TSI from baseline (0 W) to the intensity of RCP (-18±10, range from -6 to -34) was strongly correlated with the changes in systolic blood pressure (62±16, range 38-96 mmHg, r=-0.63, p<0.005) and rate pressure product (22183±4610, range 16311-34624, r=-0.65, p<0.004) from baseline to the intensity of RCP (Spearman´s correlation). The change in systolic blood pressure or rate pressure product from rest to RCP did not correlate with maximal oxygen uptake or age.

CONCLUSION: Cardiac workload response to equal submaximal exercise intensity (RCP) is strongly associated with skeletal muscle oxygenation properties in young healthy subjects. Highly elevated cardiac workload during exercise may be triggered by altered skeletal muscle oxygenation probably due to the impaired microcirculation and/or mitochondrial function even in healthy young subject.

THE EFFECTS OF REMOTE AND LOCAL ISCHEMIC PRECONDITIONING ON LOCAL MUSCLE ENDURANCE AND TISSUE OXYGENATION

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INTRODUCTION: Ischemic preconditioning (IPC) has been used for improving exercise performance but its effect on local muscle endurance is still controversial. Because IPC not only induces cardiovascular and endocrine responses but may also have an impact on local tissue oxygenation, we hypothesized that the effect of IPC on local muscle endurance depends on where IPC is applied. The purpose of this study was to investigate the acute effect of IPC with two different locations on the number of repetitions, muscle tissue oxygenation, and muscle activity in low-load elbow flexion exercise.

METHODS: In Experiments 1 and 2, eight healthy males performed unilateral elbow flexion exercise at 30% of one repetition maximum to failure on two occasions at least four days apart. Before the exercise, four sets of pneumatic compression and subsequent release (5 minutes each) were applied with an occlusive (220 mmHg, IPC) or light (20 mmHg, SHAM) pressure. Biceps brachii muscle activity and tissue oxygenation were recorded using surface electromyography and near-infrared spectroscopy, respectively, during the exercise and then averaged for 5 repetitions each at the beginning, in the middle, and at the end of exercise. Rate of perceived exertion (RPE) was measured immediately after the exercise.

To examine the effect of remote (RIPC) and local IPC (LIPC), a pneumatic cuff was attached to both thighs in Experiment 1 and to the exercise arm in Experiment 2, respectively. A washout period of at least 2 weeks was allowed between Experiments 1 and 2.

RESULTS: In Experiment 1, the application of IPC did not affect the number of repetitions (RIPC 80.0 ± 12.7; SHAM 71.2 ± 20.1, P = 0.241), RPE, muscle activity or muscle tissue oxygenation dynamics during exercise. In Experiment 2, although the application of IPC did not affect the number of repetitions (LIPC 87.0 ± 24.7; SHAM 81.4 ± 38.9, P = 0.501), RPE or muscle activity, significant interactions between time and condition were found for oxygenated hemoglobin (P = 0.011) and total hemoglobin (P = 0.023). Post-hoc analysis revealed significant differences in oxygenated hemoglobin (adjusted P < 0.01) and total hemoglobin (adjusted P = 0.024) between IPC and SHAM at the end of exercise.

CONCLUSION: These results suggest that local but not remote IPC influences tissue oxygenation dynamics in the working muscle. The increase in oxygenated blood volume, however, may not improve local muscle endurance probably because of the decreased oxygen utilization at the end of exercise.

THE EFFECTS OF MATCHED INCREASES IN CEREBRAL BLOOD FLOW WITH EXERCISE OR HYPERCAPNIA ON SERUM AND PLASMA BRAIN-DERIVED NEUROTROPHIC FACTOR IN YOUNG ADULTS

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INTRODUCTION: Despite the volume of research attempting to characterise the brain-derived neurotrophic factor (BDNF) response to exercise, there are few studies designed to investigate mechanisms of the transient increases observed. We propose that increases in cerebral blood flow and resultant shear stress are a likely target as it is the only exercise-related mechanism that stimulates both endothelial and platelet release of BDNF. This study utilised matched increases in cerebral blood flow using exercise or hypercapnia to attempt to isolate this specific mechanism of BDNF release.

METHODS: Six healthy younger adults (27.8 ± 5.5 years; female: n = 2) completed three experimental conditions in a randomised-counterbalanced-cross-over order: 1) 20 minutes of moderate-intensity cycling on a stationary recumbent bicycle; 2) 20 minutes of seated mild-hypercapnia where participants inhaled a mixture of room air and a medical grade gas (10% CO2, balance air) from an open-ended mixing reservoir; or 3) a time-matched rested control. Mean cerebral blood velocity in the middle cerebral artery (MCAvmean) was monitored using 2Mhz transcranial doppler ultrasound throughout each intervention. The exercise and hypercapnia conditions were designed to elicit matched increases in MCAvmean of 30%. Pre- and post-blood samples were collected to measure the circulating concentrations of BDNF in serum and plasma. A full blood count at both time points allowed for the determination of free vs platelet-bound BDNF levels and accounted for platelet release during the experimental conditions. The study was approved by the University of Canberra Human Research Ethics Committee (HREC-2046) and participants provided written informed consent.

RESULTS: MCAvmean increased compared to baseline and the control condition by similar levels for the exercise and hypercapnia conditions. Serum BDNF, which represents the total circulating BDNF, increased for exercise (effect size β: 1.03) and hypercapnia (β: 0.56), compared with control. By comparison, plasma BDNF, which reflects the bioavailable pool of BDNF, increased by similar levels following exercise (effect size β: 1.21) and hypercapnia (effect size β: 1.27). There was a slight increase in platelet count with exercise (β: 0.45) and a decrease with hypercapnia (β: -0.33), which may explain some of the differences in the response of serum BDNF between exercise and hypercapnia.

CONCLUSION: These initial findings suggest that increases in cerebral blood flow may be an important pathway for acutely increasing the circulating concentration of BDNF, particularly the bioavailable pool in the plasma. Designing exercise interventions to target the mechanisms of BDNF release specifically may offer a novel and efficient research method and intervention to optimise brain health. The use of hypercapnia may also be a novel technique to isolate the effects of blood flow and vascular health on BDNF and broader brain health.

SIMULATED HYPOXIA PROCEDURES: ORIGINAL INSIGHTS AND PERSPECTIVES FROM THE CLINICAL PHYSIOLOGY OF HYPOXIC RESPONSE PROJECT

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INTRODUCTION: The organ-level response of humans as altitude increases has been an intriguing field of research for the past century. In addition to field studies, stress tests for clinical purposes and special training sessions are used as altitude simulation procedures. Indeed, hypoxic exercise tests, performed under normobaric conditions, appear to be relevant in preventing high-altitude pathology and can be conducted prior to further exposure. This study aimed to fill the gap of simulated procedures in hypoxia both from the point of view of exercise testing and personalized training.

METHODS: A total of 17 healthy young students (9 f and 8 m, 23.3±4.9 years old, BMI 23.60±4.50 kg/m2) were recruited for this cross-over study consisting of three trials: control (≈160 m asl), moderate (≈2,500 m asl), and high (≈3,500 m asl) simulated altitude, conducted on separate days. The procedures were carried out using the Everest Summit II altitude generator associated with a tent (Hypoxico, USA) and participants spent ≈ 30 minutes each time inside the tent. Mean Arterial Pressure (MAP) was calculated as (2*DBP+SBP)/3 by measuring BP before and 1 minute after the experiment. Peripheral saturation (SpO2) was measured with a finger probe used before and at the end of the experiment. RM-ANOVAs with one between (sex) and two within (hypoxia and before-after) factors were used for analysis of MAP and

SpO2 responses, after controlling for sphericity, homogeneity of variances, and Q-Q plots. All trials were medically supervised.

RESULTS: Randomization of administration was confirmed: only 4 participants (22.2%) guessed the order of trials (expected proportion: 16.7%, χ2 test p=0.527). The volume of CO2 in the inhaled air during the time spent in the tent followed a one-phase exponential decay, very similar between the control (O2=20.38%, CO2=0.25%) and hypoxic trials (O2=15.40%, CO2=0.26%). MAP was overall lower in females than males (p=0.005, η2p=0.425, η2G=0.327) and did not differ across conditions. SpO2 decreased at the end of the experiment in both hypoxic conditions (p<0.001, η2p=0.937, η2G=0.758), down to 91.2±1.6% and 86.9±1.9% at 0.150±0.002 and 0.135±0.002 of FiO2, respectively, with no differences by sex. The SF ratio increased from control (481±6) to hypoxia (609±12 at moderate and 645±14 at high simulated altitude). The trend of SF followed a linear regression of the equation SpO2 = 1.416*FiO2 + 68.83 (r=0.852; Sy.x=1.731).

CONCLUSION: The procedures proved to be safe. Troubleshooting included climatic stresses inside the tent (possible hot temperature and low relative humidity) and possible data acquisition problems from the devices due to altered air composition. Accurate measurement of FiO2 and FiCO2 can be implemented in bioenergetic studies during simulated hypoxia to correct data from metabolimeters calibrated outside the tent. The typical and personal profile of SF ratio should be defined to optimize and monitor hypoxic training.

EXERCISE RESPONSES TO HEART RATE CLAMPED CYCLING WITH GRADED EXTERNAL LIMB COMPRESSION

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INTRODUCTION: Understanding how an additional stressor to exercise can alter the internal-external load relationship (e.g., heart rate achieved in reference with work done) is important for optimizing exercise prescription. For instance, environmental manipulations (i.e., acute exposure to systemic hypoxia or heat stress) may reduce the mechanical demand of exercise without a concomitant decrease in cardiovascular stimulation. Heart rate clamped cycling with graded external limb compression represents a potential therapeutic solution for individuals with acute (e.g., athletes recovering from an injury) or chronic dysfunction (e.g., patients suffering from musculoskeletal disorders) who may be unable to fully load their locomotor system. This study aimed to quantify the acute effects of graded external limb compression on the interaction between changes in mechanical output, muscle oxygenation trends and perceptual responses to heart rate clamped cycling.

METHODS: On the same day, twenty-five adults (21 men) performed six, 6-min cycling bouts (24 min of recovery) at a clamped heart rate corresponding to their first ventilatory threshold at 0% (unrestricted), 15%, 30%, 45%, 60% and 75% of arterial occlusion pressure (AOP) with the cuffs inflated bilaterally from the fourth to the sixth minute. Power output, arterial oxygen saturation (pulse oximetry) and vastus lateralis muscle oxygenation (near-infrared spectroscopy) were monitored during the final three minutes of pedaling, while perceptual responses (modified Borg CR10 scales) were obtained immediately after exercise.

RESULTS: Compared to unrestricted cycling, average power output for minutes 4–6 decreased exponentially for cuff pressures ranging 45–75% of AOP (P<0.001). Peripheral oxygen saturation (~96%) remained unchanged (P=0.472). Deoxyhemoglobin changes were larger at 45–75% versus 0% of AOP (P=0.036), whereas higher total hemoglobin values occurred at 60–75% of AOP (P<0.001). Sense of effort, ratings of perceived exertion, pain from cuff compression, and limb discomfort were exaggerated at 60–75% versus 0% of AOP (P<0.001).

CONCLUSION: When cycling at a clamped HR, cuff pressures of at least 45% of AOP applied bilaterally are required to reduce mechanical output significantly in reference to non-BFR, with exponential power decrements occurring thereafter. However, practitioners need to be cognizant that higher occlusion levels also accentuate muscle deoxygenation and exercise-related sensations.

Conventional Print Poster

CP-MH30 Injury Prevention in Sports Medicine

THE USEFULNESS OF THE JAPANESE INJURY SURVEILLANCE SYSTEMS FOR SPORTS INJURY PREVENTION

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INTRODUCTION: Injury surveillance systems (ISSs) are necessary to continuously record high-quality sports injury data. There are 15 ISSs in the world [1]. Five ISSs are in Japan, most of which are based on insurance benefits or condolence payment systems [2]. Guidelines such as the Australian Sports Injury Data Dictionary (ASIDD) and consensus statements have been published with recommendations on definitions and methods of collecting sports injury data [3]. This study assessed the usefulness of the ISSs in Japan for injury prevention by comparing the included variables within the ISSs with variables recommended in the ASIDD.

METHODS: The ASIDD provides guidelines for classifying sports injury data collection. It classifies data into three categories: core, strongly recommended, and recommended [3]. Two authors independently assessed the amount of information in the Japanese ISSs according to the ASIDD guidelines by using a scoring system [4]. The two authors discussed and reached a consensus in case of disagreements. The scoring system was '1' for data item present (could be coded according to the ASIDD guidelines) and '0' for data item absent (in the ASIDD but not in the Japanese ISSs). The k statistic was used to analyse inter-rater agreement.

RESULTS: The inter-rater agreement ranged from k = 0.096 (Japan Rugby Football Union Condolence Benefit System) to k = 0.449 (Personal Accident Insurance for Student Pursuing Education and Research). In comparison with the ASIDD, the Japan Rugby Football Union Condolence Benefit System had the highest overall score of 21 out of 30. In the category of core, all items recommended by the ASIDD were included in all five Japanese ISSs. In contrast, the score in the strongly recommended category ranged from 6 (Personal Accident Insurance for Student Pursuing Education and Research) to 10 (Japan Rugby Football Union Condolence Benefit System) out of 15. The scores in the recommended category ranged from 2 (Sport Safety Association Accident Insurance and International Budo University Sports Club Injury Survey) to 4 (Japan Rugby Football Union Condolence Benefit System) out of 8. Items recommended by the ASIDD that were not captured in all five Japanese ISSs included specific injury place, advice given to the injured person, referral, grade/level of play, time of presentation for treatment, and reason for presentation.

CONCLUSION: The five ISSs in Japan included all core data items recommended by the ASIDD. However, only 67% (10 out of 15) of the strongly recommended items and 50% (4 out of 8) of the recommended items were included. Therefore, the excluded items need to be included in future ISSs in Japan for sports injury prevention.

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GENES WITHIN THE TGF-BETA SUPERFAMILY AND RECEPTORS ARE ASSOCIATED WITH RISK OF ACL INJURY IN A LARGE INTERNATIONAL COHORT.

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Collins, M., September, A.V.

INTRODUCTION: ACL rupture is an acute musculoskeletal soft tissue injury with a lengthy recovery time, which can have a large economic burden because of possible loss of income and high cost of surgical repair. Alterations to the biomechanical properties of the joint can predispose patients to other conditions such as early-onset knee osteoarthritis post-surgery. Variants within genes of the transforming growth factor beta (TGF-beta) family and their receptors, namely TGF-beta receptor III (TGFBR3), and adhesion protein TGF-beta-induced (TGFBI), were recently implicated with risk of ACL rupture in a South African (SA) population using de novo data from whole exome sequencing. The aim of this study was to Investigate the association of variants TGFBR3 rs1805113 A>G, TGFBR3 rs1805117 T>C and TGFBI rs1442 G>C with ACL rupture risk in other populations.

METHODS: A large case-control genetic association study was conducted comprised of 1329 physically active and unrelated participants from SA (n=459), Sweden (SWE n=211), Poland (POL n=291), and Australia (AUS n=368). Genotyping was performed using Taqman© SNP genotyping assays and the QuantStudio 3™ Real-Time PCR System and software (Applied Biosystems, Waltham, MA, USA). Statistical analysis was performed using R statistical packages and correction for multiple testing was achieved using false discovery rate (FDR) method.

RESULTS: The TGFBR3 rs1805117 T/T genotype was significantly associated with increased risk of ACL ruptures (p= 0.007, OR: 0.70, 95% CI: 0.54 - 0.91) as well as a non-contact ACL ruptures. When sex stratification was performed, the A allele of TGFBR3 rs1805113 A>G (OR: 1.42, 95% CI: 1.07-1.89) was associated with an increased risk of injury while the G allele of TGFBI rs1442 G>C (OR: 0.70, 95% CI: 0.53-0.93) was associated with reduced risk of injury (p=0.042) in female participants. No association was observed in males after correction for multiple testing.

CONCLUSION: Similar to the original SA study, TGFBR3 rs1805113 and TGFBI rs1442 modulated the risk of ACL ruptures in females of a larger international cohort. Moreover, TGFBR3 rs1805117 modulated the risk of ACL rupture when all participants were analysed. This work supports the hypothesis that variation within the transforming growth factor beta family plays a partial role in modulating susceptibility to knee ligament injuries. Further work is warranted to improve our understanding of genetic sequence variability at these gene loci together with other genes in the extracellular remodelling pathway in susceptibility towards identifying potential novel therapeutic targets.

HOW TO REDUCE PEAK FORCES IN ARTISTIC GYMNASTICS TO PREVENT IMPACT INJURIES?

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INTRODUCTION: Artistic Gymnastics is characterized by high impacts on the body through push-offs, landings and dismounts on apparatuses like floor and balance beam. Due to this many high impact forces, injuries may occur [1,4,5]. The most common cause of gymnastics injuries originates in the contact between the gymnast and the surface [2-4]. Because of the high impact forces and the large amount of gymnast-surface contacts in Artistic Gymnastics, reducing the impact forces seems an appropriate strategy to reduce the incidence and severity of gymnastics injuries [2,3]. A possible solution

is 'soft gymnastics' in which more damping materials and softer apparatuses are used. This research aims to study the damping characteristics of often used additional materials in training practice to prevent impact injuries in Artistic Gymnastics.

METHODS: Impact studies with several gymnastics materials and apparatuses like damping mats, Airtracks and softer beams were performed to determine the damping values of these commonly used materials in Artistic Gymnastics' training and competiton. The maximal impact force (Fmax), deflection and rebound of a falling weight (impactor) on the surface of a number of gymnastics apparatuses with and without damping materials were measured using a drop hammer measuring system. In this way the supposed damping effects of these often used additional materials were determined.

RESULTS: A commonly used Airtrack with a thickness of 10 cm, inflated to a pressure of 155, 205, and 245 millibars, led to an average decrease of Fmax of 824 N (21%), 611 N (15%), and 450 N (11%) respectively, compared to the commonly used competition floor. When the Airtrack was placed on top of the competition floor, the decrease was even larger (1512 N (38%), 1392 N (35%) and 1320 N (33%)) when compared to the floor alone. Using a multimat or protection padding on top of the Balance Beam resulted in a decrease of Fmax of 4426 N (50%) and 2892 N (33%), respectively when compared to Balance Beam alone. The protection padding on the vault table only showed a small decrease in Fmax (159 N (3%)), which was comparable to the result of a multimat on the floor (172 N (4%)).

CONCLUSION: In conclusion, using damping gymnastics materials or apparatuses result in a decrease in Fmax, but the extent of the decrease varies widely with the used damping materials and is largely dependent on the characteristics of these materials. The use of these materials seems, despite the large variation, an effective strategy to reduce Fmax in Artistic Gymnastics training practice. Innovations concerning apparatus equipment, competition rules and training adjustments can contribute to the further development and implementation of 'soft gymnastics' in training as well as competitions to prevent or diminish high impact related gymnastics injuries.

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TEMPORAL ADAPTATIONS IN MUSCLE SYNERGY ACTIVATION DURING CHANGE-OF-DIRECTION MOVEMENTS FOLLOWING 8 WEEKS OF NEUROMUSCULAR AND TECHNIQUE TRAINING

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INTRODUCTION: Injury prevention exercise programs (IPEPs) that include specific drills to improve change-of-direction (COD) technique can reduce movement-related risk factors for non-contact anterior cruciate ligament (ACL) ruptures, e.g. a high peak knee abduction moment upon initial contact [1]. What is unknown are the underlying changes in muscle activation patterns. This information is important because muscle activation regulates how knee movement and external knee moments affect ACL loading.

Research question: What are the effects of an 8-week IPEP combined with either COD-specific or unspecific training on the activation patterns of lower extremity muscle synergies during a 135° COD?

METHODS: Sports science students (n=21, 43% female) completed a supervised 8-week IPEP including strength and balance exercises plus either COD drills (CODG, n=11) or linear sprinting drills (control group, CTRG, n=10). Excitations of nine muscles of the right (cutting) leg were measured pre- and post-training using surface EMG during six maximum-speed COD trials. The filtered and normalized EMG signals were subjected to non-negative matrix factorization to build one muscle synergy model for both groups and time points consisting of four synergy modules (M1-M4) and corresponding synergy activations. This model explained over 90% of variance in the input EMG data. Principal component analysis was used to extract the three principal features of each synergy activation waveform. The corresponding principal component scores were investigated for 'group*training' interactions using a two-way repeated measures ANOVA (alpha=0.017 [corrected for multiple comparisons], effect size (ES) partial eta-squared).

RESULTS: A significant interaction effect (p=0.002, ES=0.392) was observed for the third principal waveform feature of synergy module M1. This module predominantly represented hamstring muscle activation with co-activation from quadriceps and gluteus medius muscles throughout the final foot contact of the COD. The CODG showed a more constant activation of M1 throughout the ground contact phase following training, while the CTRG showed an opposite trend leading to the interaction effect. We did not observe significant interaction effects (p>0.023) for any other waveform features of M1-M4 although some showed large effect sizes (ES>0.14).

CONCLUSION: An 8-week IPEP including COD-specific drills resulted in different adaptations of synergistic muscle activation profiles compared to an IPEP with linear sprinting drills. Detecting such adaptations to IPEPs might improve our understanding of the underlying mechanisms through which IPEPs prevent injuries. For example, the more constant co-activation of hamstrings, quadriceps, and gluteal muscles observed in the current study may help to prevent knee valgus collapse and limit ACL strain during a COD [2].

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DIFFERENT SPRINTING STRATEGIES IN SPRINTERS WITH AND WITHOUT CHRONIC ANKLE INSTABILITY

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INTRODUCTION: Chronic ankle instability (CAI) is a chronic disorder caused by acute lateral ankle sprains (1). During gait, CAI patients exhibited altered movement patterns characterized by augmented ankle inversion and plantarflexion, which could increase the risk of subsequent ankle sprains and any other joint injuries (2). In sprinting, the ankle joint demonstrated greater plantarflexion at touchdown compared to slow running (3). Since sprinting is a vital component of many explosive sports events, it is imperative for clinicians to understand the effects of CAI on sprinting. Thus, this study aimed to compare the sprinting kinematics of the lower extremities in individuals with CAI and healthy controls.

METHODS: Seven male Japanese college sprinters with CAI and 7 matched healthy control sprinters performed 5-second steady-speed running at 7.5 m/s on a treadmill (ORK-7000, Ohtake Root Kogyo). Three-dimensional marker motion was recorded using an 18-camera motion capture system (Vicon Motion Systems, Ltd., Oxford, the UK). We calculated the joint angles using the joint coordination system of each hip, knee, and ankle joint. The running cycle was normalized to 100%, with the ground contact to subsequent ipsilateral ground contact. Statistical parametric mapping method (SPM) was used to analyze mean lower extremity kinematics between groups. The significance level was set at 0.05.

RESULTS: During the stance phase, the CAI group demonstrated increased ankle dorsiflexion angle (9% of gait phase, $p<0.05$; 0-19% of gait phase, large effect size), increased knee flexion angle (1–9% of gait phase, $p<0.05$; 0-20% and 93-100% of gait phase, large effect size), and increased hip flexion angle (0–15% and 64–100% of gait phase, large effect size) compared to the control group. There were no significant differences in ankle, knee, and hip joint angles in the horizontal and frontal planes during the whole sprinting cycle.

CONCLUSION: This study showed that individuals with CAI had unique lower extremity kinematics in the sagittal plane during sprinting at 7.5 m/s. CAI group represented the increments of ankle dorsiflexion angle and knee and hip flexion angle from the late swing phase to the stance phase. This altered kinematics can have protective effects which may help resist large external loads during sprinting. However, this protective kinematics contrasts with general sprinting kinematics. Therefore, these adaptations could potentially lead to a decrease in sprinting performance. Further research is needed to determine the influence of other biomechanical factors such as kinetics and muscle activity.

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USING MACHINE LEARNING TO IDENTIFY RISK FACTORS FOR RUNNING-RELATED INJURIES – RESULTS FROM THE 1-YEAR PROSPECTIVE COHORT STUDY (SMART INJURY PREVENTION).

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INTRODUCTION: Despite its popularity and definite health benefits, running is associated with a high number of running-related injuries (RRI). Several risk factors have been elaborated over the last decades, such as training-related, biomechanical, and medical parameters and an interrelation of these parameters seems plausible. Thus, a machine learning approach was used in this study to determine RRI risk factors and their interplay.

METHODS: A prospective cohort study was conducted over 12 months including competitive adult runners (running at least 20km per week and being injury-free for at least 3 months).1 Baseline assessment included medical examination, questionnaires (demographics, sport and injury history, menstruation, medication), and musculoskeletal blood laboratory tests. Furthermore, biomechanical evaluation was performed in a laboratory with motion capture (Qualisys AB, Sweden) and markerless software (Theia Markerless, Canada) and on a 400m track with inertial measurement units and magnetic cells (Humotion GmbH, Muenster, Germany). During the 12 months, individual continuous data were collected weekly for occurring injuries (OSTRC2; athletemonitoring.com; FITSTATS Technologies, Inc., Moncton, N-B, Canada) or per training session for biomechanical data (Humotion GmbH, Muenster, Germany) as well as training load (session duration, rating of perceived exhaustion and GPS data, strava.com; Strava, Inc., San Francisco, CA, USA). Any occurring injury was followed up and precisely diagnosed by a medical assessment with possible imaging in specialized running/sports medicine clinics. The main outcome was the injury incidence (injuries per 1000h of running exposure). A machine learning model will be used to learn the interrelation and ranking of possible risk factors with a sensitivity analysis.

RESULTS: For this study, 120 runners (33.3% female, 40.4±10.1 years, 176.4±7.9 cm, 70.6±9.5 kg, BMI 22.6±10.1 kg/m2) were included. Of these, 6 (5%) did not start reporting. Overall, included participants (95%) reported 11717.7 hours of cumulative running. Furthermore, 95 injuries were reported from 48 participants (prevalence 42.1%, 95%CI 30.2-54.0). RRI incidence was 8.1/1000h of running exposure (95%CI 6.5-9.7). The most frequent diagnoses were Achilles tendinopathy (n=13), iliotibial band syndrome (n=8), and hamstring muscle strains (n=5). As of writing the abstract, the machine learning analysis is still to be conducted.

CONCLUSION: This study is the first prospective cohort study in runners to use continuous data collection combined with an extensive medical, bone health, and biomechanical baseline assessment analyzed via machine learning. The results

of this study will give an insight into the interplay of RRI risk factors and may be a basis for possible multidimensional risk reduction strategies using novel machine learning techniques.

CO-CREATING AN INTERVENTION TO REDUCE INJURY RISK IN COMPETITIVE ADOLESCENT DISTANCE RUNNERS ENROLLED ON ENGLAND ATHLETICS' YOUTH TALENT PROGRAMME.

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INTRODUCTION: Efforts to reduce the risk of injury in youth athletes have typically adopted a 'top-down' approach where previous interventions have been developed for athletes, rather than allowing athletes (and other key stakeholders) to be involved in this process. Such an approach often leads to a decreased intervention effect in real-world settings. To counteract this issue, we co-created an intervention to reduce injury risk in competitive adolescent distance runners (16-18 years) enrolled on England Athletics' Youth Talent Programme.

METHODS: Adopting a 'co-creation approach' to intervention development, we completed six sequential steps: (1) identifying and describing the problem; (2) establishing a stakeholder group to help support intervention development; (3) surveying potential end-users to assess knowledge, behaviours, and preferences about injury risk reduction; (4) delivering stakeholder workshops to discuss information created from steps 1 and 3, and generate ideas about possible intervention content and form; (5) hosting sub-group meetings to discuss how existing evidence can support intervention content and form; and (6) developing content to include as part of a 'minimum viable product.' Each step informed the next, whereby the research team actively reflected upon and tailored the co-creation process.

RESULTS: A total of 21 stakeholders (9 females), across England, participated in the intervention development, including adolescent distance runners (n = 4), their parents/carers (n = 5), England Athletics coaching staff (n = 6), healthcare professionals (n = 3), and research scientists (n = 3). Across six workshops and two sub-group meetings, informed by the development of four short reports (including survey results), agreement was reached that an intervention to reduce the risk of injury in competitive adolescent distance runners should: (1) be focused on gradual onset (i.e., overuse) lower limb musculoskeletal injuries; (2) prioritise primary prevention; (3) include a diverse set of content (i.e., physical and psychosocial); and (4) improve competitive adolescent distance runners' self-awareness and knowledge of injury risk, whilst being framed positively ('healthy performance'). The agreed intervention content included nine topics: (1) training load and pain management; (2) recovery and nutrition; (3) specific exercise programmes; (4) description of typical injuries; (5) injury psychology; (6) sport specialisation; (7) growth and maturation; (8) relative energy deficiency in sport; and (9) female athlete health. The intervention will be accessible online and is intended to be used by competitive adolescent distance runners (end-user) year-round.

CONCLUSION: Using a 'co-creation approach' has led to the development of a broad and integrative intervention to reduce the risk of injury in competitive adolescent distance runners. Adopting this approach should improve the acceptability, feasibility, and effectiveness of the intervention when implemented in real-world settings.

on behalf of the Intervention Development Stakeholder Group.

GENETIC VARIATION WITHIN STRUCTURAL GENES COL12A1 AND TNC EXPLAIN SOME OF THE VARIABILITY OF KNEE ROTATION MEASUREMENTS

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INTRODUCTION: Understanding the functional components of the collagen fibril, the major building block of tendon and ligament, remain an area of investigation of connective tissue injury. To this end, variants within COL1A1 and allelic interactions between variants within COL5A1, COL11A1 and COL11A2 have been reported to associate with modulating specific measurements of knee laxity within the non-dominant leg. The COL1A1, COL5A1, COL11A1 and COL11A2 genes encode for α chains within types I, V and XI collagen, which are structural components of the collagen fibril within ligaments and other connective tissues. Type XII collagen, on the other hand, is located on the surface of the fibril and is a homotrimer encoded by COL12A1. Similarly, to the other collagen encoding genes, COL12A1 mutations have been implicated in connective tissue disorders with joint hypermobility as one of the symptoms. Although not a member of the collagen family, tenascin C, which is encoded for by TNC plays a critical regulatory role in connective tissue biology. Both TNC and COL12A1 have been found to share a putative stretch responsive enhancer region. Therefore, the expression of both genes are upregulated by mechanical loading. The aim of this study was to investigate whether COL12A1 and TNC variants are associated with knee laxity measurements and computed knee ligament length changes. The dominant leg undergoes more adaptation to repeated loading in comparison to the non-dominant leg. Therefore, due to the presence of the stretch responsive region within the COL12A1 and TNC promoters, these associations were investigated in both the non-dominant and dominant legs.

METHODS: One hundred and fourteen healthy participants were assessed for genu recurvatum (knee hyperextension), anterior-posterior tibial translation, external-internal tibial rotation, and ligament length changes during knee rotation of both legs. Participants were genotyped for COL12A1 (rs970547 A/G) and TNC (rs1061494 T/C, rs2104772 T/A and rs1138545 G/A).

RESULTS: The TNC rs1061494 TT genotype was associated with significant decreased measurements of external (TT: 4.8 [4.0; 5.6] °; TC: 5.8 [4.7; 6.9] °; CC: 5.4 [5.0; 6.2] °; P=0.008) and internal (TT: 5.2 [4.5; 5.8] °; TC: 5.9 [4.9; 6.7] °; CC: 6.1 [5.9;

6.3] °; P=0.002) tibial rotation, as well as slack (TT: 15.6 [13.8; 17.7] °; TC: 18.9 [14.9; 21.3] °; CC: 18.1 [16.7; 18.9] °; P=0.011), in only the dominant leg. Similarly, the COL12A1 rs970547 AA genotype was also associated with significant decreased measurements of external (AA: 5.0 ± 1.3°; AG+GG: 5.9 ± 1.5°; P=0.011) and internal (AA: 5.5 ± 0.9°; AG+GG: 6.0 ± 1.3°; P=0.042) tibial rotation in the dominant leg. The TNC rs1061494 CC genotype was associated with significant larger measurement changes during internal to external rotation of the ACL bundles (posterior ACL - TT: 2.7 ± 1.3 mm; TC: 2.6 ± 1.0 mm; CC: 4.0 ± 1.5 mm; P<0.001) within the non-dominant knee. The TNC rs1061494 TT and COL12A1 rs970547 AA genotypes, together with male sex explained 26% of the variance in external rotation of the dominant leg. Within the dominant leg, these two genotypes, together with COL1A1 genotypes and body mass explained 26% of the variance in internal rotation, while only the TNC genotype together with COL1A1 genotypes, sex and BMI explained 28% of the variance in slack.

CONCLUSION: These findings suggest that COL12A1 and TNC genotypes are associated with internal-external rotation of the dominant knee in healthy individuals, while the TNC genotype is associated with ACL length changes in the non-dominant knee. Taken together, it is reasonable to propose that loading conditions may potentially impact the ACLs length during internal to external rotation and that an individual's genetics may play a partial role in this response.

ARE COMMERCIAL GENETIC INJURY TESTS PREMATURE?

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INTRODUCTION: Several direct-to-consumer (DTC) genetic testing companies have emerged that claim to be able to test for susceptibility for musculoskeletal injuries. Although there are several publications on the emergence of this industry, none have critically evaluated the evidence for the use of genetic polymorphisms in commercial tests. The aim of this review was to identify, where possible, the polymorphisms and to evaluate the current scientific evidence for their inclusion.

METHODS: Companies that market DTC genetic tests for risk of exercise-associated injuries were identified. The product, genes tested and claims about the test were extracted directly from the company's webpage and/or the sample report the company has placed in the public domain. A review of the literature was performed for the major identified polymorphism included in the commercial tests.

RESULTS: The most common polymorphisms included COL1A1 rs1800012, COL5A1 rs12722 and GDF5 rs143383. The current evidence suggests that it is premature or even not viable to include these three polymorphisms as markers of injury risk. A unique set of injury specific polymorphisms, which do not include COL1A1, COL5A1 or GDF5, identified from genome-wide association studies (GWAS) is used by one company in their tests for thirteen sports injuries. However, of the 39 reviewed polymorphisms, 22 effective alleles are rare and absent in African, American and/or Asian populations. Even when informative in all populations, the sensitivity of many of the genetic markers was low and/or have not been independently validated in follow-up studies.

CONCLUSION: Therefore, the current evidence suggests it is premature to include 36 of the reviewed polymorphisms identified by a GWAS approach in commercial genetic tests. However, the association of MMP7 rs1937810 with Achilles tendon injuries, and SAP30BP rs820218 and GLCCI1 rs4725069 with rotator cuff injuries should be further investigated. Based on current evidence it remains premature to market any commercial genetic test to determine susceptibility to musculoskeletal injuries.

PREDICTING NON-CONTACT ANKLE SPRAINS THROUGH ASSESSMENT OF ASYMMETRICAL LOWER-LIMB FUNCTIONAL PERFORMANCE: A PROSPECTIVE STUDY WITH 318 YOUTH TAEKWONDO ATHLETES

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INTRODUCTION: The ankle sprain is the most common type of non-contact injury in Taekwondo [1,2]. Due to the unilateral nature of Taekwondo kicks, inter-limb asymmetries in the lower extremities may develop in the long-term training and competition [3]. The use of inter-limb asymmetries in tests such as the unilateral jump tests and the Star Excursion Balance Test (SEBT) has been widely reported in predicting non-contact sport injuries [4,5]. Evaluating the risk of non-contact ankle sprains in youth Taekwondo athletes through inter-limb asymmetries in the performance of these commonly used and easily accessible tests would be of great value. Thus, this study aimed to examine the relationship between inter-limb asymmetries in the jump tests and SEBT performance and non-contact ankle sprains in youth Taekwondo athletes.

METHODS: 318 male youth Taekwondo athletes, aged 6-17, participated in this prospective study. Baseline assessments were performed to determine inter-limb asymmetries in the single-leg countermovement jump, hop, triple-hop test, and SEBT. The athletes were then followed for a period of 12 months to record any incidents of non-contact ankle sprain injuries.

RESULTS: A total of 23 athletes suffered from a non-contact ankle sprain injury during the study. Athletes with higher inter-limb asymmetry in single-leg countermovement jump height showed a significantly increased risk of non-contact ankle sprain (odds ratio [OR] for 1% increase in asymmetry, 1.051; 95% Confidence Interval [CI], 1.017-1.085; p = 0.003). An asymmetry of 14.16% in single-leg countermovement jump height was found to be a cut-off point for evaluating the risk of non-contact ankle sprain in female youth Taekwondo athletes (asymmetry □14.16% vs. <14.16%: OR, 5.130; 95% CI, 2.002-13.143; p = 0.001).

CONCLUSION: Inter-limb asymmetry in single-leg countermovement jump performance can be used to predict non-contact ankle sprains in male youth Taekwondo athletes. Proper evaluation of such asymmetries has the potential to enhance injury prevention strategies for youth athletes participating in sports.

Conventional Print Poster

CP-PN22 Physiology IV

SEX DIFFERENCES IN EXOGENOUS GLUCOSE OXIDATION FOLLOWING AN ORAL GLUCOSE TOLERANCE TEST IN HEALTHY ACTIVE ADULTS

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INTRODUCTION: Females have been reported to have blunted exercise-induced improvements in insulin sensitivity in response to a 75g oral glucose tolerance test (OGTT) compared to males. However, providing the same absolute dose of glucose to males and females typically results in a larger relative glucose dose in females when normalized to body surface area, body mass, or fat-free mass, which may complicate interpretations of sex-comparative studies in exercise metabolism. Furthermore, the measurement of blood glucose during the OGTT only reflects glucose clearance from the blood and not its metabolic fate. Enriching a 75g OGTT with a 13C-labelled stable isotope tracer allows for the measurement of glucose oxidation via breath sampling, which can provide insight into the impact of exercise or inactivity on the metabolic fate of orally ingested glucose. To enhance our understanding of the relationship between sex and postprandial glucose metabolism in response to an OGTT, this project aimed to characterize blood glucose concentration and glucose oxidation during an OGTT in healthy males and females.

METHODS: Males (n=10; 24±5 yr; 72±9 kg; 22±2 kg/m2) and females (n=9; 24±7 yr; 61±7 kg; 22±2 kg/m2) completed an at-home metabolic trial via Zoom. Following 3 days of physical activity monitoring and a 12 h overnight fast, participants consumed a 75g OGTT enriched with 75mg (0.1%) [U-13C6] glucose tracer. Breath samples and finger-stick capillary glucose measurements were collected while fasted, and every 30 min postprandially for 3 h. Breath samples were analyzed for 13CO2 enrichment via isotope-ratio mass spectrometry (IRMS). Estimated carbon dioxide production (VCO2) was used to determine exogenous glucose oxidation, expressed as cumulative percent dose recovery (PDR) of the 75g glucose drink.

RESULTS: Blood glucose (peak, mean, and area under the curve) during the OGTT was not different between males and females ($p>0.05$). Interestingly, females exhibited greater exogenous glucose oxidation than males, with a PDR at 3h of 62.0±12.3% versus 48.8±6.5% in males ($p=0.008$). Neither postprandial mean blood glucose nor glucose oxidation were related to total body mass ($r=0.1$-0.2, $p>0.05$), lean mass ($r=-0.2$-0.3, $p>0.05$), body surface area ($r=-0.2$-0.3, $p>0.05$), pre-trial step count ($r=-0.1$-0.3, $p>0.05$) or moderate-to-vigorous physical activity ($r=-0.2$-0.3, $p>0.05$).

CONCLUSION: Despite similar postprandial blood glucose concentrations in response to a 75g OGTT between sexes, females oxidize a greater amount of ingested glucose than males over 3 hours of recovery. Sex differences in glucose oxidation could not be explained by differences in body anthropometrics or pre-trial physical activity. These results may be important to consider when designing sex-comparative studies investigating the effects of exercise on postprandial glucose metabolism.

SUB-MAXIMAL OXYGEN CONSUMPTION ENHANCED BY 4 WEEKS OF HIGH-INTENSITY TRAINING WITH BLOOD FLOW RESTRICTION

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INTRODUCTION: Blood Flow Restriction (BFR) training consists of exercising with inflated pressure cuffs to occlude venous return and limit oxygen delivery to the muscle [1]. Improvements in central and peripheral adaptations have been evidenced following high-intensity interval training (HIIT) combined with BFR [2]. However, cardiorespiratory adaptations during submaximal exercise following HIIT+BFR are poorly documented. Thus, this study aimed to determine if HIIT+BFR is effective in enhancing sub-maximal cycling efficiency.

METHODS: 25 participants (11 females, 14 males; 19 ± 7 years old; 175 ± 8 cm; 67 ± 8 kg) were trained 3 times a week for 4 weeks with BFR at different levels of occlusion (G1 = 20 mmHg (SHAM); G2 = 40% Limb Occlusion Pressure (LOP); G3 = 60% LOP). Training consisted of 4 to 7 cycling bouts of 90s HIIT+BFR performed at 90% of VO2max, interspersed with 2 min recovery bouts, with deflated cuffs. Pre-and post-training VO2max, Gas Exchange Threshold (GET) and Respiratory Compensation Point (RCP) were assessed. Pre-and post-submaximal responses were assessed during 10 min at baseline (BL; i.e. 50w for females, 100w for men), 6 min at moderate (MOD; i.e. BL+50%(GET – BL)), 10 min at BL, and 6 min at heavy (HEV; i.e. GET+20%(RCP – GET)) intensities. Filtered and averaged last 2 min of each bout were compared using mixed ANOVA and post hoc analysis.

RESULTS: Despite having no effect on VO2max, HIIT+BFR had an effect on submaximal respiratory data only for G3, with a significant decrease of VO2/kg during the first BL (G3: 20.3 ± 2.3 vs 17.3 ± 2.8 mL/min/kg, $p < 0.01$), and the second BL

bout of the sub-maximal test (G3: 20.2 ± 2.9 vs 17.9 ± 2.9 mL/min/kg, $p < 0.05$). Training also decreased VCO2 for G3 on the first (G3: 1.3 ± 0.2 vs 1.1 ± 0.2, $p < 0.01$) and the second BL bouts (G3: 1.2 ± 0.3 vs 1.1 ± 0.2, $p < 0.05$), but increased VCO2 for HEV bout (G3: 2.7 ± 0.6 vs 2.9 ± 0.6 L/min, $p < 0.05$).

CONCLUSION: 4 weeks of HIIT+BFR was sufficient to increase the sub-maximal cycling efficiency only for G3 by reducing VO2 and VCO2 at baseline intensity. The application of greater pressure probably increased the blood pooling in the muscles and the metabolites accumulation [3]. Thus, these findings highlight the utility of using higher pressures for BFR, particularly when training is performed at high intensity.

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EFFECT OF AT-HOME BODYWEIGHT INTERVAL EXERCISE BEFORE OR AFTER BREAKFAST ON POSTPRANDIAL GLYCEMIA, AND POST-EXERCISE PERCEPTIONS OF APPETITE AND FAT OXIDATION IN FEMALES

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INTRODUCTION: Bodyweight interval exercise (BWE) is a form of interval training that can be performed without specialized exercise equipment or facility access. It has been demonstrated that performing BWE at home 3 times per week for 12 weeks improves cardiorespiratory fitness (1); however, the physiological response and metabolic health benefit of a single session of at-home BWE is not well characterized. Considering that nutrient provision around exercise can modify physiological responses to exercise (2), characterizing the effect of low-volume BWE performed before vs. after a meal may increase translation to real-world settings. The purpose of this study was to investigate the effects of a single session of at-home BWE, performed before or after breakfast, on postprandial glycemia and post-exercise perceptions of appetite and fat oxidation.

METHODS: In a randomized and counterbalanced order, 12 females (age: 23±2 yr; BMI: 22±2 kg/m2) completed two virtually monitored trials in the follicular phase of the menstrual cycle. Participants followed a pre-recorded exercise video at home involving 10 x 1-min whole-body exercises, interspersed with 1-min recovery, either 5 min before (EX-FED) or 10 min after (FED-EX) a liquid mixed-macronutrient breakfast (470kcal). Heart rate (HR) and rating of perceived exertion (RPE) were measured during exercise, and capillary blood samples were obtained every 15 min for 2 h postprandial. A portable breath analyzer (Lumen©) and visual analog scales measured fat oxidation and perceptions of appetite during 3 h of exercise recovery, respectively.

RESULTS: There was no difference in exercise-induced mean HR (85 ± 5% HRmax) or RPE (14 ± 2) between FED-EX and EX-FED ($p>0.05$). Postprandial glucose concentration was lower in FED-EX vs. EX-FED at 30 min (6.4 ± 1.1 vs. 7.8 ± 1.2 mmol/L; $p<0.01$) and 45 min (5.9 ± 0.7 vs. 7.1 ± 1.1 mmol/L; $p<0.05$), and increased significantly from baseline in EX-FED (7.8 ± 1.2 vs. 5.3 ± 0.45 mmol/L; $p<0.0001$) but not FED-EX (6.4 ± 1.2 vs. 5.5 ± 0.68 mmol/L; $p>0.05$). Perceptions of appetite were also lower in FED-EX vs. EX-FED at pre-exercise (20.25 ± 12.55 vs. 55.77 ± 19.85 mm, $p<0.001$), post-exercise (25.15 ± 15.61 vs. 47.08 ± 18.19 mm, $p<0.05$) and cumulatively over the 3.5 h trial as reflected by a more negative AUC for overall appetite perceptions (-87.63 ± 58.51 vs. -42.06 ± 34.96 mm, $p<0.05$). Compared to pre-exercise, fat oxidation was transiently elevated 0-30 min post-exercise (4.03 ± 0.37 vs. 4.29 ± 0.33 %CO2, $p<0.05$), but was not different between conditions.

CONCLUSION: Performing at-home BWE after, compared to before, breakfast lowers postprandial glycemia and perceptions of appetite in healthy inactive females. These findings suggest that performing exercise after rather than before a meal may optimize the acute metabolic health benefits of exercise.

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CHANGES IN TEMPERATURE AND PH INFLUENCES THE EFFICIENCY OF MUSCLE MITOCHONDRIA IN MICE

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INTRODUCTION: It is well known that there is a decline in exercise efficiency during moderate to high intensity exercise. The cellular energetics and homeostasis are challenged during exercise, which is considered to influence the efficiency of the mitochondrial oxidative phosphorylation. However, the mechanism behind the loss of efficiency within the exercising muscles during exercise is not fully understood. We know that the temperature in the exercising muscle increases during exercise while the pH decreases.

Therefore the aim of the present study was to examine how increased temperature and decreased pH influences the mitochondrial efficiency and respiratory capacity in isolated mitochondria from the quadriceps muscle of wild type mice.

METHODS: Mice were euthanized at 12-16 weeks of age, and the quadriceps muscle was extracted, and then homogenized for isolation of mitochondria (n= 10). The measurements of the mitochondrial respiration were conducted using High Resolution Respirometry (Oxygraph-2k; Oroboros, Innsbruck, Austria) with four different temperature and pH settings: 1. 37°C, 7.4 pH, 2. 37°C, 6.8 pH, 3. 40°C, 7.4 pH and 4. 40°C 6.8 pH.

Mitochondrial efficiency was estimated by determining the ratio between the amount of ATP produced per oxygen atom reduced, also termed the P/O ratio. The protocol for the isolated mitochondria consisted of pyruvate (5 mmol/l) + malate (2 mmol/l) (state 2) followed by a small non-saturating amount of ADP (200 µmol/l) to determine the P/O ratio. When the flux rates reached baseline levels (state 4), a saturating concentration of ADP (5 mmol/l) and Mg (3 mmol/l) was added. A two-way ANOVA was performed to test for the effect of temperature and pH.

RESULTS: The study showed that a combination of increased temperature and decreased pH resulted in a significant lower P/O ratio ($p<0.05$) and a significantly higher state 2 and 4 leak respiration ($p<0.0001$ and $p<0.001$) in the isolated mitochondria. However, the change in temperature itself did not affect the P/O ratio significantly. The increased temperature did result in an increased leak respiration during state 2 ($p<0.01$). Furthermore, the P/O ratio and leak respiration was not significantly affected by the lower pH.

CONCLUSION: According to the results, the efficiency of the mitochondrial oxidative phosphorylation seems to be affected by a combination of an increased temperature and a decreased pH, which is the same homeostatic alterations that happens in the muscles during exercise. Though several other homeostatic perturbations occur in muscle cells during exercise, these findings suggest that mitochondrial efficiency seems to decline during exercise, which may play a role in the decline in exercise efficiency.

CROSS-VALIDATION OF A NEW GENERAL POPULATION RESTING METABOLIC RATE PREDICTION EQUATION BASED ON BODY COMPOSITION

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INTRODUCTION: Current prediction equations for resting metabolic rate (RMR) validated in a relatively small sample with high-individual variance. This study determined the accuracy of five common RMR equations and proposed a novel prediction equation, including body composition.

METHODS: A total of 3,001 participants (41±13y;BMI 28.5±5.5kg/m2;48% males) from nutrition clinic in Israel were measured by indirect calorimetry to assess RMR. Dual-energy X-ray absorptiometry used to evaluate fat mass (FM) and free-fat mass (FFM). Accuracy and mean bias were compared between the measured RMR and the prediction equations. A random training set (75%, n=2,251) and a validation set (25%, n=750) were used to develop a new prediction model.

RESULTS: All the prediction equations underestimated RMR. The Cunningham equation obtained the largest mean deviation [-16.6%;95% level of agreement (LOA) 1.9,-35.1], followed by the Owen (-15.4%;95% LOA 4.2,-22.6), Mifflin-St. Jeor (-12.6;95% LOA 5.8, -26.5), Harris-Benedict (-8.2;95% LOA 11.1,-27.7), and the WHO/FAO/UAU (-2.1;95% LOA 22.3,-26.5) equations. Our new proposed model includes sex, age, FM, and FFM and successfully predicted 73.5% of the explained variation, with a bias of 0.7% (95% LOA -18.6,19.7).

CONCLUSION: This study demonstrates a large discrepancy between the common prediction equations and measured RMR and suggests a new accurate equation that includes both FM and FFM.

MEASURED AND PREDICTED RESTING METABOLIC RATE OF PARALYMPIC ATHLETES

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INTRODUCTION: Resting metabolic rate (RMR) is an important determinant of daily energy expenditure. In Paralympic athletes, resting metabolism may be affected by a unique body composition, missing or inactive body parts, and neurological conditions. This study aimed to assess the RMR and its potential predictors in Paralympic athletes. Secondly, we evaluated the level of agreement between athletes' measured and predicted RMR.

METHODS: In this cross-sectional study, the RMR of 67 Paralympic male (n=37) and female (n=30) athletes competing in various sports was assessed. Disabilities that may affect RMR included spinal cord injury (n = 22), neurological disorders (n = 8) and spasms (n = 16). RMR was assessed by ventilated hood indirect calorimetry, body composition was assessed by dual energy X-ray absorptiometry and a fasted blood sample was collected by venipuncture. Multiple regression analyses were conducted with measured RMR as dependent variable and based on previous literature, age, fat free mass, blood concentrations of triiodothyronine (T3) and thyroxine (T4), the presence of a spinal cord injury, neurological condition and spasms as independent variables. Furthermore, measured RMR was compared with estimated RMR according to commonly used prediction equations (including revised Harris and Benedict (H&B), Cunningham, Schofield, and others) and prediction equations developed for spinal cord injury patients (Chun and Nightingale). Differences between measured and predicted RMR were analyzed by Bland-Altman analysis, individual accuracy, and intraclass correlation (ICC).

RESULTS: The age, height, body mass and fat free mass were 29±10 y, 1.62±0.19 m, 63.1±11.2 kg and 43.9±7.3 kg for females, and 26±8 y, 1.71±0.20 m, 69.7±14.5 kg and 55.5±10.5 kg for males, respectively. The measured RMR was 1386±258 and 1686±302 kcal/day for females and males, respectively. Regression analysis identified fat free mass, T3 concentration and the presence of a spinal cord injury as the main predictors of RMR (adjusted $R2=0.71$; $F=50.3$; $p<0.001$).

Despite minor proportional bias (r=-0.220; p=0.009), the Chun equation scored best on accuracy (63% of individuals within 10% of measured RMR), had a good reliability (ICC 0.79) and a low bias and limits of agreement (-67 kcal; -433.9 to 300.2 kcal) compared with measured RMR. Also, the H&B equation, based on weight instead of fat free mass, predicted RMR with small bias (13 kcal), good reliability (ICC 0.77), but slightly higher limits of agreement (-369.1 to 395.6 kcal) and less individual accuracy (56% of individuals within 10% of measured RMR) compared with the Chun equation.

CONCLUSION: In conclusion, fat free mass, T3 concentration and the presence of a spinal cord injury are the main predictors of RMR in Paralympic athletes, accounting for 71% of the variance in measured RMR. Both the Chun and the H&B equations show good agreement with the measured RMR, and should therefore be considered the preferred prediction equations for the RMR of Paralympic athletes.

EXOGENOUS LACTATE AUGMENTS EXERCISE-INDUCED IMPROVEMENT IN MEMORY BUT NOT IN HIPPOCAMPAL NEUROGENESIS

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INTRODUCTION: Adult hippocampal neurogenesis (AHN), the lifelong process of formation of new neurons in brain, plays an important role in learning and memory. Therefore, promoting AHN is considered a substantial way to prevent or ameliorate cognitive deficits, which is important for improving the quality of life. Exercise substantially promotes AHN; however, the molecular mediators of exercise-induced AHN are unknown. Notably, lactate was considered as a key mediator of exercise-induced AHN. Therefore, we hypothesized that exercise with lactate intake could augment exercise-induced AHN.

METHODS: This study conducted for 5 weeks with 7-week-old ICR male mice and was comprised two independent experiments. Experiment 1 (n=9 per group) was mainly for biochemical analysis, immunoblotting (IB) and immunohistochemistry (IHC), and experiment 2 (n=8 per group) was for behavioral analysis, Y-maze test and Radial arm maze (RAM). Mice were randomly divided into four groups: sedentary without lactate intake (vehicle, VEH), sedentary with lactate intake (LAC), exercise without lactate intake (EXE+VEH) and exercise with lactate intake (EXE+LAC). 3g/kg of sodium lactate was orally administrated. Lactate administration and exercise training was conducted 5 times per week. EXE+LAC were administrated lactate immediately after every exercise training. Exercise training was performed at moderate intensity (60 %VO2max) using treadmill. At the end, Y-maze test and RAM was performed to measure spatial working memory and reference & retention memory respectively. From dissected hippocampus, neurogenesis and expression of AHN-relevant proteins were evaluated by IHC and IB respectively.

RESULTS: From results of IHC, cell proliferation (Ki67+) of LAC tended to increase compared to that of VEH (p=0.064) and neuronal differentiation (DCX+) of LAC significantly increased compared to that of VEH (p=0.03). However, there was no difference between EXE+VEH and EXE+LAC in Ki67+ and DCX+. From results of RAM, performance of the task of EXE+LAC was significantly improved most rapidly. Furthermore, the improved reference memory was significantly retained only in EXE+LAC. Also, from results of Y-maze, the spatial working memory was significantly improved only in EXE+LAC. From results of IB, expression of AHN-relevant hippocampal FNDC5 of EXE+LAC was significantly enhanced compared to that of EXE+VEH (p=0.007). Additionally, hippocampal BDNF, PGC1α, and MCT2 expression of EXE+LAC was higher than that of EXE+VEH by 20%, 9%, and 19%, respectively (but not statistically significant).

CONCLUSION: Our study shows that exercise with lactate did not augment exercise-induced AHN. Nevertheless, the co-treatment augmented exercise-induced improvement in memory. Furthermore, AHN-relevant hippocampal proteins were effectively upregulated by the co-treatment. Therefore, we suggest that lactate has a potential to be developed as a novel supplement that improves the positive effects of exercise on the hippocampus and memory.

THE INDIVIDUAL AND COMBINED EFFECTS OF EXERCISE AND THREE CONSECUTIVE NIGHTS OF PARTIAL SLEEP DEPRIVATION ON EXECUTIVE FUNCTIONS

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INTRODUCTION: Partial sleep deprivation (PSD) has been shown to impair executive function (EF) performance in humans [1]. Conversely, moderate-intensity exercise (MIE) has an ergogenic effect on acute EF performance. However, the potential for MIE to ameliorate any impairments in EF after PSD has not been thoroughly investigated. Therefore, this study examined the individual and combined effects of PSD and MIE, on acute EF performance.

METHODS: In a randomised control crossover study, twelve healthy adults (7 males, 5 females) [mean ± SD, age: 23 ± 2 years; height: 170.8 ± 11.3 cm; mass: 66.2 ± 10.1 kg; body mass index 22.6 ± 2.2 kg·m-2; VO2max 42.1 ± 6.8 ml·min·kg-1] undertook four experimental trials. Before and after 3-nights of PSD (< 5-hours per night) and a control condition (~8 hours in bed), with a > 7-day wash out. Throughput (response rate score which integrates accuracy and reaction time) was assessed at rest, and after 20-mins of MIE (~45 % VO2max) in each trial using a computer based EF test battery. Mood and sleepiness were assessed pre and post exercise. Cerebral oxygenation and cardiorespiratory variables were collected throughout. Plasma cortisol was also collected upon the completion of each trial. Actigraphy and sleep diaries were used to record sleep parameters. Paired sample T-tests were used to assess sleep differences between the PSD and control conditions. Throughput, haemoglobin, oxyhaemoglobin, deoxyhaemoglobin, and cortisol were analysed using a 2

(Sleep status: Control, PSD) x 2 (Activity: Resting, Exercise) repeated measures ANOVA, exploring main effects and interactions. Statistical significance was set at $P < 0.05$ and data are presented as mean ± SD.

RESULTS: Participants slept less (123 ± 39 min), and spent less time in bed (172 ± 37 min) during PSD ($P < 0.001$). Of the EF tests, only the 2-choice reaction time task at rest (Control: 150.3 ± 14.7, PSD: 143.6 ± 12.7; $P = 0.02$) was reduced after the PSD. Regardless of condition, an increase in Throughput was observed in all 6 EF tests after MIE (all $P < 0.05$). Cerebral total haemoglobin, oxyhaemoglobin, and deoxyhaemoglobin increased after MIE in both conditions ($P < 0.05$). Cortisol was significantly reduced following MIE ($P = 0.011$), but did not differ after PSD. Sleepiness increased with the PSD protocol at rest ($P < 0.001$) and returned to baseline values with MIE. PSD reduced perceived vigour and increased perceived fatigue, however both were reversed with MIE.

CONCLUSION: These novel findings suggest that, regardless of sleep status, MIE appears to improve acute EF performance. Further research is needed to determine the (psycho)physiological mechanisms mediating these improvements.

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CP-BM18 Biomechanics

COEFFICIENT OF FRICTION BETWEEN SLIP RESISTANT SAFETY SHOES AND DIFFERENT TYPES OF FLOORS

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INTRODUCTION: The surface we walk on has a great impact on how we walk. One of the most important factors is the friction between the shoes and the surface. A lack of friction can cause a slip which challenges the balance. In the worst case, a slip can lead to fall and cause an injury [1]. Friction is influenced both by the shoes and the surface, which means that the best shoe on a hard concrete floor may not necessary the best shoe on a carpet. In occupational settings, safety shoes are often mandatory to meet the workplace specific safety regulations and are often characterized by an anti-slip outer sole [2]. Safety shoes are often tested with a SRA standard where the shoes outsole is tested on a ceramic tile with soap solution, or a SRB standard where it is tested on a steel plate with glycerin, the effects of other floor types and the safety shoe's friction needs to be investigated.

METHODS: A modified British Pendulum [3] was used to collect friction data between a safety shoe and tree different type of surface (carpet, linoleum, and metal) each of these with different hardness and elasticity. Kinetic data was collected at 1000 Hz using a force plate (AMTI, OR6-7-1000, Advanced Mechanical Technology, Inc. Watertown MA, USA). When testing the angle of the shoe was adjusted to simulate a toe off event with a plantar flexion of 30 degrees relative to the force plate at initial contact.

RESULTS: The highest friction was found between the safety shoe and the carpet (coefficient of Friction (CoF): 1.04±0.11, velocity: 2.36±0.14 m/s) the second highest friction was found between the safety shoe and linoleum (CoF: 0.99±0.10, velocity: 3.50±0.29 m/s), and the lowest friction was between the safety shoe and metal (CoF: 0.84±0.03, velocity: 2.85±0.08 m/s).

CONCLUSION: There were trends towards differences in CoF with the lowest value reported for metal, but the velocity differed among the three surfaces. Still our findings point at potential differences in friction that can increase the risks of slips and trips even when slip-resistant safety shoes are used. Future studies are needed to confirm these findings.

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EFFECTS OF IMMEDIATE FEEDBACK ON TACKLE TECHNIQUE IN RUGBY USING 3-DIMENSIONAL MOTION ANALYSIS: A CASE STUDY

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INTRODUCTION: Rugby is a collision sport in which players incur many more injuries of the head, neck, and shoulders than in other sports. The majority (>50%) of injuries in rugby union occur during the tackle. Proficient tackling ability can play a role in injury prevention. Player and coach education on correct tackle techniques have been used as a preventative measure for reducing tackle injuries. It's suggested that feedback tools (post-hoc video analysis and real time verbal coaching feedback) during tackle practice be implemented to ensure correct body positioning. Therefore, the aim of this

study was to investigate effect of immediate feedback and clarifying focus points with coach on tackle technique while presenting a video by 3-demensional motion analysis system in each trial.

METHODS: The participants were 2 rugby union players, Participant A (PA); BKs, Age:19, Hight 178cm, weight 83kg, Participant B (PB); Position: BKs, Age:21, 177cm, 80kg. Participants were instructed to perform their usual tackles to tackle-bag at full contact speed. Ten trials were performed each participant. PA was shown the video of the trials after each trial for feedback by himself, and a coach also gave him feedback of each trial. Then a focus point in the next trial was decided by PA and the coach. PB, on the other hand, was shown the video of the trial for feedback by just himself, and no feedback and instruction or focus points of the next trial were given by the coach. Trials were recorded by the tackling motions using an infrared motion-capture system. Eleven synchronized infrared cameras were placed around a 10 × 10–m2 field to provide an unobstructed 360° view of the subject. Forty-one reflective markers were placed onto the subjects body surface. Kinematic variables were analyzed the trunk lean angle (TLA), neck joint extension angle (NJEA), the shoulder rotation angle (SRA) and knee joint flexion angle (KJFA).

RESULTS: Kinematic variables for PA were 86.3 ° for TLA, -26.4 NJEA, 58.8 ° for SRA and 109.4 ° for KJFA in the first trial, then the kinematic variables were changed in the 10th trial such as, 85.3 ° for TLA, -4.9 ° for NJEA, 81.8 ° for SRA and109.4 ° for KJFA. Some focus points were improved in the last trial. Feedback from coach made PA clarify the focus points, (1) lower shoulder hit area by bending knee in front foot, (2) head up, and (3) reaching arms for binding. Kinematic variables for PB were 71.2 ° for TLA, -35.7 ° for NJEA, 97.4 ° for SRA and 79.5 ° for KJFA in the first trial. The kinematic variables were change in the 10th trial such as, 65.7 ° for TLA, -26.8 ° for NJEA, 90.6 ° for SRA and123.0 ° for KJFA. The tackle technique for PB was changed inconsistently.

CONCLUSION: Immediate feedback using video footage can be useful for players to recognize own performance. In addition, feedback or instruction from coach intend to make players more focus on the target clearly. It is sometimes hard to identify the problem or points to work on by only players.

VELOCITY PATTERN OF NATIONAL LEVEL FEMALE ATHLETES OF BANGLADESH IN 200M SPRINT

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INTRODUCTION: During running competition an athlete cannot maintain uniform speed throughout the course in spite of his best possible effect. Velocity pattern indicates the change of velocity at different phases of a race. Purpose of the present study was to analyze the velocity pattern of 200m sprint for National level female junior athletes of Bangladesh.

METHODS: Ten junior national level sprinters attending national coaching camp were selected as subjects. The total running distance of 200m was divided into eight equal zones of 25m each. Mean zonal times of all the eight zones for the subjects were measured. From (Distance-time) information of different zones, zonal velocities were calculated and velocity-distance curve was developed for the 200m race. Velocity pattern of the junior level female sprinters for 200m race was analyzed.

RESULTS: Results indicated that mean zonal velocity increased from start and the maximum zonal velocity was achieved during (100-125) m zone. Thereafter the zonal velocity gradually decreased for the rest part of the race. The reduction in locomotion velocity was about 10% of the maximum.

CONCLUSION: This decrease in velocity in later part of the race might be due the lack of sprint endurance of the athletes. So, the results of this study may be used as diagnostic factors for 200m sprint performance of the subjects.

HOME OFCE VERSUS ERGONOMIC WORKSTATION - IS THE ERGONOMIC RISK INCREASED WHEN WORKING AT THE DINING TABLE? AN INERTIAL MOTION CAPTURE BASED PILOT STUDY

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INTRODUCTION: In order to reduce the risk of infection with Sars-Cov-2, work practices have been shifted to the home ofce in many industries. The frst surveys concerning this shift indicate an increase in musculoskeletal complaints of many employees. The aim of this study was to compare the ergonomic risk in the upper extremities and trunk of working in a home ofce with that of working in an ergonomically optimized workplace.

METHODS: For this purpose, 20 subjects (13w/7m) aged 18–31 years each performed a 20-minute workplace simulation (10 min writing a text, 10 min editing a questionnaire) in the following set up: on a dining table with dining chair and laptop (home ofce) and on an ergonomically adjusted workstation (ergonomically optimized workplace). The subjects were investigated using a combined application of a motion capture kinematic analysis and the rapid upper limb assessment (RULA) in order to identify diferences in the ergonomic risk.

RESULTS: Signifcantly reduced risk values for both shoulders (left: $p<0.001$; right: $p=0.02$) were found for the ergonomically optimized workstations. In contrast, the left wrist ($p=0.025$) showed a signifcantly reduced ergonomic risk value for the home ofce workstation.

CONCLUSION: This study is the frst study to compare the ergonomic risk between an ergonomically optimized work-

place and a home ofce workstation. The results indicate minor diferences in the upper extremities in favor of the ergonomically optimized workstation. Since work-related musculoskeletal complaints of the upper extremities are common among ofce workers, the use of an ergonomically optimized workstation for home use is recommended based on the results.

ASYMMETRY INDEX OF KNEE EXTENSORS USING PEAK TORQUE VERSUS ANGLE-SPECIFIC ANALYSIS IN HEALTHY SUBJECTS

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INTRODUCTION: Isokinetic dynamometry remains the gold standard of strength assessment in clinical practice, sports or research settings. Previous studies have already underlined that conventional analyses of torque-angle relation strongly reduce the continuous data recorded during anisometric contractions to single values (e.g. peak torque), may lead to a loss of information [1] and may neglect the impact of joint position (angle) on torque production. Furthermore, strength deficits in patients may be increased in a particular range of motion (ROM) in comparison with peak torques [2]. However, asymmetry indexes (AI) are still calculated with peak torque in clinical practice [3] and angle-specific analysis are only practiced in research field [4]. The aim of the study was to compare the two approaches in order to question the method of evaluation of AI. We hypothesized that knee extensors AI in healthy subjects will be reduced using peak torque compared with angle-specific analysis.

METHODS: Sixty-seven healthy trained volunteers (35 women and 32 men) performed 5 maximal voluntary contractions of knee extensors in concentric and eccentric mode at 2 different angular speeds (30 and 60°/s) with right and left lower limb. Dynamic phase of the contraction was systematically preceded by a 1 s isometric maximal pre-activation and 35 s of rest were given between each trial. A classical AI was calculated for each participant with values of peak torque (AIp). A moving AI at each measuring point (e.g. 2 kHz frequency) was also calculated (AIm). The median value of AIm was computed and the proportion of ROM with Aim higher than AIp was calculated for each angular speed. After normality distribution check with Shapiro-Wilk test, paired Student's t-tests were used.

RESULTS: For 70 to 73 % of the ROM studied (e.g. 5° to 85°), AIm was greater than AIp. AIm was systematically increased from the angle at peak torque to 5° knee flexion, regardless of the contraction mode and angular velocity. The median value of AIm was significantly higher than AIp (between +38% to +61% depending on the angular speed), ($p < 0.001$).

CONCLUSION: Inter-limb strength asymmetry is a key outcome used by clinicians to guide the rehabilitation process and help in return to sport decision [3]. Our findings highlight that classical calculation of AI in clinical practice may strongly underestimate strength deficits between limbs given that angle at peak torque for knee extensors is part of the ROM at which AI are the more reduced in healthy subjects (e.g. between 55 to 70°). A moving AI through the full range of motion may allow to evaluate more precisely subjects or patients capacities without further testing procedure, but only by exploiting the usual recorded data during anisometric contractions.

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TOWARDS A NEW METHOD FOR EVALUATING IN VIVO HEAD KINEMATICS MEASURED BY INSTRUMENTED MOUTHGUARDS: A LABORATORY PROCEDURE FOR TIME-SYNCHRONISING WITH 3D MOTION CAPTURE

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INTRODUCTION: Instrumented mouthguards (iMG) are often validated against a reference sensor using a mechanical impactor and dummy headform. However, the testing conditions used do not represent the head kinematics experienced on-field. In vivo comparisons of the head kinematics measured from iMG and 3D motion capture systems (mocap) will aid in contextualising on-field measurements and in determining the signal characteristics of true- and false-positive head impacts. To permit a like-for-like comparison, development of an iMG-mocap time-synchronisation method is necessary. We aimed to assess the agreement in the relative timing of signal peaks between simultaneously measured iMG and mocap signals.

METHODS: Two participants wore custom-moulded iMGs (PROTECHT, SWA, UK) which were tightly coupled to the upper dentition. A mocap system (T20, Vicon, UK; 250 Hz) tracked the 3D displacement of a 14 mm reflective marker attached to the end of a rigid metal rod (100 mm length, 6 mm diameter). Sixteen trials of 10 rod-to-iMG impacts were recorded (N=160 impacts) with the iMG continuously recording linear acceleration at 1000 Hz throughout each trial. An impact consisted of an experimenter moving the rod horizontally towards the mouth and contacting the iMG without any intentional deceleration, before returning to the start position. Each impact was separated by at least 5 s.

The iMG linear acceleration and marker displacement, velocity, and acceleration vector norms were calculated from their respective 3D arrays. All signals remained unfiltered and no marker trajectory gaps were present. Displacements were differentiated to velocity and acceleration using the first central difference method. The signal peaks for each impact were

identified using the findpeaks function in R (R Studio, US). The 'number of peaks' parameter was set to 10 and 'minimum distance between peaks' set to 4 s based on the protocol and visual inspection of traces. The time (s) period between signal peaks, T, was calculated for every consecutive pair of signal peaks, yielding 9 periods per 10 impacts in each signal. A total of 144 T values from 160 impacts were compared between the iMG and three mocap signals using Bland-Altman analysis.

RESULTS: The mean bias +/- 95% limits of agreement for iMG vs marker displacement, velocity and acceleration T values were -0.047 +/- 0.770 s, -0.026 +/- 0.353 s and -0.027 +/- 0.346 s, respectively. Paired t-tests revealed no differences in T for either signal comparisons (P>0.05).

CONCLUSION: The data indicate difficulties in accurately aligning iMG and mocap signals. The random error is likely a function of the iMG-rod impact protocol, the selection of analysed variables, and the algorithm used to identify signal peaks. Further work is needed to refine these aspects, whilst maintaining practicality. Method refinements will aid in standardisation of a procedure for time-synchronising iMG and mocap head kinematic signals for future research.

THE CHARACTERISTICS OF DISTRIBUTION OF VOLLEYBALL PASSING FOR SEVERAL DISTANCES

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INTRODUCTION: In human movement, movement errors must not be avoided. In the case of sports movement, it also applies such as baseball pitching, and soccer kicking. Although the accuracy had a trade-off with the movement speed, the relationship between accuracy and pass distance was not obtained. Volleyball passing required accuracy than pass speed, and passing accuracy would be much more important despite the distance. In addition, according to Masahiro et al. (2017), the 95% confidence ellipse pitching distribution was dependent on the pitching form. In this study, it would be tested whether similar location distribution occurs in volleyball passing.

METHODS: Subjects were 11 male volleyball players (height: 175.8 ± 6.4 cm, age: 20.2 ± 1.7 years old, experience: 8.2 ± 2.9 years) who have played volleyball more than 3 years. They passed the ball for 3, 5, 7, 9, and 11 m targets in front of them by forearm pass. All trials were 20 times for each distance. The ball trajectories of passes around the target area were captured as ball landing points with 3D DLT method. For the coordinate axes, the Y-axis was the passing direction, the X-axis was the vertical axis in Y-axis in the horizontal plane, and the Z-axis for the vertical direction. The landing points were defined at the lowest points. Comparison of the spread of variance across different passing distances was calculated by paired one-way

RESULTS: The distribution tended to increase as the passing distance increased. However, there was no significant difference ($p = 0.999$) between 3m (0.49 ± 0.04 m) and 5m (0.53 ± 0.03 m). The mean point of the ball landing was getting shorter (subject side) as the distance increased. Although the distribution of each axis (X and Y-axis), the Y-axis was significantly greater than the X-axis in 3m ($p < 0.001$), 5m ($p = 0.004$), and 7m ($p = 0,003$) trials, there was no significant difference between X and Y-axis in 9m and 11m trials.

CONCLUSION: There was no significant difference in the distribution between 3m and 5m trials. In volleyball, players usually practice for 5-6 m for the warming-up training. The 5m passing would be the most practiced distance in volleyball. In addition, the mean landing locations tended to shorten as the pass distance increased. In a real game of volleyball, the first touch passes the ball to the net direction, so it causes the point lost that the passing distance is getting too long. Players likely tended to shorten their passes to avoid them hitting the net. The Y-axis distribution of the pass location was not higher than that of the X-axis in the 9 and 11 m trials. Generally, the movement error spread the point of the movement direction. However, in volleyball forearm pass, the characteristics were not observed. From these results, volleyball players acquire unique control programs for passing the ball in specific game situations.

THE EFFECTS OF 12-WK DANCE-MOVEMENT THERAPY ON THE FUNCTIONAL CAPACITY AND SARCOPENIA PARAMETERS IN OLDER ADULTS

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INTRODUCTION: Exercise in older adults is essential for health because it preserves and maintains muscle mass and strength, which leads to improved functional capacity (1). Recent evidence (2,3) suggests that a very potent and enjoyable type of exercise for older adults is dancing because it can significantly improve many aspects of functional fitness as well as cognition. This study investigated the effects of 12-wk of dance-movement therapy (DMT), according to Laban and his students (4), on the physical capacity and sarcopenia parameters in older adults. Chosen DMT works with the functional connection of the whole musculoskeletal system (the coordination of movement) in conjunction with the emotional experience to perceive bodily signals.

METHODS: 29 healthy older individuals aged 65≥years (training group n=14, and control group n=15, sex and aged-matched) underwent 2 x wk for 12-wk a DMT for 60 mins.

Body composition - skeletal muscle mass (SMM) was measured by bioelectrical impedance (BIA) (InBody 720, Biospace Co., Ltd., Seoul, Korea), maximal upper - handgrip (HG) and lower body isometric (MVIC) strength by dynamometry (TKK5401; Takei Scientific Instruments Co., Ltd., Niigata, Japan and Humac NORM, CSMi, Stoughton, MA, respectively). Functional capacity was tested by gait speed and chair stand test. Ultrasound index of the loss of muscle mass associated

with sarcopenia (USI) and pennation angle (PA) were calculated using muscle architecture measured on the right vastus lateralis at 65% distal length (5) by ultrasound (Mindray M5).

RESULTS: By the end of the DMT, SMM, HG, MVIC, gait speed and chair stand test did not change significantly. However, USI significantly decreased in the DMT group and increased in the control group (absolute change difference of 0.40 vs -0.8). PA also significantly increased in the DMT group and decreased in the control group (absolute change difference of 0.40 vs – 0.71).

CONCLUSION: The present findings show that 12-wk of DMT does not affect functional capacity in healthy older people. However, DMT positively affects muscle architecture parameters, specifically USI, suggesting a protective effect on age-related sarcopenia.

SYNTHETIC FEATHER VS WATERFOWL FEATHER SHUTTLECOCKS: DIFFERENCES IN MECHANICAL PROPERTIES, 3D FLIGHT KINEMATICS IN A SIMULATED SMASH AND ACCURACY OF SMASHES PERFORMED BY HIGHLY TRAINED SHUTTLERS

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INTRODUCTION: The Badminton World Federation announced plans to transit from the traditional waterfowl feather shuttlecocks (WFS) to synthetic feather shuttlecocks (SFS) for long-term sustainability reasons in January 2020. This change in shuttlecock build could affect its flight characteristics and game play. We compared 10 competition-standard Mizuno SFS versus 10 Li Ning WFS in terms of mechanical properties, discrete and continuous variables associated with 3D flight kinematics during a robot-simulated smash, and percentage of shots landing in a demarcated scoring zone during a smash by highly trained shuttlers.

METHODS: The weights, skirt diameters, lengths, and centre of mass (COM) positions were compared between 10 SFS and 10 WFS to identify differences related to mechanical properties. A three-dimensional opto-reflective motion capture system captured the flight of 10 SFS vs 10 WFS during a simulated smash by a robot under the same settings. Flight duration, peak velocity, average velocity, lateral displacement, and front-back displacement were compared between both shuttlecock types. One-dimensional statistical parametric mapping (SPM) was used to differentiate the flight characteristics between the SFS and WFS. The accuracy of 20 smashes of each shuttlecock type to land in a demarcated zone performed by 20 well-trained shuttlers were compared. All comparisons were made using two-tailed independent t-tests.

RESULTS: The SFS was on average lighter (5.20 ± 0.05 vs 5.29 ± 0.07 g), shorter (88.83 ± 0.29 vs 90.69 ± 0.40 mm) and had a more anteriorly positioned relative COM (30.67 ± 0.57 vs 31.90 ± 0.50 mm) compared with the WFS. The SFS recorded shorter flight durations (1.05 ± 0.01 vs 1.07 ± 0.02 s), higher average peak velocities (45.44 ± 0.58 vs 44.46 ± 1.03 ms-1), higher average velocities (10.72 ± 0.12 vs 10.10 ± 0.14 ms-1) and landed further down the court (11.42 ± 0.10 vs 11.02 ± 0.14 m) for the simulated smash with the robot. SPM analysis revealed significant differences in front-back displacement between the SFS vs WFS from 15% of normalized flight time with no differences in lateral and vertical displacements. Players were more accurate smashing the WFS (62.00 ± 18.24 %) compared with SFS (48.00 ± 25.26 %).

CONCLUSION: Although lighter, the SFS recorded longer flight durations and higher peak and average velocities during the robot-simulated smash compared with the WFS, possibly be due to a lower drag coefficient caused by greater skirt deformation. The faster speeds during the robot-simulated smashes of the SFS versus WFS could mean that shuttlers may find it more difficult to defend against offensive smashes using the SFS. The advantage of a faster smash of the SFS could be offset by less accurate positioning of smashes compared with WFS as identified in this study. Taken together, the higher velocities and different flight trajectories of the SFS compared with WFS would require shuttlers to adapt technically and physiologically.

Conventional Print Poster

CP-SH12 Imagery and psychological skill training

AN EXPLORATION OF DIET AND MENTAL COPING STRATEGIES DURING THE ULTRA TOUR MONTE ROSA: A CASE STUDY

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Introduction: As ultra-endurance events become more popular, investigations into the characteristics of what makes a successful ultra-athlete are growing. The importance of nutrition and coping have been identified as key factors in successful performance. However, the interplay between diet and mental coping strategies is yet to be investigated in an in-depth case study during an ultra-running event. Furthermore, overcoming stressful situations and employing relevant coping strategies is important in providing practical implications for future athletes engaging in these events. Therefore, this research aims to use Lazarus and Folkman's (1984) transactional model of stress and coping as a lens to examine how the above factors come into play within ultra-running performance.

Methods: An experienced ultra-marathoner took part in this qualitative case study. The researchers took an interpretivist approach to data analysis, with a view that data is not to be generalised, instead to provide one person's detailed account of their experience during the 100-mile Ultra Tour Monte Rosa. A pre-event interview (-5 days) was performed cover-

ing the participant's background, race overview, preparation, perceived challenges, coping strategies and nutrition plan. To capture thought processes and dietary intake during the event a GoPro was attached to the runner, who was instructed to Think Aloud (TA) and verbalise thoughts, where possible, throughout the event. GPS and heart rate data was also collected. A post-race interview (+3 days) provided a chronological account, evaluated performance, and explored experience and strategy use. Both interviews and TA data were transcribed verbatim. A timeline of dietary intake, stressors and coping responses over the duration of the race (87 miles completed) was compiled.

Results: The main stressors were nutrition, terrain, environment, physical, social and performance. Various coping strategies (problem, emotion and avoidance-focused) were adopted at different time points. During the initial stages of the race problem-focused coping was employed more frequently, which focused on the monitoring of internal physiology and fuelling. However, as the race progressed problem-focused coping reduced, and emotion-focused coping became more common. Insufficient fuelling was identified as a critical factor that may have impacted upon coping strategies and ultimately led to race withdrawal.

Discussion: These results provide detailed insight into the experiences of an ultra-runner, presenting unique data regarding how nutritional intake may affect psychological responses to stressful situations. Further research investigating the link between fuelling and coping in ultra-endurance events is needed to support the literature assessing diet and physiological response.

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THE EFFECT OF A SIX WEEKS AO PLUS MI COMBINED INTERVENTION ON GOLF PUTTING ACCURACY: A PILOT, SINGLE-BLINDED,RANDOMIZED STUDY

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The effect of a six weeks AO plus MI combined intervention on golf putting accuracy: A pilot, single-blinded,randomized study

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INTRODUCTION: Both action observation (AO) and motor imagery (MI) have been shown to have similar cognitive and neural information processing processes to actual movement execution [1], and they have been shown to have a significant role in improving motor skill learning and accuracy. A study has found that after six weeks of AO+MI intervention training, the target aiming performance of the AO+MI group was significantly higher than that of the AO or MO group alone [2]and that the combination of the two could reveal a relationship between the subjects behavioral mental processes and the actual execution of the putting stroke. Therefore, the aim of this study was to assess the effect of a six-week AO+MI intervention on the accuracy of putting in beginner college golf.

METHODS: Sixteen college beginner golfers participated as subjects and were randomly divided into a control group (n=8, 22±1.60) and an AO+MI group (n=8, 22±1.25). All subjects completed a Vividness of Movement Imagery Questionnaire (VMIQ-2) to exclude the effect of individual differences in verbal ability on the results. The experimental group underwent a six-week AO+MI psychological intervention training, twice a week for 40 minutes per intervention. After six weeks, a putting experiment was conducted in which subjects in each group made 10 putts at a distance of 3 meters. The AO+MI group would watch a 3-minute intervention script before putting it, while the control group did not have any other interventions. The vertical and horizontal distances of the ball from the hole cup, ball speed, deviation, and putting angle were measured after each putt. Paired-sample t-tests were used to detect differences in means for each indicator. A statistical level of $p<0.05$ was accepted. All data are expressed as mean ± SEM.

RESULTS: There were no individual differences in the clarity of external visual imagery, internal visual imagery or kinesthetic imagery of the subjects measured pre-experimentally. After the experiment, the hole-in-one rate was 27.5% and 10% for the AO+MI and control groups, respectively. Significant differences were found in putter speed ($P=0.041$) and vertical distance ($P<0.01$). The vertical distance was 19.92±22.66 and 56.87±47.95 for the AO+MI and control groups, respectively. horizontal distance ($P=0.267$), left-right deviation ($P=0.527$), and putter angle values ($P=0.709$) were not significantly No significant differences.

CONCLUSION: The novel finding of this pilot work was that the six-week AO+MI intervention improved the accuracy of beginner golf putters. The subjects achieved positive results by observing the correct putting stroke while repeating the simulation internally, ensuring the ball rolled towards the target cup at a reasonable ball speed based on perceived putting distance and reducing the horizontal and vertical distance between the final landing point and the cup. In summary, the use of AO+MI interventions in golf putting training sessions is clearly effective in improving putting accuracy for beginners, however, it is unclear if this affects the putting accuracy and swing performance of the actual game for beginners.

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EFFECTS OF DIFFERENT PETTLEP IMAGERY TRAINING METHODS ON HIGH SCHOOL BASKETBALL PLAYERS' JUMP-SHOT PERFORMANCE, SELF-CONFIDENCE AND ANXIETY

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Effects of Different PETTLEP Imagery Training Methods on High School Basketball Players' Jump-shot Performance, Self-confidence and Anxiety

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Abstract

Introduction

Holmes and Collins (2001) proposed functional equivalence from a neuroscience perspective. They also argued that imagery execution and movement will bring out the same neuro mechanism that leads to benefits for sport performance. In this study, we aimed to apply different delivery intervention methods to investigate the effects of regular (RI), progressive (PI), and retrogressive (RETI) PETTLEP imagery patterns (Fazel et al., 2018) to jump-shot performance, state anxiety, and self-confidence of basketball players.

Methods

Participants were recruited from 4 high-school basketball teams of Division II league. They were randomly assigned to a RI group, PI group, RETI group or a control group. Three intervention groups were implemented by following the 7 elements of the PETTLEP model. The intervention was delivered three times a week for 4-weeks, a total 12 imagery training sessions.

Discussion

The results showed: (1) PI and RETI significantly improved performance of running jump shooting, (2) RI and PI significantly reduced players' state anxiety, (3) RI and PI significantly improved players' self-confidence. To sum up, different imagery training patterns are beneficial to efficient learning for young athletes under certain circumstances that will improve sport performance, self-confidence, and reduce state anxiety levels. However, we recommend further exploration of the efficiency of different imagery intervention patterns among diverse age levels and sports. Lastly, in order to strengthen the effectiveness of imagery training, practitioners are suggested to provide different imagery patterns to match different skill development stages of athletes.

Key words: Functional equivalence, Regular Imagery, Progressive Imagery, Retrogressive Imagery, High school Basketball

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THE EFFECT OF PSYCHOLOGICAL SKILLS TRAINING ON PERFORMANCE OF COMPETITIVE ATHLETES: A SYSTEMATIC REVIEW AND META-ANALYSIS

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INTRODUCTION

Sport psychology interventions have been empirically examined during the past several decades, with the objective of improving performance and quality of athletes' experience through cognitive behavioural changes [1]. Although psychological skills training (PST) as the primary intervention conducted in various programs has been widely adopted in the field of sport psychology interventions [2,3], some authors claim there is the effectiveness of PST in modifying internal states to be related to athletic performance but limited on the enhancement of athletic performance [4,5] . The aim of the present study was to examine the effect of PST on performance of competitive athletes.

METHODS

A structured literature search was conducted in three online databases (PsychoINFO, SPORTDiscus, and Web of Science). Studies were included if they were randomized controlled trials (RCTs) that compared an PST as an intervention with a control, in current or former competitive athletes.

RESULTS

Of 3080 articles identified, a total of four studies met the inclusion criteria. The pooled result showed no significant difference between PST and performance (SMD=-0.14 with 95% CI from -0.33 to 0.05) within competitive sport. In addition, the heterogeneity of the interventions was moderate (I2=46%).

CONCLUSION

PST improved several performance outcomes in various sports. These studies should emphasis intervention fidelity within competitive sport. Given the moderate degree of evidence, high-quality, adequately powered trials are needed in the future.

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DEVELOPMENT OF AN INNOVATIVE VIRTUAL REALITY TRAINING SYSTEM AND ITS EFFECT ON MENTAL TRAINING IN GYMNASTS

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INTRODUCTION

Research on the use of virtual reality (VR) for mental training in athletes is increasing. VR can simulate situations that athletes may not usually experience, including unusual competition scenarios and environments such as stadiums the athletes have not visited before. We have been developing an innovative VR training system (iVRTS) and have used it for mental training to enhance athlete performance. Users wear a head-mounted display (HMD) and can move freely in a VR environment constructed based on an actual stadium. However, it is unclear whether the iVRTS is effective for mental training, such as performing breathing techniques while experiencing a simulated stressful situation. Therefore, this study aimed to assess the effectiveness of iVRTS for mental training by analysing biometric information.

METHODS

Participants were 20 male gymnasts (mean age ± standard deviation: 19.41 ± 0.91 years) who had competed at the national level. Participants were assigned to the VR group or the control group. Both groups had five mental training sessions over a 4-week period (Fukami, 2019). Each session comprised two 5-min breathing activities. In the first, participants stood with their eyes opened and breathed normally. In the second, they continued to stand while performing a breathing technique and were allowed to look around while turning around; the VR group, who wore a HMD (Vive, HTC) during the second activity, viewed a VR environment of an actual gymnastics stadium filmed using a 360-degree camera (QooCam 8K, KanDao) during a competition, whereas the control group saw only the gymnasium where they train. To determine the effect of the experience on mental training, salivary amylase (SOMA Cube Reader, YKC) and mental sweating (eVu TPS, MP Japan) were measured. To examine the iVRTS effect, measurements were compared between the first and final sessions (Times 1 and 2, respectively). The Kolmogorov–Smirnov test was performed to assess the distribution of the data, and the Wilcoxon-signed rank test and Mann–Whitney U test were performed to compare the data between the VR group and the control group and between Times 1 and 2.

RESULTS

There was a significant difference in the salivary amylase results between Times 1 and 2 in the VR group, but no significant differences were found in mental sweating between Times 1 and 2 or between the groups.

CONCLUSION

These results indicate that mental training using iVRTS reduces the stress response, suggesting its potential to contribute to improved psychological skills in athletes. Because salivary amylase is associated with both the sympathetic and parasympathetic nervous systems, breathing techniques performed while using the iVRTS might be useful for acquiring relaxation skills.

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AN INVESTIGATION OF THE IMAGERY ASPECTS OF BLIND SOCCER PLAYERS WITH VISUAL IMPAIRMENT: TOWARDS PERFORMANCE IMPROVEMENT

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Introduction

The theoretical basis for the effectiveness of motor imagery has been based on the neuromuscular theory (Jacobson, 1931), which states that skill improvement can be expected by imaging of vividness, controllability, and internal imagery (Mahoney & Avenir, 1977; Munford & Hall, 1985). However, a meta-analysis of imagery training showed a success rate of only half % (Murphy, 1994; Simonsmeier, et.al.,2021), and the methodology still needs to be reviewed. In addition, the examination of the imagery aspects of visually impaired players is still in its exploratory stage, and generalized findings have not yet been submitted. In the meantime, evaluation criteria for cognitive imagery strategies that are indispensable for blind soccer (Momose, 2023). Therefore, the purpose of this study was to investigation of image aspects by blind soccer players with visual impairment. This study will provide suggestions for improving the performance skills of blind soccer players.

Methods

Participants included 32 Japanese blind football players (sex: 23 males, 7 females/skill levels: 8 international, 10 national, 2 regional, 12 never participated/ vision class: 11 totally blind, 14 low vision/time: 19 congenital, 12 acquired). The scales used were (1) the Questionnaire upon Mental Imagery (QMI: visual, auditory, tactile, kinesthetic, gustatory, olfactory, and organic senses, 5-point scale), (2) Test of Visual Imagery Control; Visual Impairment Person Version (TVIC-V, 3-point scale) , (3) Movement Imagery Questionnaire-Revised; Japanese Version (JMIQ-R: internal, external, 7-point scale), (4) Evaluation Scale of Movement Imagery; Blind Soccer version(ESMI-BS: overlooking, venue, sound, subject, 7-point scale).

Results

As a result, by skill level, ANOVA analysis on the ESMI-BS for overlooking imagery ($F(3)=3.247$, $p<.05$) and venue imagery ($F(3)=3.327$, $p<.05$). Significant differences were also found by congenital or acquired on the QMI for visual imagery ($t(22.150)=2.208$, $p<.05$), and by blind or low vision on the ESMI-BS for venue imagery ($t(27.769)=-2.233$, $p<.05$) and sound imagery ($t(22.102)=-2.318$, $p<.05$). Moreover, the correlation analysis showed that the ESMI-BS overlooking imagery ($r=.427$, $p<.05$) and venue imagery ($r=.550$, $p<.05$) were significantly related to the TVIC-V scores.

Discussion

The results suggest that was inferred that the skill to easily visually imaged the venue (pitch and lines) and the game situation from a birds-eye view is required to improve the skills of blind soccer players. But controllability is required to easily image these venue and birds-eye images, was not related to vividness. Moreover, congenitally blind athletes may have difficulty imaging related to visual information (Momose and Ito, 2016). It was considered that guidance should be provided based on these results to improve performance.

EFFECTS OF EYE MOVEMENT AND INTEREST ON MEMORY OF ADVERTISEMENTS DURING SPORTS BROADCASTS

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Introduction

Because of the high viewership of TV broadcasts of mega-events such as the soccer World Cup, many companies present advertisements, but it is not clear how viewers perceive these corporate advertisements. It would be important to investigate to what extent the advertisements are seen and remembered. One scientific approach to this is eye tracking, a technique based on eye gaze measurement [1]. It is also conceivable that emotions such as interest in the sport being watched may influence memory. The purpose of this study was to clarify the influence of advertisements on memory by analyzing viewers eye movement, eye placement, and interest in baseball during a live professional baseball game.

Methods

The subjects were 20 college students (18 males and 2 females, mean age 19.65 ± 0.79) with no baseball experience. An eye tracker, EMR-ACTUS (Nac Image Technology), was used as the eye tracking device. Subjects were seated 2.0 meters away from the monitor, and a video was played after confirming that eye gaze could be measured. After the video was shown, subjects were asked to describe the advertisements they remembered and the reasons why they remembered them. The video was edited from a televised video of the first game of the Japan Series, an official game of the Nippon Professional Baseball (NPB), and lasted 180 seconds, from the pitcher in the set position before pitching to the catcher catching the ball after pitching. The ads were from 13 companies (6 billboard ads and 7 digital ads), and eye movement and gazing time were measured.

RESULTS

To see the overall trend of gazing time, we measured the gazing time and obtained the percentages. The results showed that 94.82% of the gazing time was placed on the pitcher, catcher, batter, etc. The percentage of gazing time for adver-

tisements was only 5.18%. To examine the relationship between gazing time and ad memory, we compared gazing time for the no ad memory group (n=8; 0/13 companies) and the many memory group (n=6; 3/13 or more companies). The results showed significant differences for both billboard ($F=5.83$, $p<0.05$) and digital ($F=4.84$, $p<0.05$) advertisements, indicating that the majority memory group had a longer gazing time.

To examine the relationship between interest in professional baseball and memory for advertisements, we asked participants to rate their interest in professional baseball on a five-point scale and examined the relationship with the number of ads they remembered. The results showed that those who were not interested in professional baseball tended to remember more advertisements, while those who were interested in professional baseball tended to remember fewer advertisements.

Conclusion

The results of this study showed that those who remembered more advertisements spent more time gazing at them and were less interested in professional baseball. Gaze movement and interest were found to be involved in the memory of sports scenes.

1.Akiyama,Isogai et al(2021)

THE EFFECTIVENESS OF HEAT PREPARATION AND ALLEVIATION STRATEGIES FOR COGNITIVE PERFORMANCE: A SYSTEMATIC REVIEW

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Introduction

A range of occupational and performance contexts (e.g., military personnel operations, emergency services, sport) require the critical maintenance of cognitive performance in environmentally challenging environments. Several reviews exist which evaluate the effectiveness of heat preparation strategies to facilitate physical performance however, to date, no review has explored the usefulness of heat preparation strategies for cognitive performance. Therefore, this systematic review aimed to evaluate a range of interventions for the maintenance of cognitive performance, during or following active or passive heat exposure.

Methods

This systematic review was undertaken in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. After systematically searching six electronic databases and undertaking manual searches from August 2021 to October 2022, 40 studies published since 2000 were included in the review.

Results

Of the 40 articles included, 5 examined heat acclimation/acclimatisation, 13 included a hydration strategies, 18 included cooling methods, 6 include a supplementation/mouth rinse intervention, and 2 involved psychological or "other" strategies. Interventions were subsequently categorised into chronic (i.e., acclimation/acclimatisation) and acute strategies (i.e., hydration, cooling, supplementation, psychological). The results indicate that medium-term consecutive heat acclimation may mitigate some cognitive deficits under heat stress, although heat acclimation effectiveness could be influenced by age. Furthermore, pre-cooling appears the most effective cooling method for maintaining cognitive performance under heat stress, although results were somewhat ambiguous. The hydration literature showed that the most effective hydration strategies were those which individualised electrolyte fortified fluid volumes to match for sweat loss. Limited research exploring psychological interventions indicates that motivational self-talk could be facilitative for maintaining cognitive skills following exercise in hot conditions.

Discussion

These findings can be used to help inform strategies for maintaining critical cognitive and decision-making skills in hot environments. The effectiveness of well-known physical heat preparation strategies for cognitive performance is conflicting, due in part, to the sparseness of research, and differences in methods implemented. Most studies included in this review explored an acute strategy, with a lack of existing research exploring the effectiveness of widely used chronic heat-based preparation strategies (i.e., acclimation and acclimatisation strategies) and psychological strategies for the maintenance of cognitive performance.

PHYSICAL EXERCISE INFLUENCES ATTENTIONAL ORIENTATION TOWARDS EMOTIONAL STIMULI

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INTRODUCTION: Physical performance depends on perceived exertion and pain. Attention is generally preferentially directed towards particular stimuli in the environment, such as information related to potential danger. This involuntary preferential allocation of attention would allow for an adapted response. Studies have shown that patients suffering from chronic pain have an enhanced attentional bias towards pain related stimuli (word, picture or face). Similarly, this bias is also demonstrated in participants suffering from acute pain or receiving experimentally induced pain.

Since intense physical effort can be perceived as painful, to first see how exertion influences perceptions, we were interested in physical effort as a potential source of attentional bias. Does physical effort influence attentional orientation to-

wards emotional stimuli, and in particular towards stimuli representing pain, as it does for pathological or experimental pain?

METHODS: In order to provide a more accurate measure of attention, we recorded eye movements while participants (N = 37) performed a dot-probe task. The latter consisted of the simultaneous presentation of two facial expressions (pain-neutral or neutral-neutral), one on the left and the other on the right of the screen, for 700 ms, followed by the appearance of a target at the location of one of the two stimuli. Participants were asked to freely move the eyes during the presentation of stimuli, and to manually respond as quickly as possible by pressing the mouse button corresponding to the target location. Participants first completed the task at rest, then they had to complete the task by performing the wall sit test, then once more at rest.

RESULTS: Eye-tracking data showed that the percentage of first fixations was higher for pain faces at rest (52% for pain vs 48% for neutral) and higher for neutral faces during effort (52% for neutral vs 48% for pain). Fixation time was higher for pain faces at rest (202ms vs 188ms for neutral) and higher for neutral face during effort (197ms vs 184ms for pain). Overall, physical effort leads to avoidance of pain related stimuli, contrary to pathological or experimental pain.

CONCLUSION: These findings lead to new issues. Is it an avoidance of pain faces or an attraction to neutral faces? If there had been happy faces, would there have been an attraction to them?

Since these attentional biases are complex phenomena depending on many factors, future studies are needed to characterize more precisely the extent to which physical effort could influence attentional orientation. Then, see if manipulating attention could lead to a decrease in perceived exertion, and thus improve physical performance. We are currently conducting new studies to answer these new questions.

Conventional Print Poster

CP-AP20 Sprint running

ACCURACY OF A NEW SETUP FOR MEASURING MECHANICAL VARIABLES DURING RUNNING SPRINTS USING THE 'SIMPLE METHOD'

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INTRODUCTION: Kinetic variables are often challenging to measure during sprint running. Recently, a simplified method to estimate kinetic parameters and force and velocity relationship (FxV) during running was proposed [1]. This method can be applied using an iPhone app (MySprint) with a resolution of 240 fps and presents high accuracy [2]. This study aims to test the concurrent validity of another set up to use the simple method in sprints with lower resolution smartphones (30 fps), broadening the access to this kind of tool for sprint training.

METHODS: Seven university track and field athletes (3m, 4f) underwent six 30-meter sprints. Sprints were filmed by an iPhone (iPhone 11 Pro Max - 240fps) positioned 16-m apart and 1-m above the track and by an android smartphone (30 fps) positioned on the stands, 25-m apart and 6.6-m above the track. Parallax was analogically accounted for to use MySprint [2], and digitally for the low fps smartphone using a pc app (Dvideow[3]). Dvideow calibration used pairs of markers positioned 1.22m apart, at each 2.5m until 10m and each 5m until 30m, to apply DLT and posterior 2D frame-by-frame reconstruction [3]. The low fps position data was interpolated (spline, 1000Hz). Split times were extracted for MySprint and Dvideow, and a spreadsheet [4,5] was used as reference to calculate F0, V0, Pmax and RF by the time-shift method, as well as maximum (max) and mean (me) modeled force (Fh), velocity (Vh) and power (Ph). The level of agreement between devices was tested by the ICC(2,1) (mean values), with a significance level of $p<0.05$. The coefficient of variation (CV) [6] measured the relative magnitude of error.

RESULTS: All studied variables presented ICCs higher than 0.96, except for F0 (ICC=0.84, 95%CI 0.32-0.97, p=0.005) and maximum modeled force (ICC=0.84, 95%CI 0.33-0.97, p=0.004). CVs were typically low for most variables (depicted as CV[95%CI] V0=1.9%[1.6-2.7%]; Pmax=5.5%[4.3-7.5%]; RF=2.9%[2.3 – 4.0%]; maxVh=1.1%[0.9-1.6%]; meVh=1.0%[0.8-1.4%]; maxPh=5.5%[4.4-7.6%]; mdPh=2.1%[1.7-2.9%]), but not for F0 (7.2%[5.7-9.9%]) and maxFh (7.1%[5.6-9.8%]). Descriptive statistics were close to the ones seen in the literature for this kind of athletes (DVIDEOW: F0=7.53±1.04 N·kg-1; V0=8.61±0.95 m·s-1; Pmax=16.26±3.25 W·kg-1; RF=44±4% MySprint: F0=6.88±0.83 N·kg-1; V0=8.65±0.89 m·s-1; Pmax=14.98±3.03 W·kg-1; RF= 3±3%).

CONCLUSION: The studied setup results in relatively low error for parameters of the FxV relationship when compared to a higher FPS and using MySprint. The most troubling error to consider are for F0 and maxFh. Future studies should focus on improving the setup.

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ISOKINETIC DATA RELATED TO RATE OF FORCE DEVELOPMENT IS BETTER CORRELATED TO ACCELERATION SPRINT PERFORMANCE THAN PEAK TORQUE.

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INTRODUCTION: Isokinetic tests are commonly used for strength assessment in athletes. Previous data support a relationship with knee strength and sprint acceleration performance [1], although not unanimous [2]. However, due to velocity component of sprint performance, is to be expected that isokinetic data associated with rapid force capacity would be better related with acceleration sprint performance (0-40 m) when compared to peak torque data. Therefore, the aim of this study was to investigate the association between isokinetic data associated with rapid force capacity or peak torque and acceleration sprint performance, and compare with traditional repetition maximum (RM) test.

METHODS: Seven national level male sprinters (age: 24.14±6.64) completed a 40-m sprint (mean: 5.35±0.19), 6 RM strength test and knee extension and flexion for 5 and 30 repetitions at 90°/sec and 180°/sec on an isokinetic dynamometer. Isokinetic assessment was tested for peak torque, average peak torque, torque at 0.18 seconds and time to peak torque. Measurements involved one testing day of 6 RM and isokinetic data, and a second testing day of three 40-m sprint trials. Photocells were positioned on every 10-m from the start, the best sprint trial for each participant was used. RM tests were conducted for squat and stiff exercises and were analyzed as absolute load lifted and relative load lifted to body weight. Pearson's correlation test was used to assess the association between data. Correlations were classified as trivial, (<0.1), small (0.1 – 0.29), moderate (0.3 – 0.49), large (0.5 – 0.69), very large (0.7 – 0.89) and almost perfect (0.9 – 0.99) (3). Significance was set at $p \leq 0.05$.

RESULTS: Very large correlations were found between 10 to 20-m sprint time with time to peak torque at 90º for extension for right and left leg (r= 0.772 and 0.875, respectively; $p < 0.05$). Very large correlations were found between 20 to 30-m sprint time with time to peak torque at 90º and 180º for extension, both for left leg (r= 0.789 and 0.822, respectively; $p < 0.05$) and with 6 RM stiff absolute load (r= -0.865; $p < 0.05$). Very large correlations were found between 30 to 40-m sprint time with time to peak torque at 90º and 180º for extension, both for left leg (r= 0.755 to 0.783; $p < 0.05$), average peak torque at 180 for flexion for right leg (r= 0.764; $p < 0.05$), 6 RM relative stiff load (r= -0.878; $p < 0.05$) and almost perfect correlations with 6 RM squat relative load (r= -0,954; $p < 0.05$).

CONCLUSION: Time to peak torque, average peak torque and 6 RM strength test were associated with sprint time. However, time to peak torque was consistently correlated with sprint time across a larger split range (10 to 40-m), differently from average peak torque (30 to 40-m) indicating a more reliable isokinetic data to assess sprint performance. Compared to isokinetic data, 6 RM presented larger correlation but only in (20 to 40-m split).

1. Newman et al. (2004) 2. Kabacinski et al. (2022) 3. Sawilowsky (2009)

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EFFECT OF DIFFERENT STARTING TECHNIQUES ON SPRINT SPEED AND LOWER EXTREMITY MUSCLE ACTIVATION FOR 50 M SPRINT

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INTRODUCTION: The block start position has long been regarded the best starting method for sprints. From the block start, the runner can more quickly enter the optimal running mode than from a standing start and achieve a faster start speed in the shortest time [1]. However, in recent years, the three-point start has been used in the 4*100 m relay, where those running second to fourth legs can choose to start in a standing or three-point starting position. Most of the studies have compared the differences in sprint performance between block and standing starts, but the three-point start has rarely been considered. Examining the process of sprinting is limited during field experiments, as effectively analyzing the muscle activation mode during each phase is challenging. Therefore, the purpose of this study was to explore the instant step point and lower extremity muscle activation of different starting techniques for 50 m sprinting.

METHODS: We recruited 16 college athletics sprinters. The participants performed a maximum-effort sprint of 50 meters with block, three-point, and standing starts, and three sprints were performed. We used Optojump and 5 Witty to record the real-time sprint step and time parameters. Used 8 Noraxon wireless EMG sensors to record the signals. The action phase was considered as: the crouched "set" position; 200 ms after the starting gun fire; the 1, 3, 5, 9, and maximum speed steps. The phase divided into pre-landing, initial contact, stance, and recovery. The statistical method used was One-way repeated measures ANOVA.

RESULTS: In the first 10 m sprint time and speed, and the results show that the block start was significantly faster than the three-point and standing start; the three-point start was also significantly faster than the standing start. In the lower extremity muscle activation section, the results show that the MGAS and SOL activation was significantly lower with the block start than with the three-point start.

CONCLUSION: The sprint time and speed were the fastest in the first 10 m of the block start, and the sprint time of the three-point start was faster than that of the standing start. Therefore, both the block start or three-point start can produce faster acceleration. In terms of muscle activation in the lower extremity, the activation of MGAS and SOL in the block start was significantly lower than that in the three-point start. However, the action patterns of the two were similar, and the three-point start does not provide the starting pedal to supports the ankle joint, so the MGAS and SOL provide more iso-

metric work in the "set" position. We found that the block start produced better sports performance in key indicators such as, sprint time, and speed. The overall movement performance produced with the three-point start was better than that with the standing start. The findings suggest that in the future, during start technique training, the three-point start can be used instead of standing starts.

1. Salo & Bezodis (2004)

DIFFERENCES IN HAMSTRING MUSCLE ACTIVATION DURING MAXIMAL AND SUB-MAXIMAL SPRINTS

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INTRODUCTION: Hamstring injuries are prevalent across all football codes. While recommended prevention measures include one to two sprint bouts at 95% of maximum speed per week (1) there is only limited knowledge about the hamstring muscle activation during sprinting. Existing studies were performed on a treadmill or analyzed a limited number of steps (2) leading to questions regarding the generalizability of findings to real sprinting situations. This study aims to evaluate the hamstring muscle activation during complete 40-meter sprint trials at maximal and submaximal speeds (80% and 90%).

METHODS: 10 sport students (5 male, age: 23.3 ± 2.4 years) performed multiple 40-meter sprints with maximum speed (27.66 km/h ± 2.68 km/h), 90% (25.27 km/h ± 2.90 km/h) and 80% of maximum speed (22.13 km/h ± 2.81 km/h) on an indoor multisport court. For all trials electromyographic (EMG) activity of the biceps femoris long head (BFlh) and semitendinosus (ST) muscles were recorded with a wireless sEMG sensor (Ultium, Noraxon USA Inc., Arizona). Peak and average activation of the dominant leg over all step cycles were analysed using MyoResearch Software (Noraxon USA Inc., Arizona). A repeated measures ANOVA was used to compare the peak and average EMG activity of the different trials.

RESULTS: In both submaximal sprint conditions, the average BFlh EMG activity was significantly lower compared to the maximum sprint (76.3% ± 10.2% at 90% maximum speed, $p < .001$ and 70.5% ± 13.5% at 80% maximum speed, $p < .001$). Peak BFlh EMG activity was also significantly lower during submaximal conditions with 85.3% ± 13.1% ($p = 0.040$) at 90% maximum speed and 83.9% ± 23.4% at 80% maximum speed ($p = 0.037$). No significant differences were observed between the two submaximal conditions. The average ST EMG activity was lower in both submaximal conditions compared to the maximum sprint trial, with 79.1% ± 8.4% for 90% maximum speed ($p < .001$) and 71.3% ± 17.2% for 80% maximum speed ($p < .001$). There were no significant differences in ST EMG activity between the submaximal conditions. No significant difference was found for Peak ST EMG activity.

CONCLUSION: Conclusion: Submaximal sprinting considerably reduces hamstring muscle activity compared to a maximal sprint and may therefore provide an insufficient stimulus for hamstring injury prevention.

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EFFECT OF FORCE VELOCITY AND POWER-BASED TRAINING ON SPRINT PERFORMANCE: A PRELIMINARY STUDY

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INTRODUCTION: Force-velocity relationship computed during a sprint-acceleration represents the ability of athletes to specifically apply high amounts of force in the horizontal direction. In this way, it is directly linked with sprint acceleration and overall performance (Morin et al., 2012). One goal of sprint training is to move this relationship to the right (stronger, faster and more powerful). One method used to do that is resisted sprint training (Cahill et al., 2019). While studies focus their resisted sprint training (RST) program mainly on the power zone (Lahti et al., 2020), this study aimed to evaluate the effect of a training program based on all 3 zones (speed-strength, power, strength-speed) on sprint performance and force-velocity profile.

METHODS: Seven students in sport science, were split into two groups: power-oriented training (POW) and force-power-velocity oriented training (FPV), with loads based on the decrement of maximal velocity (%Vdec). Both groups performed eight sessions of resisted sprint training over three weeks. Every session was performed in the power zone (50% Vdec) for POW, while FPV performed a same duration resisted sprint training, alternating between speed-strength (25%Vdec) power (50%Vdec), and strength-speed (75%Vdec) zones. Before (Pre-) and after (7 days after the end of the program; Post-) the training period, a force-velocity test was implemented (Fornasier-Santos et al., 2022). The velocity time curve was recorded with a linear motorized encoder (1080 Motion; 333 Hz, Lidingö, Sweden). Performance was evaluated as the 40-m time. The model proposed by Samozino et al. (2016) was used to calculate the theoretical force (F0), velocity (V0) and maximal power (Pmax). Mean, percentages of differences and Cohen's d (ES) were computed on the main variables to compare effect of training.

RESULTS: One week after the last training session, 40-m time did not significantly decrease in both groups (POW: -0.33%, ES = 0.04 vs. FPV: +0.17%, ES = 0.02). Similar results were found for both groups for Pmax (POW: +0.70%, ES = 0.03 vs. FPV:

+0.99%, ES = 0.06), F0 (POW: +2.48%, ES = 0.17 vs. FPV: -0.14%, ES = 0.01), V0 (POW: +0.13%, ES = 0.01 vs. FPV+1.09%, ES = 0.12) and Vmax (POW: +0.39%, ES = 0.04 vs. FPV: + 1.49%, ES = 0.19).

CONCLUSION: Eight sessions of RST based on power or force-power-velocity do not seem enough to improve force components of FVP. A larger number of athletes should be included to improve the analysis and a larger delay after the last training session could lead to observing greater adaptations due to more recovery time after this significant sprint overload.

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EFFECT OF HIGH-INTENSITY INTERVAL TRAINING AND REPEATED SPRINT TRAINING IN HYPOXIA ON PERFORMANCE IN FEMALE SPRINTERS

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INTRODUCTION: High-intensity interval training in hypoxia has been used widely by several type of athletes. Recently, the effect of repeated sprint training in hypoxia caused further increases in sprint performance with augmented anaerobic energy supply [1, 2]. However, the influence of combined high-intensity interval training and repeated sprint training in hypoxia on performance has not been fully evaluated in female sprinters. Therefore, the purpose of the present study was to determine the effect of combination of high-intensity interval training and repeated sprint training in hypoxia on performance among competitive female sprinters.

METHODS: Eight sprinters (height; 161.6 ± 1.1 cm, body weight; 55.9 ± 1.6 kg) performed sprint training under hypoxic conditions [fraction of inspired oxygen (FiO2): 14.5%, a simulated altitude of 3,000m] twice per week for the first half of two week once per week for the latter half of two week (total training sessions: 6). The training consisted of four types of test [10-s maximal sprint, repeated sprint (5 × 7-s sprints), 30-s submaximal sprint following 10-s maximal sprint, and high-intensity interval exercise (5-10 × 60-s submaximal sprints)]. Before and after the training period, repeated sprint ability (5 × 7-s sprints) and 60-s sprint ability tests were conducted. Respiratory samples were collected to evaluate oxygen uptake (VO2), carbon dioxide production (VCO2), ventilation volume (VE), and respiratory exchange ratio (RER) during 60-s sprint ability test. Blood lactate concentrations were determined before exercise, immediately after exercise, and 3, 5 and 7 min after exercise. Moreover, time-course changes in peak and mean power output were evaluated.

RESULTS: In the repeated sprint ability test, mean power output significantly increased compared with before training ($P < 0.01$, ES = 0.74). There was a significant main effect of time ($P < 0.01$, ES = 0.90) for blood lactate concentration, but no significant difference after the training period was observed ($P = 0.07$, ES = 0.45). Mean power output during 60-s sprint ability test was significantly increased compared with before training ($P = 0.04$, ES = 0.52). Post-exercise blood lactate concentrations did not differ significantly after the training period ($P = 0.43$, ES = 0.16).

CONCLUSION: Combined high-intensity interval training and repeated sprint training in hypoxia caused further increase anaerobic performance without affecting post-exercise blood lactate concentration.

1. Kasai et al. (2017) 2. Girard et al. (2020)

EFFECTS OF ASSISTED NORDIC HAMSTRING EXERCISE ON STRENGTH, RANGE OF MOTION, MUSCLE SORENESS AND PERCEIVED EXERTION: A PILOT STUDY

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INTRODUCTION: While the Nordic Hamstring Exercise (NHE) is used to increase hamstring eccentric strength and range of motion (ROM) to reduce hamstring strain incidence [1], poor adherence has been reported due to high exercise intensity and perceived muscle soreness [2]. However, the use of elastic resistance bands during the NHE may reduce loading to alleviate symptoms of muscle soreness. Therefore, the aim of this study was to examine the efficacy of assisted NHE to improve hamstring strength and ROM, whilst assessing perceptual measures (muscle soreness and exertion [RPE]).

METHODS: Twenty-nine university team sport athletes ([mean±SD] 21.1±2.1y) took part in an 8-week training programme twice per week, progressing from two sets of three NHE repetitions in week 1 to four sets of four in week 8. Athletes were stratified based upon NHE strength and body mass, and then assigned to a group that performed NHE (UNASSIST n=12) or NHE assisted with an elastic resistance band (ASSIST n=17). RPE was reported immediately after performing NHE with muscle soreness reported at 24 and 48 hr post-training. Hamstring strength (NHE peak force and isometric force measured at 0, 30, and 60° knee flexion [0°=full extension]) and ROM were measured pre- and post-intervention. Twenty-five athletes (UNASSIST n=10; ASSIST n=15) were included in the analyses of perceptual measures during the initial four weeks, however due to attrition unrelated to the programme, 13 athletes (UNASSIST n=6; ASSIST n=7) were included in post-intervention muscle function assessments.

RESULTS: During the initial week, UNASSIST reported significantly (P<0.05) greater muscle soreness than ASSIST at 24 (5±2 vs. 3±1) and 48 hr (4±2 vs. 2±2) post-exercise; hereafter no between-group differences were reported. No between-group differences were revealed for RPE. Post-training, significant increases in isometric strength (0° knee flexion = 25.1±23.4%, d=0.95; 30° knee flexion = 26.5±32%, d=0.85) and ROM (9.8±3.9°, d=2.53) were detected within ASSIST, with non-significant increases in NHE strength (8.8±11.1%, d=0.80) and isometric strength at 60° knee flexion (14.3±20.4%, d=0.62). Within UNASSIST, a significant increase in ROM (7.8±8.3°, d=0.95) was detected with non-significant increases in NHE strength (10.2±20.8%, d=0.48), isometric strength at 0° (18.3 ± 20.2%, d=0.92), 30° (13.0±13.9%, d=1.01), and 60° (13.5±27.8%, d=0.36) of knee flexion.

CONCLUSION: These preliminary data indicate that assisted NHE can elicit improvements in hamstring muscle strength and ROM, despite a lower exercise intensity. The reduced intensity may allow unaccustomed individuals to be eased into a NHE training programme via reduced perceptions of muscle soreness, whilst still benefiting from positive adaptations. However, further research using a larger sample size is needed to confirm these findings.

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DOES MID-COOLING WITH ICE SLURRY INGESTION IN A HOT ENVIRONMENT IMPROVE INTERMITTENT SPRINT PERFORMANCE IN FEMALES PLAYING TEAM SPORTS?

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INTRODUCTION: Effects of ice slurry ingestion on exercise performance in females have remained unclear. Then, we have compared the effects of ice slurry ingestion on exercise performance to examine the sex differences. Our previous studies showed that there was no difference between sexes for body temperature in the pre-cooling condition (1), while the post-cooling condition promoted a decrease in body temperature only in females (2). Thus, we hypothesized that cooling the body with ice slurry in females would be more effective than males when the body temperature elevates. The present study examined the effects of mid-cooling with ice slurry ingestion on thermoregulation during exercise, in particular intermittent sprint performance after a certain amount of time has elapsed in females playing team sports.

METHODS: Subjects were 11 females college students (age 20.6 ± 1.1 years, height 160.2 ± 5.4 cm, body mass 56.4 ± 6.3 kg) who played team sports. The intermittent sprint test consisted of two sets of intermittent sprint exercises separated by a 15-minute half rest in 32°C, 60% relative humidity. Each half was divided into 10 x 2-minute blocks consisting of a 4 second sprint, 100 seconds of active recovery, and 20 seconds of passive recovery. The subjects ingested 5.0 g/kg of either ice slurry at -1 ◦C (ICE) or control water at 20 ◦C (CON) during 15-minute half rest. Measurements included rectal temperature (Tre), mean skin temperature (Tsk), perceived measurements (Thermal sensation; TS, Thermal comfort; TC), peak power output (PPO), mean power output (MPO), and whole body sweat loss (WBSL).

RESULTS: Changes in Tre, Tsk, TS and TC were significantly lower in the ICE trials compared to the CON trials ($p < 0.05$). Although statistical analysis with two-way ANOVA showed no interaction effect on exercise performance, statistical analysis with magnitude-based inference method showed a partial " likely positive" effect solely on mean power output in the second half for MPO. There no differences in PPO and WBSL.

CONCLUSION: Mid-cooling with ice slurry ingestion in female may reduce the increase in body temperature in the intermittent sprint performance after a certain amount of time has elapsed, and improve exercise performance, albeit only slightly.

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CP-AP21 Recovery and Cycling

IS THE VENTILATORY THRESHOLD A GOOD SURROGATE FOR MAXIMAL LACTATE STEADY STATE?

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INTRODUCTION: Maximal lactate steady state (MLSS) is defined as the highest workload that can be maintained for a longer period without continued blood lactate (BL) accumulation and considered to be the best method to establish anaerobic threshold (AT). However, determination of MLSS requires a series of steady state exercise tests which are considered time consuming and tiring. Thus, the aim of this study was to determine if threshold analyses from gas exchanges

obtained during an incremental maximal exercise test (IMET) to volitional fatigue can; 1) be a good surrogate for MLSS testing and, 2) determine which gas exchange threshold coincide with MLSS.

METHODS: This research included 16 trained cyclists (14 males, 2 females; 26.1±5.2 years; 73.3±6.9 kg). The IMET and MLSS were done on separate visits. During the IMET, maximal power output (PO) and oxygen uptake (VO2max) were established using a metabolic cart with mixing chamber (Cosmed, Italy). PO and heart rate (HR) were determined at both the ventilatory threshold (VT), as defined by V slope method [1] and an increase in VE/VO2 [2], and at the respiratory compensation point (RCP), as defined by an increase in VE/VCO2 [2]. The IMET started at 100 watts with 20 watts/min for males and started at 70 watts with 15 watts/min increments for females until each participant attained volitional fatigue. MLSS was established using 30 minutes steady state exercise starting at about 20% below the identified VT and BL was measured (Lactate Plus, USA) every five minutes between the 10th and 30th minute. The test was terminated once BL concentration increased by more than 1 mmol/L between the first and last measurement [3]. Data were analyzed using repeated measures Anova with adjustment of Bonferroni.

RESULTS: VO2max was 62.2 ±6.3 mL/min/kg with a peak PO of 392±65 watts. VT was identified at 47.03±6.8 ml/min/kg (75% max) with a mean PO of 281±54 watts (72% max) and a mean HR of 155±15 bpm (84% max). MLSS was established at a PO of 270±50 watts (69% max) and a HR of 164±10 bpm (88 % max) with a BL concentration of 3.7±0.9 mmol/L. There was no significant difference between methods (both p>0,05) for mean PO (11.6±15.2 watts) and HR (8.75±10.6 bpm). However, PO (361±64 watts; 92% of max; p=0.0004) and HR (175±10 bpm, 95% of max; p=0.027) at the RCP were significantly higher than those identified during MLSS.

CONCLUSION: Our results show that the VT can be used as a good surrogate for MLSS testing and to establish the AT in endurance trained cyclists. Mean differences in PO (4.4%) and HR (5.8%) between both methods were minimal and non-significant. On the opposite, PO (32.7%; p<0.01) and HR (7.3% p=) data at the RCP were significantly higher (32.7% p<0.01 and 7.3% p=0.027) and does not support previous studies suggesting this parameter as an appropriate indicator of AT or to be equivalent to MLSS.

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DOES COUNTERMOVEMENT JUMP CAN BE USED TO EXAMINE PEAK POWER OUTPUT AND ACCELERATION PERFORMANCE IN SPRINT TRACK CYCLING?

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INTRODUCTION: Peak power output (PPO) of lower limbs is one of the crucial factors used to determine sporting performance during maximal athletic tasks such as sprint cycling (1). Especially, acceleration phase demands a high rate of power production, expressed relative to body weight (2). Different sport specific or non-specific tests are performed to assess ability of lower limbs to generate PPO. One of them is countermovement jump (CMJ) which has been widely used to indirectly quantify their mechanical power output capability (3). But, lack of evidence between potential correlation with acceleration performance in cycling. Thus, the main goal of this study was to examine the relationship of peak power output calculated from CMJ and acceleration performance in sprint track cyclists.

METHODS: Fourteen men sprint track cyclists: age 23.6 ± 3.3 (years), height 177.4 ± 4.5 (cm), weight 87.1 ± 6.5 (kg), percentage of body fat 11.8 ± 3.2 (%) (minimum 5 years of training experience). They performed during one training session after 15 minutes warm-up: 1) three countermovement jumps using OptoJump (MicroGate, Bolzano, Italy), 2) peak power output test lasted 6 seconds on the cycle ergometer with maximal load (Wattbike Ltd, Nottingham, UK), 3) three maximal accelerations from the standing start at a distance of 1/4 lap (62.5m) (gear ratio 3.33) with electronic timekeeping system based on dual-beam photocells (Witty System, Microgate, Italy). PPO from CMJ was calculated using the Sayers et al. equation (4). Also, Pearson's linear correlation coefficient was calculated.

RESULTS: Best time of 62.5m was strongly correlated with PPO obtained in the cycle ergometer: r = -0.73 (p<0.01) and PPO per kilogram body weight r = -0.80 (p<0.01), average power r = -0.78 (p<0.01) and relative average power r = -0.86 (p<0.001). Additionally, the acceleration sprint performance was strongly related to CMJ height r = -0.87 (p<0.001), PPO calculated from CMJ r = -0.72 (p<0.01) and PPO from CMJ per body weight r = -0.85 (p<0.001).

CONCLUSION: Our results indicate that CMJ height and calculated power parameters can be useful indicators of training control in sprint track cycling.

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ESTIMATION OF LACTATE THRESHOLD USING TIME-INVARIANT AND TIME-VARYING PARAMETER MODELS BASED ON HEART RATE AND POWER DATA

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KU LEUVEN

INTRODUCTION: The anaerobic threshold is an important marker in endurance sports used to identify training zones and monitor training progress. The determination of the anaerobic threshold requires expensive equipment, invasive sampling and a visit to a specialized facility. Therefore, regular monitoring of the anaerobic threshold is inaccessible to a large population of cyclists, even among the elite.

Mathematical modelling might form a suitable method for continuous monitoring of performance, especially in combination with wearable technology. In cycling, the heart rate, power and cadence are already continuously measured and monitored during training and competition, making them particularly suitable for integration in a modelling technique. This study attempts to estimate the anaerobic threshold with linear time-invariant and linear time-varying models based on the heart rate, power and cadence.

METHODS: 11 amateur, trained cyclists (6 male, 5 female) participated in this study. They performed an incremental cycling test on a Lode Excalibur ergometer in laboratory conditions to determine the maximal oxygen consumption (VO2max), ventilatory thresholds (VT) and second lactate threshold (LT). The workload increased with 40 watts every 3 minutes. The heart rate was measured with a 12-lead electrocardiogram (ECG). Lactate samples were taken at the end of each step and analyzed with the EKF Biosen Lactate Analyzer. Modelling and analysis was performed with the CAPTAIN toolbox in Matlab R2021b. The anaerobic threshold was estimated with both time-invariant parameter (TIP) models and time-variant parameter (TVP) models. The results were compared with the actual LT identified from the incremental step test.

RESULTS: Calculation of the LT with time-invariant parameter (TIP) models was performed with an average error of 11%. For 5 out of 11 participants, the estimated LT was approximated with an error smaller than 10 watts. The time-variant parameter (TVP) models performed with an average error of 4%. For 9 out of 11 participants, the LT was estimated with an error smaller than 10 watts. The better performance of the time-variant parameters was attributed to their adaptability and their ability to capture a highly varying signal such as the heart rate better.

CONCLUSION: Modelling techniques based on the heart rate and power output approximate the LT with a decent accuracy, with time-varying parameter models performing better than time-invariant models. Our results are interesting to the ECSS community since they propose an alternative to the current gold-standard of testing that might enable at regular monitoring of the anaerobic threshold. Given the widespread popularity of heart rate, power and cadence sensors in the cycling population, this modelling approach could The modelling approach based on wearable-captured heart rate, power and cadence data might even be applied in the field. Future work needs to focus on verifying the technique in a bigger population and adapting it to the field.

THE COMPARISON OF FOAM ROLLING FORCE ON LOWER EXTREMITY MUSCLES BETWEEN YOUNG AND MIDDLE-AGED MEN AFTER ECCENTRIC CONTRACTION

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INTRODUCTION: A foam roller (FR) is a popular toolkit for muscle recovery after delayed onset muscle soreness (DOMS) due to eccentric contraction training because of its convenience, portability, and cheapness for active people and athletes. Most studies instructed participants to place "as much body mass as tolerable" on the FR at all times. A major problem of the FR-related study is the lack of biomechanical load, especially in different muscles after the delayed onset of muscle soreness for consecutive 3 days is still unknown. Purpose: The aim of this study was to understand the FR force in different muscles in the lower extremity after delayed onset muscle soreness for consecutive 3 days.

METHODS: Twenty healthy men with regular exercise (= 5 times/ week exercise) were recruited as participants. All participants receive the DOMS-induced protocol by a dynamometer (Biodex System 4 Pro) in the non-dominant leg (DL). After that, the participant was instructed to the FR recovery program on the force plate for 20 to 30 min, targeting the major muscle groups of the anterior (quadriceps), lateral (iliotibial band), posterior (hamstrings), and medial aspect (adductors) of the thigh, along with the gluteal muscles on both the right and left legs for two 60-s bouts each for total 20 min, 2 sets for 60 s (Macdonald et al. 2014; Pearcey et al. 2015). After completing 1 set of 5 muscles (hamstrings, abductor, quadriceps, adductor, and calf muscle), repeat one set in DL. After completing 2 sets in DL, switch to non-DL for the same protocol. Participants accept the FR protocol for consecutive 3 days (0, 24h, and 48h), and relative vertical ground reaction forces measured during foam rolling for the thigh were recorded and analyzed.

RESULTS: The FR-force in non-DL was significantly greater than that in DL (29.93 ± 5.16 kg vs. 28.90 ± 5.76 kg, $p = 0.030$). The main effects of FR-force between 5 muscle groups [$F(1,18) = 6.45$, $p = .021$, $?p2 = 0.26$] were significant. The FR-force in the Calf muscle (23.56 ± 7.48 kg) was significantly smaller than that in the hamstring (34.92 ± 7.71 kg, $p < 0.001$), abduction (33.56 ± 6.79kg, $p < 0.001$), and Quadriceps (32.16 ± 7.67kg, $p < 0.001$), respectively. The FR-force in the adduction muscle (22.86 ± 8.01kg) was significantly smaller than that in the hamstring (34.92 ± 7.71 kg, $p < 0.001$), abduction (33.56± 6.79kg, $p < 0.001$), and quadriceps (32.16 ± 7.67kg, $p < 0.001$), respectively. There was no age effect (young or middle-aged men), and time effect (days 1, 2, and 3) in FR-force.

CONCLUSION: The FR-force influenced muscles in the lower extremity after delayed onset muscle soreness. The FR-force might be higher in the leg with muscle soreness condition and determined by body posture. The results may provide

coaches and athletes with post-exercise muscle recovery applications. The study was supported by the Ministry of Science and Technology (MOST109-2410-H-320-003) and Hualien Tzu Chi Medical Center (TCRD109-75).

HOT WATER IMMERSION TO BOOST MUSCLE RECOVERY IN ATHLETES: A MATTER OF HEAT DOSE?

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INTRODUCTION: Athletes who require rapid recovery between bouts of damaging exercise should implement evidence-based recovery strategies. Hot water immersion (HWI) has shown promising results to promote muscle recovery [1], despite limited data on the optimal heat dose [2]. The objective of this study was to compare the responses of two exogenous heat strains (40°C, HWI40 and 41°C, HWI41) on core body temperature and key functional markers of muscle recovery following exercise-induced muscle damage (EIMD). We hypothesized that both modalities would increase core body temperature, with HWI41 but not HWI40 attenuating EIMD-induced decline in muscle strength.

METHODS: Twenty-eight athletes underwent a customized EIMD protocol by means of an isokinetic dynamometer, immediately followed by one of the following recovery interventions: HWI40, HWI41, or 36°C (CON36). Markers of endogenous heat strain such as gastrointestinal temperature, thermal impulse (area under the curve > 38.5°C), physiological strain index and heart rate were tracked throughout HWI. Finally, functional markers of quadriceps muscle recovery [peak concentric torque (Tpeak), late-phase rate of force development (RFD100-200)] were assessed before EIMD (pre-), 24 hours (post-24h), and 48 hours (post-48h) after EIMD.

RESULTS: By the end of immersion, HWI41 induced a more pronounced increase in gastrointestinal temperature than HWI40 (38.8 ± 0.1 vs. 38.0 ± 0.6°C, $p<0.001$). Thermal impulse only increased during HWI41 (14.9 ± 8.72 °.min, $p<0.05$). The physiological strain index was significantly higher during HWI41 compared to HWI40 (5.93 ± 0.96 vs. 3.81 ± 1.19 AU, $p<0.05$). HWI41 but not HWI40 mitigated the decline in RFD100-200 at post-24h (-7.1 ± 31.8%; $p = 0.63$) and Tpeak at post-48h (-3.1 ± 4.3%, $p = 1$).

CONCLUSION: A single session of HWI41, rather than CON36 or HWI40, provided the required endogenous heat strain to mitigate the decline in muscle strength following mild exercise-induced muscle damage. Heat-based protocols should be designed to achieve a sustained core body temperature (~ 25 minutes) above 38.5°C when muscle recovery is of primary importance.

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COMPARISON OF TWO DIFFERENT WAYS OF ACTIVE RECOVERY AFTER A MAXIMAL 500M IN HUNGARIAN YOUNG KAYAKERS.

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INTRODUCTION: Efficient lactate clearance after maximal exercise is a key in competition. Athletes in canoe sprint reach high lactate values, therefore, an effective lactate clearance method is fundamental to restore homeostasis. Active recovery has been indicated more effective in blood lactate clearance than passive recovery (1,2). However, there are differences in the efficiency of the active recovery whether using the same or different muscles from those which are mainly used during the specific sport activity (3). The aim of this study was to compare the effectiveness of active recovery on water and on cycle ergometer.

METHODS: Fourty-one (21 boys; 17 girls; 16±1 ys) well-trained kayakers (part of the national team of the Olympic Hopes 2022) performed a maximal 500meter on flat water. Participants were randomly divided into 3 groups (A,B,C). A: active recovery by kayaking on water. B: active recovery on cycle ergometer (Precor Spinner Ride, Spinning Hungary). C: control group, passive recovery. Athletes in A and B group had previously performed a step test to determine their individual maximal lactate clearance heart rate zone. The recovery phase lasted 20 minutes and athletes of A and B group had to remain in their individually determined heart rate zone. Heart rate was continuously monitored during and after the race (HRmax, HR5', HR10', HR15', HR20') (Garmin HRM-Dual). Blood lactate was measured after the race (Lamax) (Lactate Scout, EKF Diagnostics, Germany) and during the recovery in every 5 minutes (La5', La10', La15', La20'). After a normality test, one-way ANOVA or Friedman test were used to detect changes between the different recovery methods. Significancy was set at $p<0.05$.

RESULTS: There were no significant differences between the maximal lactate and maximal heart rate values in the three groups (A:11.93±1.86, B:11.95±1.76, C:11.52±2.21 mmol/L and A: 189±6, B:183±24, C:190±5 bpm/min, $p>0.05$). There were significant differences during the recovery in the lactate values between the kayak and passive groups (A vs C: La5': 7.85 vs 10.21, La10': 5.52 vs 8.99, La15': 4.01 vs 7.40, La20: 3.40 vs 6.31 mmol/L) ($p<0.05$). At the end of the recovery, we also found significant differences between the cycling and the passive group (La20': 4.27 vs 6.31 mmo/L). The average heart rate during the recovery was the highest on water, the lowest in the passive group and in between on the cycle ergometer.

CONCLUSION: According to the results of the study, the on-water kayaking is more effective to eliminate the blood lactate than the use of cycle ergometer. However, individual differences in the efficiency of lactate elimination were observed in each group.

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NON-LINEAR HEART RATE VARIABILITY AS A NONINVASIVE BIOMARKER TO ASSESS THE PHYSIOLOGICAL STATUS OF TRIATHLETES DURING SIMULATED WARM-UP BOUTS

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INTRODUCTION: The non-linear index alpha 1 of Detrended Fluctuation Analysis (DFA a1) of heart rate variability (HRV), has revealed potential as a marker of fatigue during endurance exercise. This report is an initial exploration of the ability of DFA a1 to assess the physiological status of triathletes as a surrogate marker for "readiness to train" while performing simulated warm-up sessions the day after two different exercise sessions.

METHODS: After the recruitment of 11 triathletes from a local triathlon club, the first ventilatory threshold (VT1) was determined during a baseline assessment. During the four other laboratory visits, triathletes were instructed to perform 10-min of cycling at 90% of VT1 (simulating a warm-up bout) before (PRE) and within 36 h after (POST) light and heavy running exercise. The effects of the performed exercise sessions were verified by means of the recorded RR intervals for DFA a1 analysis along with neuromuscular testing. Besides common statistical methods, magnitude-based inferences (MBI) were utilized to assess the changes in true score and thus also the practical relevance of the magnitude.

RESULTS: The heavy exercise session induced a significant higher rating of perceived exertion as opposed to the light exercise session ($p < 0.001$, $d = 0.89$). In terms of MBIs, PRE versus POST comparisons revealed a significant reduced DFA a1 with large effect size after the heavy exercise session ($p = 0.001$, $d = - 1.44$) and a 99% chance that this negative change was clinically relevant.

CONCLUSION: Observation of the DFA a1 to power relationship during simulated warm-up bouts seems to represent a valuable measure to depict physiological status and guide athletes in their training as an easy-to-apply monitoring procedure. The inter-individual differences observed indicate the need for a regular assessment including individual data history and statistical references for identification of response. Further data are necessary to confirm the results in a larger and more homogeneous population.

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CP-SH13 Sport psychology II

THE COMPETITIVE SPORT MENTALITY AND THE MENTALITY OF INDIVIDUAL ATHLETES AS REVEALED THROUGH JUNGIAN-ORIENTED COUNSELING

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Introduction

Jungian psychology provides specific concepts such as "self," "individuation," "wholeness," "shadow," and "persona," etc. which guide the psychotherapeutic approach. One of the manifestations of this is the importance of "images" and "symbols," and expressive methods such as dream analysis, sandplay technique and drawing methods are often used in psychotherapy. Furthermore, we do not understand episodes narrated by clients causally (causality), but rather from the point of view of their meaning (teleology) by paying attention to their synchronicity or constellation.

Purpose

The purpose of his study was to identify the psychological characteristics (mentality) of both competitive sports in general and in individual athletes as revealed through sports counseling oriented to Jungian psychology.

Method

The authors analyzed material derived from the psychotherapeutic cases that they have reported at various occasions (articles, books, case conferences, etc.) and the findings of others who have taken similar therapeutic approaches. Factors related to both types of mentality were extracted which at the same time were unique, significant and highly common.

Result and Discussion

Analysis of the case reports resulted in the identification of the following characteristics: 1) A balance (wholeness) between adaptation to reality (performance enhancement) and individualization (personality development) is a key psychological issue in psychotherapy, and a strong bias toward adaptation to reality in their athletic history experienced up to that point may be problematic. 2) Many of their narratives are related to the "body" in terms of movement and performance, and through these narratives (unconscious, symbolic), the athlete addresses his/her own psychological issues, and thus the narratives about the "body" serve as a "window" into the therapeutic relationship between the athlete and the therapist to approach through which the athletes inner experience. 3) The experience of the athletic situation and the expectations of those around them add to the formation of a specific persona (e.g., sport-only identification) that serves as a background for psychological problem and which makes the athlete reluctant to tackle psycho-developmental tasks (self-reliance, ego

identity, and subjectivity) that give rise to psychological problems. These mentalities can also replace common therapeutic cues and issues in psychotherapy of athletes, regardless of differences in therapeutic approaches.

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IMPLEMENTATION OF THE SPECIFIC TRAINING OF EXECUTIVE FUNCTIONS IN FOOTBALL (STEFF) AMONG LOWER DIVISION FEMALE PLAYERS: A PILOT STUDY

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Introduction

Evidence from the past two decades associate executive functioning with sport expertise, especially in football. This collective knowledge showed that inhibition and working memory tend to have higher association to defending and goal-scoring skills, whereas cognitive flexibility tends to be strongly linked to assists and dribble skills. While there is not enough evidence to support nor deny the effectiveness of computerized or face-to-face cognitive training to improve in-game decision-making, findings have suggested that these practices constitute far transfer which do not influence performance, whereas the inclusion of these tasks in technical training sessions enables near transfer of these skills. This pilot study aims to implement and test the effects of a training protocol that taps onto executive functions.

Methods

We drew eight pre-training sessions of 10 minutes each to be used before the main training session. The club's roster of 28 players, participated of the protocol four times a week, throughout a one-month pre-season period. Executive functions were assessed by standardized measures and in-game decision-making was assessed by the Decision-making coding instrument from Romeas et al. (2016). We collected the data before and after the intervention, and a 60-day follow-up.

Results

Repeated-measures ANOVA retrieved significant improvement in working memory ($p<.05$), cognitive flexibility ($p<.01$) and decision-making ($p<.001$), but no statistical difference for inhibition ($p=.12$). Bonferroni's post-hoc analyses revealed significance for working memory and cognitive flexibility between pre- and post-intervention ($p<.05$), but non-significant results between post-intervention and follow-up ($p=.21$ and $p=.37$, respectively). Decision-making yielded statistically different results between both time frames ($p<.05$).

Discussion

We investigated whether a protocol would be able to produce changes on cognition and decision-making among female football athletes. STEFF potentially influenced working memory and cognitive flexibility which points out to a possible far-back transferability, from the sport environment to the pencil-and-paper test. However, decision-making kept increasing which might be influenced by confound variables. Because it was a pilot study, and to comply with the club's conditions, we decided not to constitute a control group, which means that our results might be influenced by time or by technical training, which are likely to help the improvement of decision-making as well. Nevertheless, our findings are partially supported by previous literature and STEFF seems a promising new set of short training sessions that could be adopted within a pre-season plan to improve cognitive outcomes and decision-making among footballers.

"IS IT REALISTIC?": THE EXPERIENCES OF ELITE FEMALE ATHLETES CONSIDERING PARENTHOOD

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The gender inequities experienced by pregnant and parenting elite athletes have been documented by the media and in sport research. However, the experiences of elite female athletes considering parenthood are underrepresented. Various sporting bodies, including the International Olympic Committee, have called for more research in this often-overlooked group. Such research is necessary for the development of evidence-informed policies and practices to support athletes during pre-conception, pregnancy, and while parenting. The purpose of this study was to describe the experiences of elite female athletes considering parenthood. Participants included 10 North American elite female athletes (ages 29-36 years) who are considering parenthood in the next five years. Nine of the ten athletes had previously competed at one or more Olympic Games. Using a qualitative description study design, participants engaged in one-on-one semi-structured interviews. Interviews were audio-recorded, transcribed verbatim, and analyzed using a process of content analysis. Participant experiences of considering parenthood are represented by five main themes: (a) Calls for essential mandates and leadership; the lack of National-level sport policies and practices supporting pregnant and parenting athletes was described as a major barrier to becoming mother-athletes, (b) "How do your support yourself?"; concerns regarding limited financial and social support for athlete-parents were expressed, (c) Concern about body changes; physiological and psychological changes that result from pregnancy were noted as a concern, (d) Age inequities; participants described

barriers experienced from societal notions that as athletes reach a certain age they will (or should) leave sport to become mothers, and (e) Being proactive about reproductive health; participants identified the need for early and comprehensive education about reproductive health. Grounded in the experiences of elite athletes, these findings provide necessary evidence to inform the development of sport policies and practices that support gender equity and participation of girls and women across all levels of sport.

"WE'RE NOT THE SAME": A COMPOSITE VIGNETTE ON PREGNANCY AND MOTHERHOOD FOR ELITE ATHLETE MOTHERS IN AND OUT OF FUNDING PROGRAMMES

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28th Annual ECSS Congress France/Paris, July 4-7 2023

"We're not the same": A composite vignette on pregnancy and motherhood for elite athlete mothers in and out of funding programmes

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Introduction

Today, pregnancy is often viewed as a temporary phase allowing a break from the physical and mental pressures of high-performance sport rather than career closure. Yet, obtaining the elite athlete mother identity is not without struggle. A cultural shift sees sporting organisations developing contracts and policies to support the success of the post-partum return. Although there is much research on elite athlete mothers within professional contracts or in receipt of funding it has yet to explore how experiences differ between elite athlete mothers with and without these financial agreements. The present study aims to provide insight into the disparity between support of elite athletes with and without National Governing Body funding in hopes of informing future policy, provisions and practices for those elite athlete mothers who fall short of funding.

Method

This study took on a qualitative approach, creating composite vignettes using extracts from the raw data of a published study containing three semi-structured interviews exploring pregnancy and postpartum experiences of a funded Paralympian and an unfunded Olympian. Bengtsson's (2016) 4-stage content analysis was used to find disparities between the two elite athlete mothers. Stage 1 involved reading and rereading transcripts. Stage 2 removed extraneous data. Stage 3 the first author coded quotations and consulted the wider research team to group codes into topics. In stage 4 quotes were used to construct an initial composite vignette involving a conversation between the participants. Using member reflections, a co-constructed composite vignette was created.

Results

A co-constructed composite vignette involving a discussion between two elite athlete mothers, one receiving funding and the other not was presented. Topics such as views on sport as a hobby or job, competition and qualification and the relationship with the NGB highlight distinctions between being an elite athlete mother in and outside of funding structures. Further topics highlight the dichotomy of sport vs motherhood, discriminatory policies and gender of performance directors.

Discussion

This current study highlights disparity between elite athlete mothers in and outside of funding structures. Results indicate the need for further change within policy, provision and practice to encompass athlete mothers who meet the definition of elite but not the requirements for funding. Simple improvements in competition and training opportunities and in NGB communication may enhance the experiences of unfunded elite athlete mothers.

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GROUP INTERVIEWS ON MENSTRUATION WITH FEMALE AESTHETIC SPORTS COLLEGE ATHLETES —BASED ON THE FRAMEWORK OF HEALTH PROMOTION—

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Introduction

The Female Athletes Triad (FAT) is a typical health issue of female athletes. The risk of FAT is higher in aesthetics and weight class competitions (Torstveit and Sundgot-Borgen, 2005). Recent studies on FAT have focused on menstruation. Several studies have investigated the effects of the menstrual cycle on athletes' condition and performance. However, only a few studies have investigated how athletes feel about menstruation. The understanding of menstruation is increasing in sports and society. The increased interest and social changes are likely to impact female athletes.

Purpose

This study aimed to identify knowledge and attitudes about menstruation among female college athletes competing in gymnastics, an aesthetic sport considered high risk for FAT.

Method

The author conducted semi-structured interviews in groups of two to four students, with 14 female gymnastics club members (mean age 19.3 years). The interviews lasted approximately one hour and inquired about students' attitudes and coping with menstruation. We classified the data based on the content and examined them from the perspectives of personal and environmental factors based on the health promotion framework.

Results

We classified personal factors into three facilitating factors: "worries about menstruation," "correct knowledge about menstruation," and "coping behavior during menstruation," and an inhibiting factor, "wrong perception of menstruation. We also classified environmental factors into three inhibiting categories: "spread of false knowledge within the club," "transmission of false knowledge from family members," and "restrictions by family members." Based on the health promotion framework, the results indicated that many personal factors are moving in the direction of promoting health behaviors for correct menstruation, while environmental factors are inhibiting at the micro-level.

Discussion

The results of this study indicated that many personal factors promoted resolving problems related to menstruation, suggesting that athletes might try to engage in correct health behaviors regarding menstruation from the perspective of health promotion. On the other hand, environmental factors provided by familiar figures such as family members and teammates were the only factors that inhibited menstruation-related proper health behavior.

Recently, social interest in menstruation among women, including female athletes, and knowledge of menstruation-related diseases are increasing. Conventional obstetrics and gynecology clinics are now called "ladies' clinics" or "outpatient clinics for female athletes," suggesting that macro-level environmental factors promote understanding menstruation and correct health behaviors. However, micro-level environmental factors, such as family and teammates, might inhibit female athletes attempts at conducting appropriate menstruation-related health behaviors.

ASSESSMENT OF COMPLAINT MECHANISMS FOR INTERPERSONAL VIOLENCE: WHAT CAN SPORT SETTINGS LEARN FROM RESEARCH-BASED RECOMMENDATIONS?

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Sport represents a context associated with a host of physical and psychological benefits, yet the sport environment can sometimes be characterized by interpersonal violence (IV). Research has shown that experiencing IV in sport can lead to anxiety, depression, and eventually dropping out of sport. To ensure access to a safe sporting environment, it is essential that people confronted with IV, whether themselves or as witnesses, feel safe and informed as to how to report their experience. While research is sparse on this subject, results indicate that reporting rates remain particularly low. Studies have highlighted the lack of formal, independent complaint mechanisms as one of the most significant barriers to reporting IV in sport and seeking help. There is, however, a growing interest by athletes, decision-makers, and researchers in implementing well-defined mechanisms. To do so, it is essential to identify the key practices that could help in this endeavor. This communication will present the results of a rapid review that aimed to document the recommendations issued from the evaluation of IV complaint mechanisms. The rapid review was conducted following the guidelines provided by the Cochrane Rapid Review Interim Guidance (Garrity et al., 2021). Given the recency of these efforts in the sport domain, any mechanism for receiving complaints pertaining to IV were included. The initial search through the databases (PubMed, PsycInfo, ProQuest Dissertation and Thesis Open, SportDiscus, Human Resources Abstracts, and Sociology Abstracts) yielded 306 references, and two members of the research team then screened to assess for eligibility. A total of 35 references published from 2012 to 2022 were identified, and they covered mechanisms mainly targeting IV in general (any type) or sexual violence more specifically. Complaint mechanisms varied in scope and as a function of the setting considered, including work, university, military, and medical settings. Our review identified recommendations spanning four broad categories: 1) Institutional accountability (e.g., public transparency regarding the process and the results, collaborative efforts between stakeholders); 2) Awareness and accessibility of the complaint mechanism (e.g., targeted educational workshops, regular promotion); 3) Adapted process (e.g., ensuring anonymity and protection, providing timely response and regular feedback); and 4) Ongoing evaluation strategies (e.g., continuous monitoring and adjustments). Findings from this rapid review will inform current efforts to develop and implement formal and independent complaint mechanisms in the sport domain. The synthesis of recommendations from various research disciplines and types of mechanisms offers a comprehensive portrait of best practices currently implemented. Strategies to adapt and integrate such recommendations within an independent complaint mechanism in the sport context will be discussed.

THE ASSOCIATION BETWEEN SPORTS SELF-IMAGE AND SPORTS PERFORMANCE IN COLLEGIATE ATHLETES: A MIXED METHODS STUDY

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INTRODUCTION

This paper conceptualizes self-image as a novel measure in the sports performance world as it pertains to an athlete's perception of themselves with an emphasis placed on their body and appearance both on and off the field. Strengthening one's self-image may make a player stronger and more effective in their performance–and carry on with them throughout their life, not just in their respective sport.

METHODS

This study investigates the association between sports self-image and sports performance amongst collegiate athletes using a mixed methods approach. 40 Division 1 collegiate athletes participated in the study and were given two open-ended qualitative questions: 1) "Are you conscious of your body image or appearance while you are playing your sport?" and 2) "Does how you feel about your body-image or appearance affect your performance on the court or field?" Afterwards, self-image was assessed using the Body Self-Image Questionnaire (BSIQ) and sports performance was assessed using the Athlete Sports Performance Survey (ASPS).

RESULTS

The qualitative data suggests that self-image and its subsequent effect on performance varies by sport. Beach volleyball players expressed feeling highly conscious of their body self-image while playing in small, tight uniforms while they are in direct comparison to their competition across the net. Women's water polo players described their ability to experience flow while playing, but once they stepped out of the water, they felt self-conscious about their bodies. Men's basketball players suggested that their self-image was important to them; many expressed wanting to look good in order to feel good and play well. Co-ed track and field explained that they struggled with feeling confident while wearing their tight-fitting uniforms all the time. Women's tennis suggested that it became hard to maintain a high body self-image when always being compared to other players. Quantitative analyses await a second round of data collection (in progress) that will allow for a longitudinal assessment of the relationship between self-image and performance across two time points, three months apart.

CONCLUSION

We found that most of the elite athletes are conscious of their body self-image, especially while they were not performing. However, once it was gametime, many were able to reach a flow state and block out the excess noise. Overall, the qualitative data suggests that most athletes struggle with their body self-image regardless of gender, age, sport, and performance. Research that explicitly details the importance of enhancing a player's self-image illuminates the critical role that coaches play. Moreover, the research can teach athletes at critical ages to appreciate their bodies.

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Conventional Print Poster

CP-SH14 Children and physical education

PARALLEL MULTIPLE MEDIATION EFFECT OF PHYSICAL EDUCATION MAJORS STUDENTS'S COLLEGE LIFE ADAPTATION ON THE RELATIONSHIP BETWEEN PHYSICAL SELF-EFFICACY AND CAREER PREPARATION BEHAVIOR

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This study attempted to verify the multiple mediating effect of college life adaptation in the relationship between Physical Education Majors Students's physical self-efficacy and career preparation behavior. The study targeted 229 students of University in Korea. The survey tools used the physical self-efficacy (Rycman, Robbins, Thornton & Cantrell, 1982), college life adaptation (Baker & Siryk, 1989), and career preparation behavior (Kim, 1997) scales. Physical self-efficacy consists of perceived physical confidence(PPC) and physical self-expression confidence(PSEC), and college life adaptation consists of academic adaptation(AA), social adaptation(SA), emotional adaptation(EA), physical adaptation(PA), and attachment to college(AC). Career preparation behavior consists of career exploration(CE), information gathering(IG), and occupational experience(OE). All scales consist of a 5-point Likert scale. The collected data were analyzed through SPSS 21.0 and PROCESS macro (v.3.3) model 4 to verify the parallel multi-mediatied effect, and the mediatied effect was further verified through Bootstrapping. Results show that, Firstly, PPC was found to have a significant effect on AA(β=.186, p<.01), SA(β=.267, p<.001), EA(β=.284, p<.001), PA(β=.178, p<.01), IA(β=.177, p<.01), and PSEC was found to have a significant effect on SA(β=.238, p<.001), EA(β=.331, p<.001), PA(β=.286, p<.001), AC(β=.235, p<.001). Secondly, AA was found to have a significant effect on CE(β=.244, p<.001), IG(β=.623, p<.001), OE(β=.788, p<.001), and SA was found to have a significant

effect on CE(β=.255, p<.001) and OE(β=.149, p<.01). Third, the relationship between PPC and CE was mediated by AA(95% CI=.011~111) and SA(95% CI=.083~.292). Fourth, the relationship between PPC and IG was mediated by AA(95% CI=.034~.179). Fifth, the relationship between PPC and OE was mediated by AA(95% CI=.044~.245) and SA(95% CI=.013~.070). Sixth, the relationship between PSEC and IG was mediated by SA(95% CI=.017~.132). Seventh, the relationship between PSEC and IG was mediated by SA(95% CI=.017~132) and AC(95% CI=.007~.076). Eighth, the relationship between PSEC and OE was mediated by SA(95% CI=.014~.114).

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THE IMPACT OF PE, SPORT AND PA FOR SOCIAL INCLUSION IN ROMANIAN SCHOOLS

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The impact of PE, Sport and PA for social inclusion in Romanian schools

Introduction

The project is a collaboration between National University for Physical Education and Sports (UNEFS), Romania and Norwegian School of Sport Sciences (NSSS) with several researchers from both countries participating.

The study represents a thorough assessment of Romanian pupils (aged 10-15 years) accessibility to physical and motor activities and the way PE, PA and sports activities can play a role in facilitating a context of sustainable social integration for students with different challenges or with specific vulnerabilities.

Method

2,600 pupils and 760 teachers who work directly with the pupils participated in the study. The study involved three types of correlated surveys: questionnaire survey; structured interviews and focus groups interviews. The sociological survey involved the application of 2,600 questionnaires to the main target group (pupils with vulnerabilities). At the level of the secondary target group (teachers), 760 semi-structured interviews were applied and 16 focus groups were organized where a total of 131 teachers participated.

Results

One conclusion is that Physical education and sports class has an impact in terms of increasing the inclusion of pupils and strengthening the solidarity between pupils.

Results from the survey also show that PE, PA and sport improve relationships, favor cooperation between people from different social categories or who have different physical or psycho-emotional conditions. The study showed that PE, PA and sport can constitute a social integration solution for pupils from disadvantaged environments, and it can offer children with unfavorable conditions participation in the activities

Discussion

The project was organized based on two general research goals:

1. analyze and discuss the ways PE, sports activities and PA can be used to reduce the social exclusion of pupils with vulnerabilities.

2. analyze and discuss if PE, sports activities and PA can be used as a strategy to fight absenteeism from school.

The project has so far resulted in several publications and now a new public policy is to be drawn up to strengthen PE and PA in Romanias schools.

THE EFFECT OF A 10-WEEK PHYSICALLY ACTIVE LEARNING INTERVENTION: FOCUS ON 10-YEAR OLD PUPILS DEVELOPMENT IN MATHEMATICS

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Introduction

Regular physical activity has been proven to have a positive impact on executive functions and cognitive performance in youth. Physically active learning (PAL) with active student engagement in classroom-based lessons can effectively contribute to both the development and outcomes in academic learning and specifically, in mathematics. The use of innovative tools and their associated methods to support movement-based development in primary school mathematics is considered an area with limited research. Hence, the aim of this study is to demonstrate the effectiveness of an innovative sports tool and its associated motor coordination methods in the learning of mathematics in lower primary school pupils.

Methods

The sample of this study consisted of 4th-grade pupils from a primary school in a county town. One experimental group (EG, n=28, Mage=9,81±0,35) and one control group (CG, n=27, Mage=9,98±0,39) took part in the study. An innovative

ladder was utilized to support the teaching-learning process in mathematics during the 10-week program for EG. The total time spent using the tool for EG was 80-90 minutes per week depending on the main tasks. The teaching of mathematics of the two groups was exactly the same as related to content and process. The effectiveness of the program was assessed by completing 4 tasks of algebra and 2 tasks of geometry worksheets for both groups. Besides, 2 classroom teachers and 2 leaders of the school were interviewed to understand the experiences and impact of intervention in the school on a larger scale.

Results

The EG demonstrated significant improvements in 2 tasks of algebra, 1 task of geometry variables, and also in the overall scores. However, no statistically significant difference was found between the pre-and post-test for CG. Repeated ANOVA analysis yielded significant differences in the overall factor for group, time, and variables (F= 3.965; p= 0.00066). The in-depth interviews supported the effectiveness of the innovative sport system, not only on pupils' cognitive but also on emotional and social development. Teachers and leaders believed that the ladder was clearly developmental because it was able to provide opportunities for differentiation and to develop learning in a complex way through playful activities, while at the same time providing pupils with optimal peer and teacher support.

Discussion

Based on the present study, it can be affirmed that 15 minutes of non-traditional classroom exercise per day for 10 weeks resulted in a significant improvement in academic achievement in algebra and geometry tasks for lower primary school students. Furthermore, the program increased the levels of activity and attention and with that, pupil behavior and concentration. It is recommended to future studies to further explore PAL in different types of interventions and content areas and also include cognitive, affective, and social aspects.

OVER-TIME CHANGE IN INTERNALIZING PROBLEMS IN CHILDREN WITH DEVELOPMENTAL COORDINATION DISORDER: A TWO-YEAR FOLLOW-UP STUDY

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Introduction: Preschool children with developmental coordination disorder (DCD) are characterized by poor motor coordination which has been found to be associated with an increased risk for internalizing problems, such as anxiety or depression. However, due to a lack of longitudinal research, our understanding is limited towards the over-time change in mental health in young children, specifically within the Asian context. Therefore, this two-year study was to investigate the over-time difference in internalizing problems between preschool children with and without DCD.

Methods: One hundred and twenty-three preschool children aged between 4 and 6 years participated in this study at baseline. The Movement Assessment Battery for Children – Second edition was administered to assess their motor coordination, whereas the Child Behavior Checklist was completed by their parents to report internalizing problems. Preschool children who scored at or below the 16th percentile were further confirmed whether they met the DSM-V diagnostic criteria for DCD (n=23, 13 boys and 6 girls). All participants were asked to receive the re-assessment of internalizing problems one year later. However, only 92 children (17 DCD and 75 typical development (TD)) returned in the second year. Generalized estimating equations was used to evaluate the main effects of group (DCD vs. TD) and time (first vs. second year) and the interaction of group by time on internalizing problems, while controlling for sex and age.

Results: In Model 1 with group and time as predictors, there was a significant time effect on internalizing problems ($p = .02$) and a marginally significant group effect ($p = .07$). When adding sex and age as covariates, the time effect became non-significant, and the group effect became statistically significant ($p = .04$). Nevertheless, after the group by time interaction was further added, no any significant effect was found.

Conclusion: While controlling for sex and age, children with DCD may consistently have more internalizing problems during early childhood, compared to their TD peers. However, a non-significant group by time interaction indicates that these problems may not deteriorate over a two-year period. A longer follow-up duration is recommended to better understand the long-term development in children with DCD.

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HOW DO PARENT ATTITUDES TOWARDS PHYSICAL ACTIVITIES INFLUENCE CHILD EXERCISE BEHAVIOR?

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INTRODUCTION: The physical activity level of Japanese children has been steeply decreasing in the last decades. This study examines the hypothetical psychological model concerning how parent attitudes towards exercise and physical activities influence their childs exercise behavior.

METHODS: The subjects included 600 Japanese elementary school pupils (male: 292, female: 308, mean age=10.06, SD=0.863) and their parents (mother: 300, father: 300, mean age: 45.05, SD=5.51) who voluntarily answered a questionnaire composed of items concerning parent attitudes towards physical activities, child attitudes towards physical activities and child exercise amount. Positive Exercise Attitudes Scale (PEAS), Negative Exercise Attitudes Scale (NEAS), and Child Exercise Amount Scale (CEAS) have shown acceptable reliabilities and structural validities in previous studies, and Child Positive Exercise Attitude Scale (CPEAS), Child Negative Exercise Attitude Scale (CNEAS) were developed in this study. Exploratory factor analyses, confirmatory factor analyses, and reliability analyses were conducted to develop the CPEAS and CNEAS, and covariance structure analyses were conducted to confirm the acceptability of the hypothetical model and the relationship among subscale factors.

RESULTS: We hypothesized that parents attitudes towards physical activities would impact their childs attitudes towards exercise, influencing their behavior. The analysis showed that our hypothetical model (with the subscales of PEAS and NEAS as independent variables, CEAS as dependent variables, and CPEAS and CNEAS as mediators) yielded acceptable fit indices (GFI: 0.992, AGFI: 0.956, CFI: 0.980, RMSEA: 0.072). Parent positive attitudes had direct effects on positive child attitudes (β: 0.30, $p < 0.001$) and no significant impact on negative child attitudes(β: -0.02, n.s.), while parent negative attitudes had direct effects on negative child attitudes (β: 0.30, $p < 0.001$) and relatively small negative effects on their positive attitudes (β: -0.14, $p < 0.001$). Child exercise amount was found under more influence their positive attitudes (β: 0.43, $p < 0.001$) than their negative attitudes (β: -0.13, $p < 0.001$).

DISCUSSION:

The results indicate that the hypothetical model can be used to design programs to increase childrens exercise amount. Targeting parent attitudes towards exercise, such as providing parents with information on health and physical activities and making exercise opportunities available in the community, potentially change their childs attitudes towards physical activities and exercise level and frequency. Further research is needed to assess what interventions are effective for parents with school children.

PARENTS' EXPECTATIONS THAT FACILITATE CORPORAL PUNISHMENT BY COACHES

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Introduction

Human Rights Watch (2020) published a report entitled "I was hit so many times I can't count: Abuse of child athletes in Japan." After the death of a student who suffered corporal punishment at the hands of a teacher-coach in 2012, corporal punishment by coaches garnered significant attention; however, it remains a serious issue. Ueno (2021) cited "The Fraud Triangle" (Albrecht, 2014), which explains the factors leading to fraud, and examined the situations in which coaches resort to corporal punishment. Ueno also showed that the expectations or pressures from parents of players perceived by coaches facilitate corporal punishment. Consequently, this study aimed to clarify the type of parents' expectations that facilitate corporal punishment by coaches.

Methods

Among 299 coaches participating in a coach training course, 136 coaches of children up to high school participated in this study's survey. These participants were certified as coaches by the Japan Sport Association, and coached various sports, including track and field, sailing, and boxing. This survey was conducted to investigate coaches' experiences with corporal punishment (violence, verbal abuse, coercion, excessive training, or sexual harassment) within the past five years and the expectations and the pressures (winning, proprieties, enjoyment, teamwork and cooperation, technique and physical strength, and hard work ethics) perceived by them from parents of players.

Results

The percentage of coaches who facilitated corporal punishment in five years decreased compared to that stated by Ueno (2021). The results of a multiple regression analysis showed that the parents' expectation of teaching "proprieties" had a positive effect on coercion.

Discussion

Various initiatives are implemented for the elimination of corporal punishment in coaching. Nonetheless, these results show that coaching that relies on corporal punishment is still being carried out. The background of persistent corporal punishment, despite its strong disapproval, appears to involve parents who in certain situations facilitate corporal punishment because they expect that the sports instruction will result in various outcomes such as winning and personality development. The results of this study suggest that corporal punishment issues should not be solely attributed to the respective coach, but also study the contexts (especially stakeholders such as parents) in which it is carried out.

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EFFECTS OF ACUTE EXERCISE AT DIFFERENT VOLUME-MATCHED LOADS ON EXECUTIVE FUNCTION IN OLDER ADULTS

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The benefit of acute exercise on executive function (EF) has been observed in an increasing number of studies; however, the effect varies depending on exercise-related variables (e.g., intensity, duration). The dose relationship between acute exercise and EF was ensured by combining exercise intensity and duration (e.g., volume). The present study investigated the effects of acute exercise with different volume-matched loads on the planning dimension of EF in older adults. A total of 40 healthy participants between the ages of 55 and 70 were recruited for the study. Reading control condition and three exercise volume-matched conditions were included in the counterbalanced and repeated-measure experimental design: 1) acute exercise at a moderate intensity for a 30-min duration (M-30); 2) higher intensity exercise for 16 minutes (H-16); and 3) lower intensity exercise for 40 minutes (L-40). After each condition, we examined the Tower of London (TOL) task. Acute exercise, regardless of exercise conditions, led to greater move-related scores (i.e., total correct scores, total move scores) and time-related scores (i.e., total executive time, total problem-solving time), excluding violation-related TOL task scores, as compared to the reading control condition. Regardless of the exercise volume loads involved, these findings suggest a selective benefit in terms of TOL performance following a single bout of exercise.

EFFECT OF PARENTAL INVOLVEMENT AMONG HUNGARIAN YOUNG HANDBALL PLAYERS

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Aims and background: As elsewhere, the dropout rate of young athletes is high in Hungary, which also affects handball. The reasons for dropping out are complex, however parental support is critical to succeed or continue after failure or injury. Unfortunately, excessive parental pressure might cause negative effects on childrens psychosocial outcomes in sports. Studies also show that the childs involvement in sports could cause stress for most parents. We mapped the Hungarian youth handball players' parental involvement and the stress factors related to their childs sports. Methods: Using convenience sampling, 1,196 parents (Mage= 44; SD = 4.62) completed the online questionnaire. In addition to the psychological scales (PISQ-H, PSSS), demographic and sports-related questions were included. At least 1 child (Mage= 13.66; SD = 1.69) of each respondent played handball weekly. Results: Results of the independent samples t-test and one-way ANOVA test indicate that fathers scored lower on Praise and Understanding than mothers. Parents of children in the sampling stage showed a higher level of Directive Behavior and lower level of stress as compared to parents of those at either the specializing or the investment stage. Parents of children with previous sports injuries reported higher stress also. Parental stress showed low but significant positive partial correlations with parental pressure. Discussion: The intensity of parental stress and parental behaviour might be influenced by the childs stages of sports development. Parental involvement could decrease while parental stress increases over time.

Conventional Print Poster

CP-AP22 Force-velocity profile and testing

PREDICTING ONE REPETITION MAXIMUM FROM THE LOAD VELOCITY RELATIONSHIP IN LOWER EXTREMITY RESISTANCE EXERCISES

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INTRODUCTION: Previous research has shown that the one repetition maximum (1RM) in dynamic resistance exercises can be accurately predicted using the load-velocity relationship. There is, however, a lack of studies investigating the ability to predict 1RM in single-joint exercises in both untrained and trained participants. Therefore, the present study aimed to investigate the concurrent validity of an estimated 1RM from the load-velocity relationship compared to a measured 1RM in ten lower extremity resistance exercises.

METHODS: Twenty-two healthy adults participated in the study. Each participant attended three sessions separated by at least 48 hours. The first session was a familiarization session allowing the participants to familiarize themselves with the ten exercises and estimate their approximate 1RM for each exercise. In the second session, knee flexion, hip flexion, hip adduction, ankle dorsiflexion, and seated ankle plantar flexion were tested. In the third session standing ankle plantar flexion, knee extension, hip extension, hip abduction, and leg press was tested. The order of the exercises was randomized for each participant. In each exercise, three repetitions were performed at 20%, 40%, and 60% and one repetition was performed at 80% and 100% of the approximate 1RM load. If the participants surpassed the approximate 1RM, the

load was increased until failure. Mean velocity during the concentric phase at was computed using data from a linear transducer on all repetitions. Simple linear regressions (i.e., one for each participant and each exercise) with mean velocity as a function of load were constructed using all submaximal loads to predict 1RM. Bland-Altman plots were created to evaluate concurrent validity between measured and predicted 1RM in each exercise.

RESULTS: The coefficient of determination (R2), standard error of the estimate (SEE), and Bland-Altman mean bias (BIAS) were as follows for all exercises. Ankle dorsi flexion (R2 = 0.68±0.31, SEE = 0.014±0.010, BIAS = 1.95), Seated ankle plantar flexion (R2 = 0.73±0.25, SEE = 0.029±0.020, BIAS = 1.23), Standing ankle plantar flexion (R2 = 0.69±0.35, SEE = 0.021±0.016, BIAS = 4.34), hip abduction (R2 = 0.61±0.42, SEE = 0.055±0.027, BIAS = 0.68), hip adduction (R2 = 0.45±0.47, SEE = 0.066±0.043, BIAS = 1.04), hip extension (R2 = 0.56±0.36, SEE = 0.078±0.048, BIAS = 0.25), hip flexion (R2 = 0.61±0.37, SEE = 0.075±0.039, BIAS = 0.19), knee extension (R2 = 0.72±0.23, SEE = 0.097±0.035, BIAS = 1.27), knee flexion (R2 = 0.47±0.43, SEE = 0.075±0.042, BIAS = 0.20), and leg press (R2 = 0.69±0.21, SEE = 0.035±0.018, BIAS = 5.16).

CONCLUSION: The coefficient of determination was lower, and the standard error of the estimate larger than previous studies reported. Although BIAS between measured and predicted 1RM was low, the limits of agreement were very wide. As such, predicting the 1RM in lower extremity resistance exercises from the load-velocity relationship is not considered to exhibit high concurrent validity.

INTER-INDIVIDUAL VARIABILITY IN ENDURANCE CAPACITY IN JUMPING: A SUPPORT TO FORCE-VELOCITY-ENDURANCE PROFILES

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INTRODUCTION: Maintaining power over a series of repetitions (i.e., endurance) is key in daily physical and sporting activities. Endurance depends on exercise intensity, often quantified via power output: the higher the power output, the lower the endurance. Across individuals, some display better endurance at high power outputs, while others present better endurance at lower ones, highlighting distinct individual power-endurance profiles. Recently, endurance in jumping has been shown to also depend on the force-velocity (Fv) condition in which power is produced: at matched absolute or relative power, lower force-higher velocity conditions increased endurance [1]. However, it was undetermined whether an individual exhibiting the best endurance in high force-low velocity condition would remain so in low force-high velocity condition. Such inter-individual variability, supporting the existence of distinct individual force-velocity-endurance (FvE) profiles, is yet to be explored. Knowledge of these profiles may enhance testing and training individualization [2]. Our aims were to test the inter-individual variability in endurance across Fv conditions and to assess individuals' FvE profile.

METHODS: 14 participants performed repeated squat jumps tests during which endurance was quantified by the maximum repetitions until exhaustion. Tests were conducted in 10 force-velocity-power (FvP) conditions over 6 sessions (≥48h rest), including 3 at matched relative power output to assess FvE profile (slope of the maximum repetitions-F-v conditions relationship).

RESULTS: Correlations (absolute values of r) of endurance between FvP conditions ranged from 0.019 to 0.76, with 9 correlations being significant over 45 tested ($p<.05$). At the matched relative power output, some individuals displayed one of the best endurance in the highest force-lowest velocity condition, while others displayed one of the best endurance in the lowest force-highest velocity condition. This inter-individual variability was interpreted as force-oriented and velocity-oriented FvE profiles, respectively (FvE profiles ranged from -0.05 to -1.6, with between-individual coefficient of variation ~60%). For instance, two individuals showed similar endurance in the moderate force-moderate velocity condition (~1.5% of difference), but the one with a force-oriented FvE profile (slope: -0.2) had better endurance in the highest force-lowest velocity condition (~34% of difference), and the one with a velocity-oriented FvE profile (slope: -1.6) had better endurance in the lowest force-highest velocity condition (~57% of difference).

CONCLUSION: Endurance evaluation in a single Fv condition provides a limited view of endurance capacity in jumping, partly due to inter-individual variability in FvE profile. This profile can be approached by assessing endurance in multiple Fv conditions, and is notably of interest when facing distinct Fv conditions within the same activity.

[1] Rivière et al. (2020)

[2] Pinot & Grappe (2011)

DIFFERENCES IN LOAD-VELOCITY AND LOAD-POWER RELATIONSHIP BETWEEN MALES AND FEMALES

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INTRODUCTION: Velocity based training (VBT) is an objective autoregulation method, that uses barbell velocity to manage and quantify resistance training sessions. The minimum velocity threshold (MVT) represents the lowest velocity at which an exercise can be performed1. Evidence suggests how MVT may be different based on sex2 and excercise performed1 . The aim of the present study was to investigate sex differences in the load-velocity and load-power relationship during back squat exercise, with the hypothesis that males and females would show different profiles.

METHODS: Thirty males (age: 28 years±6.4; body weight:80kg±11.99; height: 179cm±6.70; 6.9 years of experience±3.7; 1RM/BW:1.60±0.30) and twenty-seven females (age: 24.2 years±3.45; body weight: 57.11kg±5.1; height: 164cm±4.50; 4.29

years of experience±3.7; 1RM/BW:1.54±0.28) performed an incremental 1RM test on the back squat. Barbell velocity was registered with a linear position transducer (LPT) (Vitruve; SPEED4LIFTS S.L). Load-velocity and load-power profiles of all subjects were analyzed and prediction equations were created for all subjects using a second-degree polynomial. Velocity and power output values were compared from 10% to 100%1RM in 5% increments performing indipendent t-tests. Power output was normalized for body weight during analysis.

RESULTS: Both velocity and power output were significantly different between males and females at each load including MVT (males: 0,30±0,06 m·s-1; females 0,25±0,04 m·s-1) ($p<0.05$). Males and females achieved peak power output at the same percentage of load (60% 1RM). In addition, general prediction equations were developed for both males and females, showing an excellent degree of fit for the load velocity relationship (males $R2=0.95$; females $R2=0.93$). While a poor fit was found for the general load-power equation (males $R2=0.52$; females $R2=0.36$).

CONCLUSION: ales showed higher velocities at each load, including MVT and higher power outputs at each load, both as absolute value or normalized by body weight. Both males and females achieved the peak power output at the same percentage of 1RM. The good fit of the general equation with individual data for the load-velocity relationship suggests that general equations may be used to prescribe VBT training still acknowledging their limitations.

References:

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2. Torrejón, A., et al., (2019)

INFLUENCE OF SEX AND STRENGTH DIFFERENCES ON THE LOAD-VELOCITY RELATIONSHIP OF THE SMITH-MACHINE BACK SQUAT

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INTRODUCTION: There is general agreement that movement velocity is strongly related with relative load in response to several multi-joint resistance exercises ($R^2 > 0.95$) [1] . However, the inclusion of female participants in the load-velocity relationship analysis is quite recent [2,3,4,5,6]. Additionally, despite there is some evidence that the load-velocity relationship is stable regardless of the individual strength levels, this is not a universal finding [1,7]. For instance, past research has shown that, besides differing between sexes, the load-velocity relationship varies as a function of muscle strength [3,8]. Therefore, different levels of muscle strength between males and females may confound sex comparisons in the load-velocity relationship. Unfortunately, this possible confounding factor has not yet been examined for the smith machine back squat, a variation of the back squat exercise that better accounts for technical flaws or horizontal displacements of the bar. We aimed at determining whether the load-velocity relationship of the Smith machine concentric-back squat differs between sexes and persons with different levels of strength.

METHODS: Thirty-two participants (16 males: 23.3±3.8 and 16 females: 26.1±2.7 years) were included. All participants underwent a familizarization session. Load and mean concentric velocity (MCV) were obtained individually during an incremental test (30-90% one-repetition maximum – 1RM) with a previously validated Chronojump linear position transducer, which sampled the bar's velocity at a frequency of 1000 Hz (Chronojump, Barcelona, Spain) coupled to the Smith machine.

RESULTS: We obtained strong linear relationships between the individual MCV and relative load ($R^2>0.95$). Overall, relatively strong persons reached faster MCVs throughout the full range of relative loads (effect size [ES]: 0.48–0.93), except at 1RM. We also obtained steeper slopes and higher velocity intercepts (y intercepts) in relatively strong participants (ES: 0.05 and 0.83, respectively; $p<0.01$). Finally, we found that males attained steeper load-velocity relationships (ES favoring relatively strong and weak males: 2.8 and 1.4, respectively) and higher velocity intercepts (ES favoring relatively strong and weak males: 2.0 and 1.0, respectively) than females ($p<0.0001$).

CONCLUSION: The novel finding of this study is that MCV can be used to estimate relative load on the Smith machine concentric-back squat in males and females with different levels of muscle strength, however, the load-velocity relationship is affected by muscle strength and sex. Therefore, the extraction of individual load-velocity relationships is advisable instead of computing group estimations.

1.Gonzalez-Badillo & Sanchez-Medina (2010); 2.Balsalobre-Fernández et al. (2018); 3.Torrejon et al. (2019); 4.Pareja-Blanco et al. 2020; 5.Garcia-Ramos et al. (2021); 6.Marques et al. (2021); 7.Sanchez-Moreno et al. (2017) 8.Munoz-Lopes et al. (2017)

THE INFLUENCE OF MAXIMAL ISOMETRIC STRENGTH ON COUNTERMOVEMENT JUMP PERFORMANCE AND STRATEGY

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INTRODUCTION: Countermovement jump (CMJ) performance provides valuable information regarding neuromuscular status and lower body power. Jump strategy, the movement of an athlete's centre of mass (COM) reflected by the vertical ground reaction force-time series generated during the CMJ, influences jump performance. Previous investigators (1, 2) have suggested that peak ground reaction force occurring at or soon after the moment of transition between the eccentric and concentric phase is required for a biomechanically efficient jump as it would maximise the effects of the stretch-

shorten cycle (SSC). The jump strategy required to generate early time to peak force (TPF) is described as having greater unweighting of the COM during the eccentric phase. However, this strategy is likely associated with high neuromuscular demands and some athletes may not have the required strength to effectively decelerate their COM and transfer the benefits of the SSC to concentric performance. Therefore, the aim of this study was to determine the influence of maximal isometric strength on jump strategy and CMJ performance.

METHODS: A total of 104 males (mean ± SD height: 1.80 ± 0.08 m; mass: 84.7 ± 16.5 kg; age: 21.6 ± 3.0 yr) from various sports volunteered and provided informed consent to participate in this study, which was approved by the institution's ethics committee. Each participant performed three CMJs and three isometric squat tests (ISQ) on a dual force platform (JM6090-06, Bertec, USA) and data was collected using Forcedecks (Vald Performance, Australia). Two groups were created using the group mean relative isometric force as a threshold, separating participants into strong (≥ 32.7 N.kg-1) and weak (< 32.7 N.kg-1) groups. An independent t-test and Cohen's d effect size were used to determine the effect of maximal strength on CMJ performance, TPF and eccentric phase jump strategy variables.

RESULTS: The strong group had greater jump height (43.7 ± 6.6 vs 39.8 ± 6.9 cm, $p < 0.05$, ES = 0.58) and modified reactive strength index (0.60 ± 0.13 vs 0.52 ± 0.1 AU, $p < 0.05$, ES = 0.68) compared to the weak group. All jump strategy variables were significantly ($p < 0.05$) different as strong males demonstrated lower minimum eccentric force (-7.13 ± 1.86 vs -6.14 ± 2.17 N.kg-1, ES = 0.49), greater eccentric velocity (-1.38 ± 0.26 vs -1.20 ± 0.28 m.s-1, ES = 0.66), countermovement depth (-35.3 ± 6.6 vs -32.6 ± 6.3 cm, ES = 0.42), force at zero velocity (16.1 ± 3.5 vs 13.9 ± 3.2 N.kg-1, ES = 0.68) and earlier TPF (14.3 ± 24.5 vs 26.7 ± 30.1 %, ES = 0.45) compared to the weak group.

CONCLUSION: Stronger athletes demonstrated better CMJ performance, earlier TPF, and kinematic and kinetic features reflecting a more efficient eccentric phase. It may be suggested that athletes require a certain level of strength before adopting such a jump strategy to enhance vertical force production during the CMJ.

1. McHugh et al., Transl Sports Med, 2021

2. Bayne et al., Sports Biomech, 2021

COUNTER MOVEMENT JUMP WITH ARM SWING PRODUCES MORE CONSISTENT FORCE CURVE PERFORMANCES THAN COUNTER MOVEMENT JUMP WITHOUT ARM SWING

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INTRODUCTION: Vertical ground reaction force curves during a countermovement (CMJ) can vary in shape between subjects (e.g., non-modal, unimodal, or bimodal). Thus, athletes adopt different movement strategies that may be dependent on performance related factors [1] (i.e. biological or task constraints). Studies based solely on discrete values may mask such factors [2]. On the contrary, analysing curve profiles may reveal different performance subgroups. Although previous studies exist applying clustering analysis to CMJ (vGRF data), no investigations were found for applying this type of analysis to CMJ with an arm swing, a type of jump that enhances performance. Our hypothesis was that there would be a differentiating effect of arm swing during CMJ that could be captured with subgroup analysis.

METHODS: Three hundred and thirty-two male adult high-level athletes from various sports, performed a series of CMJ and CMJ with arm swing (CMJas) on a 1D force platform. From those tests, only the best were kept for further analysis. Hierarchical cluster analysis (Ward's method) was used to extract common kinetic patterns from 1-D curves. Each curve was interpolated to a length equal to 101 points. For the hierarchical algorithm, pairwise distances were calculated using Euclidean distance. The assessment of the derived clusters' quality was conducted by calculating the cophenetic correlation coefficient between the hierarchical cluster tree and the pairwise distances. The optimal number of cluster selection was determined using the gap statistic [3].

RESULTS: Hierarchical cluster analysis revealed three distinct subgroups for the CMJ force-time curves. The cophenetic correlation coefficient for the three dendrograms was above 0,7. The sizes of those clusters were 117, 145, and 37 curves, respectively. The subgroups revealed three shapes: a bimodal with the peak ~60% of the jump duration, a bimodal with the peak at ~90% of the jump duration, and a unimodal shape with a single peak at ~80% of the jump duration. For the CMJas force-time curves, the gap statistic suggested a single cluster with a bi-modal shape with an early peak at ~65% of jump duration and a higher one later at ~90% of jump duration.

CONCLUSION: These results suggested that CMJas - vGRF shapes were more consistent with similar kinetic patterns among participants, whereas, in line with previous research, CMJ has more variability in terms of vGRF patterns. These findings also support the efficacy of clustering techniques to analyze force time curves and search for similar subgroups in the population. Further research is needed to identify the mechanical properties of momentum transfer from the arms that dictate a single performance pattern in the CMJas.

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USING MOBILE APPLICATIONS TO EASILY AND RELIABLY CAPTURE PERFORMANCE FATIGABILITY DURING FUNCTIONAL EXERCISE TEST: PRELIMINARY EVIDENCE

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INTRODUCTION: Performance fatigability refers to objective changes in a performance indicator during and/or after a physical task (1). This measure can inform on overall physical abilities and could help coaches or clinician to manage their athletes or patients. The common protocols used to evaluate performance fatigability require expensive and cumbersome equipment thus limiting their use in daily life settings (e.g. home, sport clubs). Further, implementing the systematic assessment of performance fatigability in some widely used field tests (e.g. one minute sit-to-stand test, STS1min) could help in overcoming their drawback of being self-paced, with the test performance (i.e. number of repetitions for the STS1min) potentially influenced by pacing strategies. We aimed to overcome these issues dealing with the evaluation of performance fatigability in two different studies.

METHODS: A first study aimed to create a test that could easily capture performance fatigability and assess its test-retest reliability. We asked participants to perform the isometric wall squat exercise during successive stages of incremental duration. Participants performed two squat jumps and two sit-to-stand (from a chair) exercises at the end of each stage. We used MyJump (2) and Sit to Stand (3) mobile applications to assess performance fatigability through the kinetics of changes in squat jump height (SJh) and sit-to-stand time (STSt), respectively.

In a second study, we aimed to determine if the STS1min could induce a significant and reliable level of performance fatigability, as assessed by the pre-post decline in STSt measured with the Sit to Stand mobile application (3). In both projects, participants (young healthy adults, study 1: N = 16; study 2: N = 24) performed the test in two separate days.

RESULTS: The new test we developed in the first study was able to induce progressive levels of performance fatigability, reaching at exhaustion a decrease of 22±11% in SJh, and an increase of 31±13% in STSt. Changes in both fatigability indicators were highly reliable (e.g. CV of 4.8% and ICC of 0.88 for SJh recorded at isotime).

In the second study, we observed a significant pre-post decrease of 8±6% in STSt after the STS1min. Changes in this fatigability indicator was associated with a good relative test-retest reliability (ICC of 0.86).

CONCLUSION: We proposed through these two studies new, low cost, and easy to implement alternatives to assess performance fatigability in an ecological fashion. The use of various fatigability indicators is a tremendous advantage to be considered with very distinct populations, e.g. athletes, patients. One important next step will be the establishment of reference values in a wide range of age groups, ensuring optimal interpretation in specific populations.

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RELATIONSHIP BETWEEN CHANGE OF DIRECTION ABILITY AND LOWER-LIMB STRENGTH AND POWER MEASURES IN JUNIOR FEMALE RUGBY LEAGUE ATHLETES

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INTRODUCTION: Research has demonstrated that change of direction (COD) ability is dependent upon factors such as anthropometry, technique, linear sprinting speed and leg muscle qualities (1). However, almost all COD research has been limited to male athletes that have been reported to possess different physical capacities and COD abilities to female athletes (2). Therefore, this study aimed to determine the relationships between COD ability and lower-limb strength and power measures in junior female rugby league athletes.

METHODS: Semi-elite junior female rugby league athletes (n=27, 17.5±0.5 yr; 1.7±0.5 m; 71.5±13.0 kg) were recruited for the study. Athletes underwent countermovement and squat jump testing using a linear position transducer (Gymaware, Fusion Sport, Australia) (3) The isometric mid-thigh pull (IMTP) was performed on a custom rig and measured using portable force plates (ForceDecks, VALD, Australia) (4). 10m linear sprint speed was assessed through a 40m sprint using electronic timing gates (Fusion Sport, Australia), from which 10m sprint momentum was calculated (2). COD ability was assessed bilaterally through the 505-test using electronic timing gates from which COD deficit was calculated (5). Repeat efforts were provided with adequate recovery provided. Descriptive statistics were calculated, and a multiple stepwise linear regression used to determine the strength of the relationships between COD ability and lower-limb strength and power measures.

RESULTS: The 505-time (mean ± SD) between left (2.44±0.12 s) and right (2.23±0.13 s) sides was similar and therefore, the mean 505-time (2.44±0.12s) was used for further analysis. The mean COD deficit was 0.46±0.08s. The (absolute; [relative]) power measures for the CMJ (2810±500 W; [39.7±0.5.4 W.kgBM-1), SJ (2748±477 W; [38.8±5.2 W.kgBM-1) and IMTP (1940±283 N; [2.8±0.4 N.kgBM-1). Lastly, the 10m sprint time was 1.98±0.09 s, equating to a 10m sprint momentum of 361±61 kg.m.s-1. The statistical model demonstrated good fit ($F(2,24)=39.181$, $p<0.001$, $R2=0.766$) with COD ability, despite including only body mass (ß=0.006 [0.004-0.009; $p<0.001$) and 10m sprint momentum (ß=0.028 [0.020-0.036; $p<0.001$).

CONCLUSION: The results demonstrate that only body mass and sprint momentum demonstrated a relationship with COD ability in junior female rugby league players. The data demonstrate that female athletes with higher body masses and subsequently higher sprint momentum tended to possess poorer COD abilities. Interestingly, no measure of lower-limb strength or power demonstrated a significant relationship and hence was not included in the multiple regression model related to COD ability. Future research should continue to explore how the physical capacities of female athletes relate to COD ability to inform future training practices of team-sport athletes.

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OPEN TRAP BAR, A VALID MODALITY FOR ASSESSMENT OF POWER, AND FORCE-VELOCITY PROFILE IN WEIGHTLIFTERS' SQUAT JUMPS.

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INTRODUCTION: Power and force-velocity profile can be easily assessed through ballistic movements, such as squat jump (1). However, these tests may not be specific to certain disciplines like weightlifting and may pose an additional risk when heavy loads are used. In a recent study, authors (2) compared the data obtained from squat jumps with a hexagonal bar, using both a strength platform and the Samozino method. They found that the results were highly valid for calculating force-velocity profile parameters. However, no comparison has been made with a conventional weight bar (CWB) in back squat, which is more traditionally modality. Therefore, the aim of this study was to determine the validity of an open trap bar (OTB) during squat jump to assess vertical force-velocity profile parameters, in comparison to bask squat jumps with CWB, i.e., the reference modality.

METHODS: Seventeen weightlifters (10 males and 7 females; age: 22.4 ± 2.7 years; height: 1.72 ± 0.35 m; body mass: 66.35 ± 11.56 kg; 2 to 3 training sessions by week) participated in this study. They performed four vertical jumps with different additional load (0%, 25%, 50% and 75% of their body mass) in back squat jump with CWB and squat jump with OTB. All force-velocity profile output variables (theorical maximal force, F0; theorical maximal velocity, V0; maximal power, PMAX; slope of force-velocity profile, SF-v and force-velocity imbalance; F-vIMB) were calculated using system mass, push-off distance, and jump height. Validity of OTB was determined by comparing the results of the OTB to those obtained with the CWB, using Pearson correlation, coefficients of variation and bias.

RESULTS: Nearly perfect correlations ($r > 0.90$; $P < 0.001$) were observed between force-velocity profile outputs obtained using CWB and OTB for all calculated variables (F0, V0, PMAX, SF-v and F-vIMB). The results showed bias values and narrow 95% confidence interval for maximal jump height (-0.01 m [-0.05–0.03]), F0 (79.7 N [-147–306]), V0 (0.04 m·s-1 [-0.33–0.42]) and PMAX (30.8 W [-243–181]).

CONCLUSION: Squat jumping with an OTB is a valid alternative to back squat jumping with a CWB for assessing the force-velocity profile parameters. Jumping with the OTB is more specific to certain disciplines, such as weightlifting, and may allow using heavier loads for testing. Indeed, the independence between the trunk and load likely leads to a more forward position of the center of mass, which is more specific to weightlifting.

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CUSTOM-MADE BADMINTON-SPECIFIC FITNESS TEST DISCRIMINATES COMPETITIVE LEVEL OF PLAYERS

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INTRODUCTION: Badminton is an intensive sport and demands both aerobic and anaerobic capacities (Phomsoupha and Laffaye, 2015). Many lunge steps are performed with unequal loads on each side of the legs in the game. Therefore, conventional tests consisted of cyclic and symmetrical exercises (e.g., running, pedalling) may not evaluate the physical fitness of badminton players. We have found that the anaerobic power test on a bike or the lactate curve test by running could not discriminate the physical fitness between international and national levels (unpublished data). Therefore, we developed a novel badminton-specific fitness test and examined if that could discriminate the competitive level of players.

METHODS: Ten collegiate women competitive badminton players participated in the study. Five of them earned a podium of the Japanese intercollegiate tournament (highly-trained), while the others were unable to participate (trained). The participants performed the badminton-specific test on a court. They reacted quickly with badminton-specific movements to sensors located at four corners of the court from the center. The direction was pseudo-randomly selected by software and displayed on a monitor located on the opposite court. They reacted eight times at specific intervals (depending on the stage, described below), which were repeated six sets with a rest of 20 seconds in each stage. There were three stages in the test and exercise intensity was increased by shortening the intervals between each reaction, such as 1.2, 1.0, and 0.8 seconds for stage 1, stage 2, and stage 3, respectively. The time from the displayed direction to reaching the sensors (reach time) were averaged in each stage. Blood lactate accumulation (BLa) was measured from finger tips between

stages (rest of 75 seconds). The effect size (r) was calculated to compare averaged reach time and BLa between competitive levels. The value of r was interpreted as 0.10 < r ≤ 0.30 for small effect, 0.30 < r ≤ 0.50 for medium effect, and 0.50 < r for large effect.

RESULTS: Reach times were shorter in highly-trained than in trained with medium or large effect sizes (stage 1: 1.56 ± 0.03 s vs 1.62 ± 0.03 s, r = 0.50; stage 2: 1.56 ± 0.03 s vs 1.63 ± 0.08 s, r = 0.36; stage 3: 1.55 ± 0.03 s vs 1.63 ± 0.06 s, r = 0.69). BLa were lower in highly-trained than in trained with medium effect size (stage 1: 2.9 ± 0.2 mM vs 5.1 ± 2.5 mM, r = 0.50; stage 2: 3.8 ± 0.7 mM vs 6.0 ± 3.3 mM, r = 0.46; stage 3: 5.8 ± 2.0 mM vs 7.6 ± 3.5 mM, r = 0.33).

CONCLUSION: As there were no differences in the lactate curve test by running between highly-trained and trained in the present study (unpublished data), it is suggested that the badminton-specific fitness test can discriminate the competitive level of players. It is possible that elite players move quickly and economically in badminton-specific steps.

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CP-AP23 Endurance Testing

DETERMINATION OF RUNNING CRITICAL POWER AND W´ THROUGH TWO-TIME TRIALS

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INTRODUCTION: The power-duration curve (PDC) enables the identification of critical power (CP), which represents the maximal work rate at which the metabolic stability is sustainable, and the work capacity over CP (W´), referring to determining the time to exhaustion (TTE) at the severe intensity domain. CP shows a strong correlation and non-significant differences with the work rate associated with the respiratory compensation point. W´ can accurately estimate the TTE at the severe domain.

Although the CP concept determines that PDC should be constructed with four to five-time trials, the linearity of the work-time (CPwork) and power-1/time (CP1/time) relationship along such intensity enables the use of two-time trials. Thus, this study aims to determine the level of agreement of CP and W´ values obtained from different two-time trial combinations with the ones derived from five-time trials using the linear CP models.

METHODS: Fifteen highly trained athletes participated in the study. PDC was defined through five-time trials (i.e., 3, 4, 5, 10, 20 min) during a three-week training period. CP and W´ were defined through the CPwork and CP1/time using five and different two-time trial combinations.

After a warm-up, athletes began the time trial under the instruction of completing the longest distance possible. The five-time trials were performed on a 400 m track at a self-selected pace. To determine mean absolute running power (in W) for each trial, a Stryd running power meter was attached to the laces of the right shoe of the participants. The reference values for CP and W´ were derived from five-time trials and also obtained from the different two-time trial combinations. The level of agreement (LoA) was examined using systematic bias, coefficient of determination and standard error of the estimate obtained from linear regression analysis, and intraclass correlation coefficients using a two-way mixed model for absolute agreement. An acceptable LoA was considered when the following criteria were met: low bias and SEE (CP: < 14 W [corresponding to ± 5%mean CP]; W´: < 2.0 kJ [corresponding to ± 10% mean W´]), R2 > 0.90, and ICC > 0.81. Statistical significance was set at P ≤ 0.05.

RESULTS: 7 min between the short and long-time trial was required to obtain a valid two-point combination. The 3-10 min was the shortest valid combination for CPwork (Bias: 9.2 [4.3 to 14] W; SEE: 9.0 W; ICC: 0.99 [0.87 to 0.99]; R2: 0.98) and CP1/time (Bias: 3.3 [-0.2 to 6.9] W; SEE: 6.4 W; ICC: 0.99 [0.99 to 1.00]; R2: 0.99). For W´, validity criteria was not met for any two-time trial combination.

CONCLUSION: CP parameter can be accurately estimated from two-time trials. For both CP linear models, the 3-10 minutes was the shortest valid combination, while the 3-20, 4-20 and 5-20 min showed the greatest LoA with CP derived from five-time trials. The W´ presented a high SEE in both CP linear models when using the five-time trials. Thus, none of the two-time-trial combinations reach an acceptable level of accuracy

REVISITING THE VALIDITY OF THE MAXIMAL AEROBIC POWER CONCEPT: THE MECHANICAL WORKRATE AT VO2MAX IS AN ARRAY, NOT A VARIABLE.

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INTRODUCTION: The terms "maximal aerobic power" (MAP) and "velocity at maximal O2 uptake (VO2max)" are conceptually similar and extensively used in the exercise sciences. There are multiple definitions for MAP, including: a) the lowest power output (PO) that elicits VO2max during an incremental test, b) the peak power in said test (PPO), and c) the PO esti-

mated from extrapolation of the submaximal VO2 vs PO linear regression. Each definition disregards the dissociation between VO2 and PO during incremental testing compared to constant work rate exercise and assumes a unique PO corresponding to VO2max i.e. MAP is a variable. However, it is well documented that activities performed within the severe exercise intensity domain should elicit VO2max if enough time is provided for the full expression of the VO2 slow component. The aim of this study was to test the hypothesis that a range of POs at or below PPO would elicit VO2max and therefore, that MAP should be conceptualized as an array , not a variable.

METHODS: Eight recreationally active individuals performed a ramp incremental test (30 W/min) and 3-4 time to task failure (TTF) trials at PO ranging from 70 to 100% of ramp test PPO (nb: one participant did not complete a TTF at 90% PPO). Breath-by-breath VO2 was recorded during all trials and converted to 20 s moving averages. VO2max was taken as the maximal value recorded during the ramp test, and VO2peak was taken as the highest recorded during each TTF trial. VO2max and VO2peak for each TTF trial were compared using a paired-samples T-test, in addition to Bland-Altman analyses. VO2peak for each TTF was also compared individually to VO2max, assuming a threshold of <100 mL/min to be considered equivalent.

RESULTS: Group mean VO2max was 3.81 ± 0.64 L/min. Participants reached a VO2 within 100 mL of VO2max at 94.4±3.2% of PPO during the incremental test, which occurred 10-70 s before task failure. VO2peak during the TTF trials was not significantly different (p>0.05) to VO2max at 70% PPO (3.69±0.69 L/min, N=8), 80% PPO (3.90±0.71 L/min, N=8), 90% PPO (3.79±0.66 L/min, N=7) and 100% PPO (3.73±0.65 L/min, N=8) . Bland-Altman mean bias was 112 (95% CI -260–485) mL/min, -96 (-435–242) mL/min, -91 (-222.6–203) mL/min, and 74 (-244–391) mL/min for the 70, 80, 90 and 100% PPO TTF trials. Duration of TTF was 752±352 s, 334±75 s, 194±51 s and 129±27 s at 70%, 80%, 90% and 100% PPO, respectively. Six, 7, 5, and 6 participants achieved a VO2peak within 100 mL/min at 70, 80, 90, and 100% PPO, respectively.

CONCLUSION: During constant workrate exercise to task failure in the severe intensity domain, VO2max was elicited across a range of PO, which extended beneath the lowest PO at which VO2max occurred during an incremental test. These results confirm that MAP is an array and therefore, the validity of the MAP concept should be revisited, as there is not a unique PO associated with VO2max.

MECHANICAL POWER OUTPUT AT 4 MMOL/L BLOOD LACTATE OF ELITE JUNIOR ROWERS IS ASSOCIATED WITH LONG-TERM CAREER ATTAINMENT

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INTRODUCTION: It is well established that successful rowers exhibit larger anthropometrical characteristics and higher laboratory-based performance than their less successful peers. While talent identification programs in juniors typically include performance and anthropometric variables, their effect on long-term career attainment has not been sufficiently examined. Similar to a previous study focusing on anthropometrics [1], we aimed to assess the effect of laboratory-based performance outcomes on long-term career attainment in elite junior rowers.

METHODS: Retrospectively, 976 junior German national team rowers (female n=427) from 1992-2018 were grouped according to their highest progressive career level, being U19-, U23-, Senior World Championships (WCh), or Olympic Games (OG). We analyzed differences in absolute (P4) and allometrically scaled (P4-index=P4/(body mass +15)^(2/3)) power output at 4 mmol/L blood lactate (5-6x4min step test) and tested their effect on long-term career attainment. Therefore, a one-way ANOVA with post-hoc test (Bonferroni correction) and proportional odds model (POD) with odds ratio (OR) analysis was applied.

RESULTS: Distribution for those female and male rowers reaching the U19-level as highest progressive career level was 53.4% (P4 231 ±18 W, P4-index 11.8 ±0.8 W/(kg+15)^(2/3) and 52.8% (322 ±24 W, 14.9 ±1.0 W/(kg+15)^(2/3), reaching U23-level: 26.9% (235 +18 W, 12.1 +0.9 W/(kg+15)^(2/3) and 29.9% (337 ±27 W, 15.4 ±1.2 W/(kg+15)^(2/3), reaching WCh-level10.1% (239 ±18, 12.3 ±0.9 W/(kg+15)^(2/3) and 7.1% (344 ±26 W, 15.6 ±1.0 W/(kg+15)^(2/3), reaching OG-level 9.6% (247 ±18 W, 12.7 ±0.9 W/(kg+15)^(2/3) and 10.2% (353 ±30 W, 16.0 ±1.2 W/(kg+15)^(2/3), respectively. We calculated significant medium to large effects for P4 ($F(3,426) = 9.504$, $p<.001$, $\eta2 = 0.063$ and $F(3,548) = 31.937$, $p<.001$, $\eta2 = 0.150$) and P4-index ($F(3,426) = 16.320$, $p<.001$, $\eta2 = 0.104$ and $F(3,548) = 24.201$, $p< .001$, $\eta2 = 0.118$) among female and male progression levels. Further, both P4 (OR=1.024, p<0.001 and 1.029, p<0.001) and P4-index (OR=1.983, p<0.001 and 1.872, p<0.001) had significant effects on career attainment in females and males.

CONCLUSION: Our findings suggest that higher P4 and P4-index within a group of adolescent elite junior rowers are associated with long-term career progression in international elite rowing. Importantly, in females the allometrically scaled P4-index had larger effects compared to unscaled P4. Our data set may be used as thresholds associated with career success. However, as maturation to the elite senior level is inherently multi-dimensional, laboratory-based performance outcomes like P4 must not be exclusively used for talent identification. Rather, a holistic approach including at least anthropometric, physical, skill, and mental variables should be applied.

1.Winkert et al. (2018)

AGE-RELATED DIFFERENCES IN BLOOD LACTATE ACCUMULATION AND MAXIMAL BLOOD LACTATE CONCENTRATION IN RECREATIONAL ENDURANCE ATHLETES

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INTRODUCTION: In endurance performance diagnostics, training zones are usually defined based on individual blood lactate curves, which are influenced by maximum blood lactate concentration (Lamax). As there is a decline in Type-II muscle fibres with high capacity to produce lactate with ageing, a change in lactate production in skeletal muscles might occur. Therefore, the study aims to investigate whether age has an impact on blood lactate accumulation as well as maximal blood lactate concentration. For this purpose, a retrospective observational approach was implemented using endurance performance diagnostic data of the last decade.

METHODS: A cohort of recreational endurance athletes (n = 264) was drawn from a larger database (n = 2040) who completed a multistage incremental endurance test until exhaustion on either treadmill or cycling ergometer and met the following inclusion criteria: integrity of data, stage duration (3 or 5 min) and maximal exhaustion (RPE > 16). In all subjects, blood lactate samples were taken during a 30-second break after each stage. Statistical data analysis was divided into three approaches. First, a sample of subjects at High-Performance Age (HPA, n = 70; 45 male and 25 female, 24.6 ± 3.3 years) was matched pairwise to athletes at Master´s Age (MA, n = 70; 45 male and 25 female, 55.5 ± 5.5 years) on sex, type of test and stage duration. Descriptive statistics were used to compare Lamax between the two age groups. Second, averaged blood lactate curves in the groups were evaluated graphically to assess the practical relevance of differences in Lamax. Third, several mixed regression models with age, sex and type of test as predictors and random effects for individuals using the full sample were conducted. The models were compared by the goodness of fit (Akaike and Bayesian information criteria).

RESULTS: Lamax was higher in the High-Performance Age group (10.76 ± 2.34 mmol·l-1) than in the Master´s Age group (7.85 ± 2.25 mmol·l-1 ; $p < .001$). Regression analysis predicts lower Lamax with increasing age. However, the age-related effect on Lamax was lower than the difference between the groups HPA and MA (1,20 mmol·l-1). Average blood lactate curve analysis showed overall lower blood lactate concentration (La) in MA. The exponential rise of La (increase in the curve´s tangent angle) is higher in HPA group resulting in higher Lamax.

CONCLUSION: An age-related decline in Lamax and a difference in blood lactate accumulation within incremental performance testings was observed. This suggests a lower rate of lactate production in Master Athletes. Possible reasons may be an age-related or training induced decline in Type-II muscle fibres or a higher aerobic capacity of Master Athletes. In practical terms, training zones may be adjusted to average lower La in Master´s to prescribe targeted training. Further, exercise at high-intensities in Master´s may reduce age-related effects. However, whether it should be aimed for higher La is depending on training objectives.

PATTERN OF THE HEART RATE PERFORMANCE CURVE IN MAXIMAL GRADED TREADMILL RUNNING FROM 1100 HEALTHY 18-65 YEARS OLD MEN AND WOMEN: THE 4 HAIE STUDY

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INTRODUCTION: Heart rate performance curve (HRPC) in maximal incremental cycle ergometer exercise has been shown to be neither linear nor uniform (1) and three different patterns (downward, linear and inverse) have been prescribed with some main implications for exercise prescription. A downward deflection was the most frequent and was suggested the regular version (2). However, no detailed data for running exercise are available yet. This study therefore investigated the deflection of the HRPC in maximal graded treadmill tests (GXT) from the 4 HAIE study (3). We hypothesized a similar distribution of HRPC patterns as in the cycle ergometer results (4) and comparable dependence on sex, performance and age.

METHODS: Additional to maximal values, the first and second ventilatory thresholds as well as the degree and the direction of the HRPC deflection (kHR) were determined from 1100 active (60%) and sedentary (40%) subjects (489 women) GXTs with diagnostic software (Vienna CPX Tool) by applying linear regression analyses. HRPC deflection was categorized as downward ($kHR < -0.1$), linear ($-0.1 \leq kHR \leq 0.1$) or inverse ($kHR > 0.1$) curves. Four (even split) age- and two (median split) performance-groups were used to investigate the effects of age and performance on the distribution of regular (downward) and non-regular (linear + inverse) HR curves for male and female subjects.

RESULTS: Men (age: 36.8 ± 11.9 yrs, BMI: 25.0 ± 3.3 kg.m-2, VO2max: 46.4 ± 9.4 ml.min-1.kg-1) and women (age: 36.2 ± 11.9 yrs, BMI: 23.3 ± 3.7 kg.m-2, VO2max: 37.4 ± 7.8 ml.min-1.kg-1) presented 556 / 449 (91% / 92%) regular downward deflecting, 10 / 8 (2% / 2%) linear and 45 / 32 (7% /6 %) inverse HRPC´s. Chi-squared analysis revealed a significantly higher number of non-regular HRPC´s in the low-performance group and with increasing age. Binary logistic regression revealed that the odds ratio (OR) to show a non-regular HRPC is significantly affected by maximum running speed (OR = 0.840, 95% CI = 0.754 - 0.936, p = 0.002) and age (OR = 1.042, 95% C I= 1.020 - 1.064, $p < 0.001$) but not sex.

CONCLUSION: Like in cycle ergometer exercise, three different patterns for the HRPC were identified from the maximal incremental treadmill exercise with the highest frequency of regular downward deflecting curves but no differences between males and females. Older participants and participants with a lower performance level had a higher probability to show a non-regular linear or inverse curve which needs to be considered for exercise prescription.

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SELF-REPORTED VAS SUBSTITUTING RPE TO EVALUATE EXERCISE LOAD IN AN INCREMENTAL RUNNING TEST

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INTRODUCTION: Incremental exercise tests identify the dynamic relationship between external load and integrated physiological systems. Although a combination of the rate of perceived exertion (RPE, using the Borgs 6-20 scale) and physiological parameters (e.g., blood lactate, BLa) contributes to load quantification during incremental running tests, finely-marked intensity zones and previous values of RPE might interfere next self-assessment, amplifying the inconsistency between subjective and objective values in continuous use. it might correlate more to accumulative load (refered to BLa concentration profile). One way to circumvent the interference of previous values is by using a visual analogue scale (VAS) on which the subjects have to indicate their feeling of fatigue using a slider which is reset every time, it might correlate more to accumulative load (refered to BLa concentration profile).

METHODS: Eighteen healthy trained (398.8 ± 102.4 km/month) male long-distance runners (21.5±2.0 yr; 178.6±5.0 cm; 70.3±6.0 kg) were recruited. They performed a 2-phase incremental running test to exhaustion on the treadmill with +1% slope. Each runner had a 5-min familiarization and standardized warm-up 3 min prior to the test. The first phase of the test consisted of 5 constant velocity stages, and the second phase was a continuous progressive run until exhaustion. The initial velocity was 7 km/h for 5 min and it increased 2 km/h after each stage in first phase, while a 1 min interval between each stage was set for negative recovery and blood sampling. The continuous stage started at 15.5 km/h and increased 0.5 km/h per minute until exhaustion. Verbal encouragement and performance feedback were given for motivation every minute. Immediately before and after the test, immediately after every stage, a 20 μL earlobe capillary blood sample was collected for BLa concentration profile. During 10-s blood sampling, RPE and VAS were utilized in a random sequence with a 5-s interval to evaluate perceived load as subjective fatigue.

RESULTS: Before exhaustion, Pearsons correlation (n=107) showed a stronger relationship of BLa-VAS (r=0.90, p<0.001) than BLa-RPE (r=0.87, p<0.001), although both were strong. Optimal results of regression indicated that RPE increased more as a linear (y=0.38x+6.83, R^2 = 0.84), while VAS (y=-0.002x^3+0.122x^2+0.45x+9.04, R^2 = 0.77) changed in parallel with the BLa profile (y=-0.0006x^3+0.036x^2-0.29x+1.87, R^2 = 0.70) as a typical curve relationship. The average subjective feeling of exhaustion reflected on the RPE was 19, which corresponded to 87 AU on the VAS.

CONCLUSION: Based on the current incremental exercise test we conclude that the VAS had a stronger correlation with the BLa profile, closer matching the load accumulation than RPE did. This indicates it might be more suitable for measuring acute training load. Further integration of the VAS in training monitoring and quantification can be considered.

AGE AND GENDER SPECIFIC EVALUATION OF TWO DIFFERENT ENDURANCE TESTS IN TENNIS – HIT & TURN TENNIS TEST AND YO-YO INTERMITTENT RECOVERY TEST

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INTRODUCTION: The aim of the present study was to compare the validity of two different endurance field tests for elite junior tennis players based on the correlations between the main performance outcomes and the national ranking position as well as on the comparison of the characteristics of age and gender specific performance.

METHODS: 378 nationally ranked junior male (m) and female (f) tennis players of different age groups (U12, U14 & U16) completed the Hit & Turn Tennis Test (HTT) [1] and the Yo-Yo Intermittent Recovery Test Level 1 (YY) [2] under similar standardized conditions. 50 players completed both tests, separated by six months. Test results are described by the total distance covered as well as by VO2max (estimated by equations [1],[2]) and HRmax. Tennis performance is defined by the age and gender specific position on the national ranking list. Correlations are calculated by Pearson's correlation coefficient (r) and means were analysed using one-way ANOVA and t-test (95% confidence intervals).

RESULTS: Total distance covered significantly correlated between both tests (r=0.68, p<.001) and increased significantly with age in males and females during both tests with males reaching a significantly higher test performance than females (HTT: m=2137±378m; f=1827±343m; p=.004 and YY: m=1268±430m; f=885±276m; p<.001). Estimated VO2max (r=0.64, p<.001) and HRmax (r=0.56, p<.001) were correlated as well between both tests with similar values in HRmax but significantly different values for VO2max (e.g., HTTm14: 60.7±4.0 vs. YYm14: 47.7±3.0 ml/min/kg). Low to moderate correlations were found between the total distance covered and the official ranking position in both tests for almost each group (HTT vs. YY in m12: r=-0.26 vs. r=-0.11; f12: r=-0.29 vs. r=-0.27; m14: r=-0.12 vs. r=-0.39; f14: r=-0.22 vs. r=-0.27; m16: r=0.15 vs. r=-0.10; f16: r=-0.60 vs. r=0.03). A strong and significant correlation between endurance performance and ranking was only found for f16 during HTT (r=-0.60, p=.003).

CONCLUSION: Both, HTT and YY can monitor the age and gender dependent endurance performance development and lead to a similar maximum cardiorespiratory exhaustion (HRhtt: 200±7; HRyy: 200±8 bpm). Inconsistent VO2max values for YY demonstrate that indirect equation might underestimate the actual VO2max for junior age groups. The difference can be explained using different equations for the estimated VO2max for each gender and age group during the HTT.

Differences in the test specific external load can explain the correlation for the U16 group with other physiological parameters become more relevant during adolescence in male and female. Regarding the validity of both tests for tennis specific endurance performance no clear distinction can be made since the correlations of both tests to the ranking position remains low to moderate. Tennis specific endurance (HTT) might be more important for the overall tennis performance in older female junior players.

1. Ferrauti et al., 2011

2. Bangsbo et al., 2008

THE SAME PHYSIOLOGICAL VARIABLES WERE RELATED TO MIDDLE DISTANCE PERFORMANCE IN RUNNING AND IN DOUBLE POLING

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INTRODUCTION: There has already been established a relationship between middle distance performance and maximal aerobic speed (MAS; 1) and maximal anaerobic speed (MANS; 2). Equivocal findings have been reported regarding the impact of anaerobic capacity measured as either maximal accumulated oxygen deficit (MAOD) or time to exhaustion (TTE) at a supra-maximal intensity related to MAS (3,4). The purpose of the present study was to compare the impact of MAS, MANS, TTE and MAOD on 800 m time trial performance in running and in double poling in a ski ergometer.

METHODS: 55 healthy active adults (37 running and 18 double poling) participated in the present study. In running, maximal oxygen consumption (VO2max), oxygen cost of running (Cr), time performance at 100 m (100TT) and 800 m (800TT), and TTE at 130 % of MAS were measured. In double poling, the participants were tested for peak oxygen uptake (VO2peak), oxygen cost of double poling (CDP) and 100TT, 800TT and TTE at 130 % of MAP in a Concept 2 Ski Ergometer. MAS was calculated as VO2max/Cr in running and as VO2peak/CDP, presented as maximal aerobic power (MAP), in double poling. MANS and maximal anaerobic power (MANP) were calculated from the 100TT performance in running and double poling.

RESULTS: Both MAP and MANP in double poling ($r = -0.936$ and -0.922, respectively, $p < 0.01$) and the relationship between 0.8 MAS + 0.2 MANS in running ($r = -0.836$, $p < 0.01$) correlated strongly with 800TT. Neither in double poling nor running, did TTE correlate with 800TT. There was no correlation between MAOD and 800TT in double poling.

CONCLUSION: The findings in this study shows that 800TT is determined by MAS/MAP and MANS/MANP in both running and ski ergometer double poling. Anaerobic capacity measured as either 130 % MAS/MAP or MAOD do not seem to be a determining factor for middle distance performance.

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A VERIFICATION PHASE ADDS LITTLE VALUE TO THE DETERMINATION OF MAXIMUM OXYGEN UPTAKE IN TRAINED YOUNG ADULTS

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INTRODUCTION: The main objective of this study was to investigate if performing a supra- or submaximal constant exercise test to exhaustion, termed verification phase, following an incremental exercise test provides additional value in the determination of the true maximum oxygen uptake (VO2max).

METHODS: Seventeen males and fourteen females performed two incremental exercise tests to maximal voluntary exertion. Immediately after both exercise tests, a verification phase was performed, with the load in one verification phase being 95% and in the other 105% of the previously achieved maximum workload. The duration of the recovery phase prior to the verification phase lasted until capillary blood lactate concentration was ≤ 3 mmol/L. If a VO2 plateau occurred during the incremental test the following verification phase was termed as no added value, since true VO2max was already determined. If no VO2 plateau occurred and the verification VO2 was < 97%, between 97-103%, or > 103% of the highest VO2 achieved in the incremental test, no added value, uncertain added value, and certain added value was attributed to the verification phase, respectively.

RESULTS: Participants mean VO2peak was 60 ± 8 mL/kg/min. Overall, in 50% of the 62 incremental tests performed, a VO2 plateau occurred, providing no additional added value from the subsequent verification phase. Of the remaining 31 tests where no VO2 plateau occurred, no added value, uncertain added value, and certain added value were obtained in

the 95% verification phase in 35%, 65%, and 0%. Considering the 105% verification phase, the values were 64%, 36%, and 0%, respectively.

CONCLUSION: Because of an additional physical strain, particular time expenditure, and no certain added value in any case, the benefit of conducting a verification phase is questionable.

Conventional Print Poster

CP-SH15 Stress and anxiety

STUDY OF THE PSYCHOLOGICAL PROCESS DURING THE ANTERIOR CRUCIATE LIGAMENT INJURY USING THE TRAJECTORY EQUIFINALITY APPROACH (TEA)

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Introduction

Anterior cruciate ligament (ACL) injuries are severe, potentially life-altering injuries for athletes. While the importance of ACL injury prevention has been emphasized, the incidence of ACL injuries has remained the same; internal and external factors leading to ACL injuries have been classified and reported, but the psychological processes of athletes who sustain ACL injuries need to be better understood. In this study, we focused on the process of ACL injury in athletes and attempted to typify the psychological approach by comparing multiple experiences.

Methods

Semi-structured interviews were conducted with six patients (2 males and 4 females) who underwent ACL reconstruction from April 2020 to March 2022. The analysis method used was the Trajectory Equifinality Approach （T EA）

Results

In games and practices where ACL injuries were sustained, athletes who were highly motivated by their sport affected their psychological state during competition as their condition on the day of the injury and their athletic performance were affected by the competitive situation. The process of ACL injury was shown to be a result of changes in concentration due to the expression of emotions of wanting to win the game and win the match against the opponent and choosing to make decisions such as modifying the play or making a decision to play.

Discussion

A possible factor in athletes selection of injury-risk behaviors is that changes in their psychological states during competition may contribute to their obsession with winning.

The psychological states of the study subjects changed significantly during the competition compared to before, suggesting that the psychological state during the competition may vary depending on ones performance in the contest and the competitive situation. Furthermore, changes in a psychological state may contribute to the obsession with winning. The subjects in the present study played sports with a strong will to win and improve their skills. Athletes with these personality traits strongly desire to fully demonstrate their athletic performance and gain an advantage in the battle. In other words, the athletes athletic performance status and the competitive situation significantly distort the athletes subjective view. As a result, the athletes psychological state during competition may change, creating a desire to take advantage of the game and a strong desire not to lose the match, thus demanding a higher level of athletic performance from themself.

Thus, the change in psychological state fosters a focus on winning, which may induce behaviors that are more demanding than the athletes own body can tolerate and may put the athlete at risk for injury.

To prevent serious sports injuries such as ACL, it may be necessary to examine biomechanical and medical aspects from an interdisciplinary perspective, including behavioral science.

THE EFFECTS OF EXERCISE AND SPORT SCIENCE OBJECTIVE STRUCTURED CLINICAL EXAMINATION ON STUDENTS' STRESS RESPONSE AND ACADEMIC ACHIEVEMENT.

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Introduction

The objective structured clinical examination (OSCE) is a method for assessing clinical competencies and skills widely used in health careers (e.g. medicine, physiotherapy). The use of OSCE to assess competencies in social sciences students is not usual and there is a need to research its convenience. The aim of this study was to analyze the autonomic stress response of Exercise and Sport Sciences Degree (ESS) students in their OSCE..

Methods

We analyzed, in 88 undergraduate students (72 men and 16 women; 24.5±3.5 years old; 23.5±3.0 Kg·m-2), the autonomic stress response, cortical arousal, subjective distress perception, and the expected academic achievement before and after the OSCE.

Results

All the heart rate variability results showed that the ESS students had an anticipatory stress response before the OSCE that decreased after it (HRmin: 6.7%; HRmax: 9.0%; HRmed: 10.4%; RMSSD: 32.0%; PNN50: 66.3%; LF/HF: 20.3%; LF: 7.7%; HF: 28.7%; SD1: 32.7; SD2: 20.5; all $p<0.05$). Also, the cortical arousal was significantly higher before the OSCE than after it (2%; $p<0.05$). However, the subjective stress perception was significantly greater after the OSCE (20%; $p<0.05$). And the expected academic achievement was also lower after the OSCE (7.3±1.0 vs 7.0±1.0 over 10, respectively; $p<0.05$), and both higher than the actual academic achievement (6.2±0.9 over 10).

Conclusion

Therefore, OSCE methodology triggered and anticipatory anxiety response while their competency's perception is not affected before the examination, and it decreased autonomic stress and cortical arousal responses in ESS students. However, the subjective distress perception increased, and the expected academic achievement decreased after the OSCE.

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RELATIONSHIPS BETWEEN PSYCHOLOGICAL RESILIENCE AND COMPETITIVE LEVEL IN JUDO

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INTRODUCTION

Numerous researchers and professionals have been interested in the role of psychological resilience in competitive sports and its relationship with sports performance. In this sense, various studies confirm a positive relationship between high levels of resilience and optimal sports performance. Could resilience be a psychological quality among athletes who reach a high competitive level? The purpose of this study was to assess the possible association between the competitive level in Judo and psychological resilience, both in men and women.

METHODS

The sample consisted of 703 Judo practitioners. Men (n = 469, 66.7%) and women (n = 234, 33.3%) were 40.32 ± 14.09 and 31.42 ± 10.97 years old, respectively. We assessed psychological resilience with the 10-item Connor-Davidson Resilience Scale (10-item CD-RISC; Campbell-Sills & Stein, 2007), with a score range from 0 to 40. Higher scores indicate greater resilience levels. The judokas were classified into two groups based on their competitive level: TOP level [when all or some of the following inclusion criteria were met: (i) form or have formed part of the national junior or senior Judo team; (ii) be or have been recognized as a High Level Athlete (HLA) and/or High Performance Athlete (HPA) by the competent official bodies; (iii) occupy or have occupied the top 70 positions in the world junior or senior Judo ranking in their corresponding weight category] and non-TOP level (none of the three criteria were met).

RESULTS

TOP level judokas (n = 194, 27.6%) reported significantly higher levels of resilience than non-TOP level judokas (34.25 + 4.13 vs. 32.58 + 5.08, respectively, $p< .001$). Since both groups were significantly different in other variables under study (gender, age, age of initiation in the practice of Judo, years practicing Judo, weekly hours of practice and years competing), an ANCOVA was carried out for men and another for women, introducing these variables as covariates. Both in men [$F(1,469) = 5.04$; $p = .025$; eta squared = .011], as in women [$F(1,234) = 12.45$; $p = .001$; eta squared = .052], the differences in resilience scores between TOP and non-TOP level judokas were confirmed.

DISCUSSION

The results shows that being or having been a judoka at a highly competitive level (TOP level judoka) is related to higher levels of resilience in men and women. Although the effect size is small in both cases, it seems that this relationship is more robust in the case of women. From a practical point of view, these results seem to indicate that specific work on resilient qualities could contribute to reaching a highly competitive level in Judo, especially in women.

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THE IMPACT OF WAR-INDUCED STRESS ON THE HEALTH AND PHYSICAL ACTIVITY OF UKRAINIANS

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Introduction. The full-scale invasion of russia into Ukraine on 24th of February 2022 has changed the lives of millions. Some of these people decided to stay at home, some decided to move to the calmer regions of Ukraine or abroad, and all of them have stress. In our research project we examine the impact of war-induced stress on the health and physical activity of Ukrainians and how they have been changed in comparison with their level before the full-scale invasion of russia into Ukraine.

Methods. We have applied an online questionnaire for Ukrainian adults including the Patient Health Questionnaire (PHQ-9), the Visual Analogue Scale for Pain (VAS), the Insomnia Severity Index (ISI), the Saltin-Grimby Physical Activity Level Scale (SGPALS), and Self-perceived fitness (10-score scale). The survey started in February 2023. Preliminary data includes 93 participants, who at the moment of survey were in Ukraine (n=77) or abroad (n=16), aged 17-67 years ($\bar{x}$=36,9, SD = 11,4), 93,1% female and 6,9% male.

Results. The health level of Ukrainians has decreased in various outcomes from the time before 24th of February 2022 to the time of the survey. According to VAS 49,5% of Ukrainians have moderate or severe back pain, 36,6% head pain, 35,5% pain in arms or legs, and 23,7% stomach pain. Most Ukrainians reported to have sleeping problems (62,4%), while 42,1% of respondents showed moderate or severe insomnia symptoms based on the ISI. Chronic diseases increased by 18,3%, panic attacks by 17,6%, headaches by 15,1%, back pain by 14,0%, increased blood pressure by 8,6% and frequent respiratory diseases by 7,5%.

Interestingly, the level of physical activity of Ukrainians has increased. The number of physically inactive persons or with light physical activity decreased by 17,2%, and 7,5% of respondents began to engage in intensive training. On average, Ukrainians rate their fitness level lower (5,5 points) than before the full-scale invasion into Ukraine (6,2 points).

Conclusions. Our data showed tremendous impact on the health levels of Ukrainians compared to before the full-scale invasion of russia into Ukraine. The survey showed a high exacerbation of chronic diseases, panic attacks, headache and back pain. Close to half of the respondents showed moderate to severe symptoms of insomnia. This research project is still ongoing. Data collection will proceed June 2023. Further statistical analyses on the effects of stress experiences on health outcomes, and stress-buffering effects of physical activity will be presented based on a considerably larger sample size.

THE EFFECTS OF MENTAL STRESS ON SWIMMERS' PERFORMANCE AND PSYCHOPHYSIOLOGICAL VARIABLES

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INTRODUCTION: Chronic stress is defined as a state of threatened homeostasis in which affective, physiological, biochemical and cognitive changes could lead to many diseases. Yet, acute stress represents the body's reaction to a current situation and can be specifically negative during an activity that requires working memory and decision-making. Following that, some studies demonstrate cognitive exertion (e.g., arithmetic tasks) has a negative effect on subsequent physical performances [1] possibly by the modulation of the autonomic nervous system [2] and others psychophysiological variables [3]. We hypothesized that a mental stress task would be associated with lower performance in a swimming test. Moreover, the perceived exertion would increase as the focus becomes more associative and the affect gets negative.

METHODS: Five randomized competitive swimmers (15±0,44y) participated in a mental stress (ME) and control condition (CON) before a swimming test. In ME, athletes performed continuous arithmetic tasks for 15 min. In CON, they sat quietly with eyes opened for 15 min. A 200 m maximal swimming test analysis was performed and stroke length, stroke rate, and stroke index from each split were individually analyzed. Ratings of perceived exertion, heart rate variability, attentional focus, and affect (arousal and valence) were collected before the warm-up (M1), after the warm-up (M2), after ME or CON (M3), after the swimming test (M4) and 20 min after the test (M5). A two-way ANOVA was used to determine the effects of condition (ME and CON) and time (M1, M2, M3, M4) for all dependent variables. A t-test was used to compare the 200 m time from both conditions.

RESULTS: There was a significant condition x time interaction for arousal ($p=0.02$) and a main effect for time ($p<0.05$), but not for condition ($p=0.38$). There was no significant condition x time interaction for affective valence, attentional focus, or perceived effort ($p>0.05$). However, there was a main effect for time for focus ($p=0.04$) and perceived effort ($p<0.05$). Besides, there was no significant condition x time interaction for 50 m splits times, HF and LF/HF ratio ($p>0.05$) or main effect for condition ($p>0.05$), but there was a main effect for time for 50 m splits time ($p=0.01$). There was a significant interaction between condition x time for LF ($p<0.05$), but no main effect for condition or time for LF ($p>0.05$). In addition, the t-test revealed significant interactions between both conditions ($p<0.05$).

CONCLUSION: As hypothesized, athletes decreased performance when swimming after a mental stress task. Besides exercise, mental stress pre-exercise also modulated athlete's responses by increasing arousal, perceived exertion, and sympathetic activity, also focus became more associative. Therefore, the athletes were 1,842 s slower in the ME. For future reference, it would be interesting to investigate whether coping strategies can interact with these results.

1. Brown et al. (2020)

2. Wang et al. (2016)

3. Ekkekakis (2009)

PHYSICAL BEHAVIOR PROFILES IN PHYSICAL EDUCATION TEACHERS: DO PROFILES DIFFER IN RECOVERY EXPERIENCES?

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28th ECSS Congress Pars/France, July 4-7 2023

Physical Behavior Profiles in Physical Education Teachers: Do Profiles Differ in Recovery Experiences?

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Introduction

Teaching physical education (PE) is a high stress profession requiring substantial physical and mental resources. To prevent ill-health, recovery after work is highly important. Previous studies showed positive relations between physical behavior during leisure time and recovery experiences. However, they applied self-report measures, assessed physical activity only and did not address PE teachers. Therefore, the present study aimed to investigate the association between physical behavior and recovery experiences in PE teachers, using a holistic approach and objective measures for physical behavior.

Methods

Forty-five PE teachers were recruited as a subsample in the context of the "Schulsport 2030" project (BMBF). Physical behavior was continuously measured for one week using accelerometers and then classified into four physical behavior intensity categories (i.e., sedentary, light, moderate, vigorous). Recovery experiences (detachment, relaxation, control, mastery) were assessed with the Recovery Experiences Questionnaire (Sonnentag & Fritz, 2007). To identify physical behavior profiles, hierarchical cluster analysis was used.

Results

Based on the cluster analysis, PE teachers were classified into two distinct profiles based on their physical behavior. The "active profile" was characterized by significantly higher proportions of moderate ($t(43) = 3.29$, $p = .002$, $d = 0.98$) and vigorous ($t(43) = 9.54$, $p < .001$, $d = 2.85$), but not light ($t(43) = -0.14$, $p = .890$, $d = -0.04$) activity and lower proportions of sedentary behavior compared to the "less active" profile. In addition, only the "active profile" achieved the physical activity guidelines of the WHO (Bull et al., 2020). When comparing recovery experiences between the activity profiles, PE teachers within the "active profile" showed significantly higher values in mastery experience ($d = 0.66$, $p = .032$), control ($d = 0.72$, $p = .02$) and the overall recovery experiences score ($d = 0.79$, $p = .011$) compared to the "less active" profile.

Discussion

For recovery experiences, a more "active profile" with less sedentary behavior and more moderate and vigorous physical activity is favorable against a "less active profile". As practical implications, the results suggest to integrate recovery strategies in teacher training programs and highlight moderate to vigorous physical activity as a successful strategy to buffer the detrimental effects of stress.

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CP-SH16 Motivation

OPEN GOALS PRODUCE MORE ENJOYABLE EXPERIENCES AND EQUIVALENT LEVELS OF PHYSICAL ACTIVITY WHEN COMPARED TO SMART GOALS FOR INSUFFICIENTLY ACTIVE ADULTS

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Introduction

Goal setting is one of the most frequently employed behaviour-change techniques in physical activity (PA). When employing goal setting, it is common practice in PA to promote the use of specific goals, which are commonly implemented as "SMART" goals in practice (i.e., specific, measurable, achievable, realistic, and time-bound goals). However, recent evidence from lab-based walking studies has indicated that open goals (e.g., "see how active you can be") could be a promising alternative to SMART goals for increasing PA and producing adaptive psychological outcomes. This study aimed to examine the effects of open goals and SMART goals on PA and psychological outcomes over one week in active and insufficiently active individuals.

Methods

A three-arm, randomised controlled-trial design was employed. Active (n = 30) and insufficiently active (n = 31) participants were randomly assigned to one of three experimental groups: (1) SMART; (2) open; or (3) control. Participants took part in a baseline week, followed by an experimental week, in which participants recorded daily information regarding their physical activities and responded to a range of psychological measures. Data were analysed using three-way mixed-model ANCOVAs.

Results

Open and SMART goals had no significant effect on PA compared to the control condition, and no differences were found between active and insufficiently active participants. However, insufficiently active participants reported significantly greater enjoyment (compared to SMART), perceptions of performance (compared to SMART and control) and perceptions of confidence (compared to the SMART and control), whereas active participants reported significantly greater levels of enjoyment in the SMART condition and the control condition compared to the open goal condition.

Discussion

This study offers the first insights into the effects of open and SMART goals outside lab-based walking tests and has several important findings. First, findings in the current study were consistent with meta-analytic evidence demonstrating that non-specific goals are as effective as specific goals for the purpose of increasing levels of PA. Second, the study provided further evidence that open goals produce more positive psychological outcomes (enjoyment, perceived performance, and confidence) when compared to SMART goals for insufficiently active adults but extends existing evidence by demonstrating such positive psychological outcomes over an extended period of time, and in more ecologically valid PA settings. Third, the study supports existing evidence which has indicated that active adults, with prior experiences in PA, may experience adaptive psychological outcomes when pursuing SMART goals compared to open goals. This research therefore extends understanding of open and SMART goals in PA and provides further evidence that open goals may be a potentially advantageous alternative goal type for insufficiently active adults.

EXPRESSIVE PSYCHOLOGY OF DEOPBAEGI DANCE

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Introduction

The Deotbaegi Dance is a dance of the Gyeongsang-do region of Korea. This dance is heavy and is based on folk rituals. 'Deotbaegi' refers to the Gyeongsang-do-style Madangnori dance, and in particular, the Daegu region's Deotbaegi dance is a clunky and dynamic dance that expresses the excitement of Koreans well. In deotbaegi, 'deot' means 'to add' or 'to get rid of' and has the meaning of 'mask' or 'mask'. Also, baegi has the meaning of baekda or veda. This study intends to infer the expressive psychology of the deopbaegi dance movement that includes the meaning of such a dance.

Methods

As for the research method, literature study through prior research and field study for dance motion analysis, that is, dancing motions were recorded and analyzed on video, and then oral interviews were conducted with the dancers. Oral is the process of recording personal memories and contents verbally. And by analyzing the video footage taken from the field, the expressive psychology of the deopbaegi dance was inferred.

Results and discussion

First, most of the movements of the deopbaegi dance are bending the knees and exhausting them tightly. It expresses the shamanistic psychology of taking bad energy and pushing it away. This shamanistic psychology is based on Korean exorcism, and the action itself symbolizes the meaning of getting sick. Therefore, it refers to the psychology that means to get rid of what is out of place.

Second, it symbolically expresses the actions that are performed while working in the fields. In other words, it symbolically expresses the action of digging the ground, the action of holding a colander on the head, and the action of sowing seeds in the field. The meaning of these fields should be understood as a place of agriculture, 'a place where food was produced'. Therefore, it is said that they danced a dance related to farming to soothe the tiredness of farmers who were working in the fields.

Third, the dance moves are not a stereotyped dance that is aesthetically well structured, but improvisation, expressing the heart of the dancer from time to time. In other words, it expresses improvisation, such as a 'makchum', in which you dance according to the music. Therefore, this dance is not a dance choreographed by someone, but an impromptu dance that is not tied to a special format when people have a desire to dance.

Fourth, like Madangnori, where everyone gathers and plays happily, the excitement of Koreans is expressed in dance movements. In Korea, everyone dances together when they are excited even after doing difficult and arduous work. In particular, it gives people energy to go back to their daily lives by raising the excitement of peoples minds through the fast beat of music and solving their dissatisfaction through that excitement.

THE RELATIONSHIP BETWEEN MOTIVATIONAL REGULATIONS AND PHYSICAL ACTIVITY LEVELS DURING PHYSICALLY ACTIVE LESSONS AMONG 6TH AND 8TH GRADE ADOLESCENTS.

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The relationship between motivational regulations and physical activity levels during physically active lessons among 6th and 8th grade adolescents.

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INTRODUCTION

Physically active lessons (PAL), the combination of physical activity (PA) and academic content, has shown to be a promising way of increasing children's PA levels as well as academic-related outcomes without reducing academic time (Daly-Smith, et al., 2021). Less is known about how pupils' motivational regulation relates to the PA executed during PAL. Based on self-determination theory (Ryan & Deci, 2017), this study aimed to examine the relationship between motivational regulations for PA and the objectively measured PA levels during PAL among early adolescent pupils.

METHODS

Thirty-seven pupils were recruited from the 6th and 8th grades. PA levels were measured by Actigraph triaxial accelerometers, worn by the pupils only during lectures that consisted of a scheduled PAL. Data were collected during 25 PAL sessions within six months throughout the schoolyear. All PA data were analyzed in 1-sec epochs. Evenson cut-off points were used to define minutes of sedentary time, light, moderate and vigorous PA. Motivational regulations were assessed using a Norwegian version of the BREQ-2.

RESULTS

A significant positive correlation was found between intrinsic motivation and vigorous PA ($p < 0.01$) whereas amotivation was significantly negatively correlated with vigorous PA ($p < 0.05$) during PAL. A positive significant correlation was found between amotivation and sedentary behaviour ($p < 0.05$). Linear regression analysis showed that intrinsic motivation was a positive significant predictor of vigorous PA (Total $R^2=0.28$, $\beta=0.49$, $p < 0.05$).

DISCUSSION

Pupils who were intrinsically motivated were more likely to be more active during PAL. In contrast, this relationship was reversed for pupils who were amotivated. This may be of practical importance for some activities (e.g., competitive relays) or where pupils are allowed to choose the activity level to solve a PAL activity. Consequently, amotivated pupils may choose to be less active, whereas intrinsically motivated pupils may dominate activities and show high PA levels. The motivational regulations of the pupils may therefore be a key factor for teachers to consider when planning PAL.

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TESTING MEASUREMENT INVARIANCE OF MOTIVATIONAL PROFILES IN SPORT AND PHYSICAL EDUCATION CONTEXT

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Introduction

The importance of a multidimensional conceptualization of motivation in sport and Physical Education (PE) proposed by the Self-Determination Theory (Deci & Ryan, 2000) has been supported by a large body of empirical evidence. Recently there was an increased interest in using person-centered analytical approach to examine sport motivational profiles, which reflect the simultaneous presence and interactions of multiple motivations within the same individual. Although a measurement invariance (e.g., scalar invariance) of the extracted profiles constitutes an important methodological prerequisite of valid between-profile comparisons in outcomes, this prerequisite was never empirically tested in previous studies.

Method

The Czech version of the Sport motivation scale (Komarc et al., 2020) was used to measure different types of motivational regulations (intrinsic, identified, introjected, external, amotivation) in a sample of N=456 undergraduate students. The optimal number of profiles was determined using the Latent Profile Analysis (LPA), a model-based clustering method. Invariance tests based on gender, competitive level and type of sport (individual vs. team) were then conducted using a multi-group analysis framework.

Results

The model fit indices and parameters for different LPA models supported existence of 4 distinct latent motivational profiles in our sample. The largest latent profile (Moderately autonomous) consisted of 51.5% participants, who reported the highest levels of intrinsic motivation compared to other profiles. Participants in the smallest profile (Highly amotivated, 7.5%) on the other hand, reported extremely high levels of amotivation. Multigroup LPA supported configural invariance (number of profiles is the same) for all 3 grouping variables. Further analyses have indicated that a partial metric invariance is a plausible hypothesis after removing equality constrains on several latent profile indicators.

Discussion

Consisted with our expectations and previous research using the LPA modeling framework, we identified four distinct sport motivation profiles. Evidence of partial metric invariance for the extracted profiles provides a sound basis for assessing between-profile differences in motivational outcomes, which are of a great interest for coaches and sport psychologists. Future studies are however warranted in order to replicate our findings and/or expand available evidence about invariance in other contexts (e.g., PE) and for other important grouping variables such as age, experience with sport participation, or culture.

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Acknowledgments

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MEDIATION EFFECT OF BASIC PSYCHOLOGICAL NEEDS IN THE RELATIONSHIP BETWEEN LEADER'S AUTONOMY SUPPORT AND COLLEGE LIFE ADAPTATION IN STUDENT-ATHLETES

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Introduction

This study attempts to verify the mediating effect of basic psychological needs in the relationship between autonomy support of leaders recognized by university athletes and their adaptation to college life.

Methods

In this study, data were collected from 227 athletes attending K University in Seoul, Korea. The survey tools used the leaders autonomy support (Deci, 2000), basic psychological needs (Deci & Ryan, 2001), and college life adaptation (Baker & Siryk, 1989) scales. Leader's autonomy support(LAS) is composed of a single factor, and basic psychological needs are composed of autonomy, relationship, and competence. college life adaptation consists of academic adaptation(AA), social adaptation(SA), emotional adaptation(EA), physical adaptation(PA), and attachment to college(AC). All scales consist of the Likert 5-point scale. The collected data were analyzed through SPSS 23.0 and PROCESS macro (v.3.3) model 4, and the mediating effect was verified through Bootstrapping.

Results and discussion

First, it was found that the LAS had a significant effect on autonomy(β=.424, p<.001), competence(β=.499, p<.001), relationship(β=.501, p<.001), and AA(β=-.162, p<.05). Second, autonomy was found to have a significant effect on AA(β=.424, p<.001), EA(β=.670, p<.001), PA(β=.409, p<.001), and AC (β=.444, p<.001), and competence was found to have a significant effect on AA (β=.424, p<.001) and PA (β=.409, p<.01). In addition, it was found that relationships had a significant effect on SA (β=.475, p<.001) and AC (β=.174, p<.05). Third, it was found that autonomy (95% CI=.095~.254) and competence (95% CI=.083~.292) had a mediating effect in the relationship between LAS and AC. Fourth, it was found that the relationship (95% CI=.150~.361) had a mediating effect in the relationship between LAS and SA. Fifth, it was found that autonomy (95% CI=.202~.430) had a mediating effect in the relationship between LAS and EA. Sixth, autonomy (95% CI=.107~.258) and competence (95% CI=.025~.205) were found to have a mediating effect in the relationship between LAS and PA. Seventh, it was found that autonomy (95% CI=.092~.237) and relationship (95% CI=.013~.149) had a mediating effect in the relationship between LAS and AC.

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THE EFFECTS OF EMPOWERING AND DISEMPOWERING MOTIVATIONAL CLIMATE ON SELF DETERMINATION THEORY, FUN, AND BOREDOM AMONG STUDENT IN PHYSICAL EDUCATION CLASSES

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Introduction: Teachers can guide students motivational experiences through a variety of guiding teaching methods (Braithwaite et al, 2011). Previous studies have found that in the perspective of socio-psychology individuals' behaviors and attitude play an important role in the activity, In recent years, Duda and colleagues (2016) combined previous studies of achievement goal theory and self-determination theory, and proposed empowering and disempowering, expanding the scope of previous climate measurements. The main purpose of this study was to investigate the potential motivational processes of positive and negative effects of empowerment and disempowerment climate toward self-determination theory and the relationship it has with the behaviors of fun and boredom in the context of physical education.

Method: This study retrieved 550 questionnaires from universities that attended physical education course in universities and after the elimination of invalid questionnaires, a total of 449 valid questionnaires was used . The hypotheses were estimated using one-way ANOVAs and linear regression for the path hypothesis.

Results: The basic descriptive analysis of students were 240 male and 259 female. The linear regression analysis revealed a significant amount which explained variance on empowering and disempowering with ($r = -0.615^{**}$, $p < 0.01$) and the relationship of empowering and competence, autonomy and relatedness ($r = 0.445^{**}$; $r = 0.622^{**}$; $r = 0.561^{**}$, $p < 0.01$) and a negative relationship of disempowering toward competence autonomy and relatedness ($r = -0.168^{**}$, $r = -0.376^{**}$, $r= -0.300^{**}$, $p < 0.01$). Furthermore, SDT had a positive relationship on fun ($r = 0.617^{**}$; $r = 0.672^{**}$; $r = 0.562^{**}$, $p < 0.01$), and a negative effect on boredom ($r = -0.489^{**}$;$r = -0.584^{**}$;$r = -0.464^{**}$, $p < 0.01$). R square= 0.515 the explanatory power for predicting fun on behalf of all other variables in the model with a F value of 0.5.

Discussion: In this study, the physical education class was further explored to elucidate the different potential motivational processes that explain the positive and negative effects of an empowering and disempowering climate. Students grow stronger and rely most on teachers when they seek to create a learning environment that meets their three basic psychological needs such as, autonomy (e.g., students feel psychologically free to participate positively in decision making), competence (e.g., students feel competent), and relatedness (e.g., students feel a sense of connection and belonging with their classmates or with their teachers). Therefore, three basic psychological needs produce mediating effects between empowerment and disempowering motivational climate and basic psychological needs of fun, boredom.

THE ASSOCIATIONS BETWEEN PERCEIVED EMPOWERING AND DISEMPOWERING MOTIVATIONAL CLIMATE, COACH-RELATIONSHIP, SATISFACTION, AND DROPOUT INTENTION AMONG ATHLETES

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Introduction: The behavior of coaches in sports settings has been extensively studied in relation to athletes motivations and feelings and reactions to the sports they participate in. Duda (2013) an empowering motivational climate framework as a theoretical basis for predicting and explaining achievement performance, motor motivation, and related behaviors. Previous studies have suggested that climate reduces basic psychological needs, making motivation less autonomous, participation of activity less motivated, making individuals more prone to physical burnout or anxiety (Bartholomew, et al., 2011). Furthermore, in situations like sport team training, the coach and the athlete are the primary interaction which may affects the athletes decision to continue to participate in the sport and can even have an effect on individual and team performance (Jowett & Ntoumanis, 2004). The purpose of this study was to extend the applicability of Empowering and Disempowering Motivational Climate, Coach-Relationship, Satisfaction, and Dropout Intention Among Athletes.

Method: A total of 308 high school athletes were surveyed using a questionnaire. With the use of (Empowering and Disempowering Motivational Climate Questionnaire ; EDMCQ-C) scale (Jowett & Ntoumanis, 2004) and (Coach-Athlete Relationship Questionnaire, CART-Q) with back forward translation to Chinese questionnaire including sport motivation scale with Pearsons product difference correlation was used to understand the relevant situations, multivariate stepwise regression was used to analyze and the predicted the relationship, and the mediation effect was verified using the bootstrap method.

Results: This study found that player empowerment climate was positively correlated with intamacy, commitment, complementarity, and satisfaction of coach-player relationship; ($r = .61$, $r = .64$, $r = .60$, $r = .57$, $r = .53$; $p < .001$) on the contrary, Disempowering climate was negatively correlated with intimacy, commitment, complementarity and satisfaction of coach-player relationship empowerment climate was significantly negatively correlated with disempowerment climate and dropout intention ($r = -.39, -.35$; $p < .001$).

Discussion: The results showed that when players perceived that the coach was shaping an empowering climate, there were higher levels of intimacy, commitment, and complementarity in the coach-player relationship, and higher levels of satisfaction development; conversely, when players perceived that the coach was disempowering climate and lower levels of commitment in the coach-player relationship, this resulted in dropout intentions. This finding is consistent with previous studies (Olympiou, Jowett, & Duda, 2008; Duda et al., 2014) .

BORN TO BE PROUD OR LEARNED TO BE PROUD: ANALYSES OF ASSOCIATIONS OF PRIDE WITH PERSONAL DETERMINANTS AND CAUSAL ATTRIBUTION STYLES

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The social emotion pride appears to be closely associated with performance in sport. However, pride can be divided into the more functional emotion pride and the more dysfunctional emotion hubris (Tracy & Robins, 2007). The semantic differentiation between pride as a positive experience of success and hubris as a positive emotion regarding a striving for dominance shows parallels to the descriptions of the implicit motives for achievement and power (Wegner, 2020). Moreover, pride is more likely to be associated with an internal-variable attribution style and hubris with an internal-stable attribution style. Attribution styles, however, correlate with the motive components of hope and fear (Schüler & Elbe, 2020). Since pride can be considered a functional emotion, especially for sports (Sabiston et al., 2020), the goal of enabling athletes to better regulate pride and hubris arises. Attention should be paid to individual determinants–personality traits and individual factors (Kobylińska & Kusev, 2020). For this purpose, it seems necessary to identify associations between the emotions pride and hubris with individual implicit motives, attributional styles, and motivational components. In an ongoing cross-sectional survey with currently N = 11 recreational athletes (ten of them female, one male), pride, implicit motives, motive components, and attributional styles will be assessed using the Pride Scale (Tracy & Robins, 2007), the Picture Story Exercise (Winter, 1994), the Multi-Motive Grid (Schmalt et al., 2000), and the Attributional Scale Questionnaire (Peterson et al., 1982) to explore the associations between pride and pride with individual determinants using bivariate Pearson correlation analyses. Initial results show exclusively negative correlations for pride with the motive components fear of failure (r = -.78, p = .008, CI95%[-.94; -.26]) and fear of loss of control (r = -.70, p = .035, CI95%[-.93; -.03]). In contrast, correlations of pride with hope for success (r = .75, p = .020, CI95%[.12; .94]), hope for control (r = .86, p = .003, CI95%[.41; . 97]), internal-variable causal attribution (r = -.76, p = .017, CI95%[-.94; -.16]), and the implicit motives of power (r = .76, p = .017, CI95%[.15; .94]) and achievement (r = .81, p = .009, CI95%[.26; .95]). More pride is found to be associated with lower fear components of both the implicit power and achievement motives. More pride is associated with stronger expressions of the implicit motives and their hope components, as well as less internal-variable causal attribution. Accordingly, future studies should increasingly discuss the function of motive components in influencing pride and hubris as well as the conditional relationship between an internal-variable causal attribution and hubris.

NEED TO BELONG AND EXERCISE PARTICIPATION OF COMMUNITY-DWELLING ELDERLY FROM TAIWAN

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ntroduction

Need to belong is one of the basic psychological needs of human and individuals are motivated to engage what satisfy this need (1;2). According to our previous work on adults, people who were high in need to belong seldom engaged in solitary activities and tented to have lower level of self-esteem. For the elderly, physical activities not only help to maintain their health but also provide a context in which need to belong can be satisfied through interpersonal interactions. In this study, we attempted to extend the understanding of physical activity participation of the elderly by investigating the relationship between levels of need to belong and exercise participation as well as possible gender differences.

Method

One hundred and ten community-dwelling elderly from Taiwan without physical and mental disabilities participated in this survey. Questionnaire consisted of demographic, need to belong scale, Rosenberg self-esteem scale, self-reported exercise behavior and exercise status preference.

Result

Three underaged participants (under 65) and 7 multivariate outliers were deleted from the sample during data screening. There were 30 males and 70 females in the sample, aged 65-94 (M= 74.09, SD= 5.74). All of the participants were capable of independent mobility, 64% of them exercised almost every day and 51% of them usually exercised with others; 14% of participants disliked exercise alone, and only 5% of them disliked exercise with others. The Pearson product-moment correlations showed that need to belong (M = 28.29, SD = 5.06) was positively related to preference for exercising with others (r = .22, p = .031) and was correlated negatively to self-esteem (M = 38.03, SD = 3.92) (r = -.34, p < .001), however, was not related to the frequency of exercise participation. In addition, t-test showed that female (M= 29.00, SD= 4.62) had a higher level of need to belong than male (M= 26.63, SD= 5.70) (t = 2.19, p = .031).

Conclusions

It was encouraging to find that, in this sample, the majority of the community-dwell elderly exercised regularly. Need to belong seemed not associated with the frequency of exercise participation, however, the elderly who were high in need to belong did showed a preference for group exercise. This study also showed that senior women had higher level of need to belong than senior men. This might provide a possible answer to the question why community-based exercise groups usually attracted more female than male. Finally, people who were high in need to belong tended to have lower self-esteem. It seems necessary to pay more attention to this issue.

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THE SUSTAINABILITY INFLUENCE OF HOME TRAINING CONSUMPTION ENVIRONMENT ON HOME TRAINING CONSUMPTION BEHAVIOR OF RESIDENTS URBAN

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Introduction : From 2019 to 2022, the sporting environment of the entire international community has changed significantly as a result of major public safety events.The development of the entire sports industry has been largely static because of the epidemic, but on the contrary, home-based sports have risen rapidly and peoples attitudes towards sports have changed a lot.The initiative of peoples fitness becomes stronger, almost all on-line and off-line go out, the national health demand is increasing.Peoples health awareness has improved significantly compared to the past, and more attention has been paid to health, and the number of people exercising at home has increased significantly.As Koreans exercise using YouTube home training videos, more and more people are interested in their health.In particular, the number of views on home training videos has increased by more than 40% since the pandemic began in earnest (YouTube Data, 2020).According to a survey of Chinese nationals, 27.2% of the Chinese people value healthy exercise habits more during the epidemic, 23.8% learn more home-based fitness skills and 21.1% have more stable exercise habits(2020年大众运动健康报告，2020).Health awareness and awareness of home training in China and South Korea have improved significantly compared to before the outbreak. Objectives : If dangerous situations end and peoples needs are not constrained, will home-based fitness continue?Will we do better than we do now when dangerous situations come again?This is a topic worthy of discussion and reflection.Only by reflecting on the past can we look forward to the future.Therefore, it is necessary to analyze the change characteristics of urban residents home-building behavior and make theoretical exploration. Methods : This study takes urban residents as the object of investigation and Shangqiu City, Henan Province, China as the regional scope.A total of 1000 questionnaires were distributed, 912 valid questionnaires were issued .Reliability 0.881 and validity 0.946.With demographic characteristics as the background variable, home fitness environment as the independent variable, sports demand as the medium variable and sustainable behavior as the dependent variable.To explore the sustainability of home-building behavior of urban residents in the course of outbreak and after epidemic by using ERG theory.After the end of the epidemic, peoples behavior is not compulsory, so how the peoples fitness behavior will change and whether home-based fitness behavior will continue. Result & Discussion : The results show that when the survival needs are met, the home environment has a positive impact on the sustainability of home-building behavior of urban residents.When the interrelationship and growth needs are suppressed, the home environment has positive and negative effects on the sustainability of home fitness behaviors of urban residents due to different ages and occupations. Conclusion : YouTube Data(2000). KR, Mar 15 ~ Sep 30, 2020 vs. Jan 1 ~ Mar 14, 2020.

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Conventional Print Poster

CP-AP24 Olympic Sports

ROAD TO PARIS 2024: FORCE- VELOCITY PROFILE IN SPEED CLIMBERS

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INTRODUCTION: Speed climbing will be a new discipline at the next Olympic games in Paris 2024 within sport climbing along with bouldering and lead climbing. Physical requirements of speed climbing are different from the other modalities, especially due to the short event time (WR men=5" & WR women=6.53"). Previous studies indicate that speed climbing requires higher level of strength and power (1,2). These parameters have been measured through the F-V profile previously in different type of climbers (3). However, there are no known results evaluating at different speed climbing performance to determine whether this is a determining factor between levels. The purpose of this study was to evaluate the F-V profile on different speed climbers' ability (national vs international). We hypothesized that international climbers may have a different F-V profile to national level climbers.

METHODS: A total of 26 speed climbers participated in this study divided into two groups (International level n=9 and national level n=17). The participants performed pull ups and squat incremental tests in the same day in a non-competitive period where velocities performed with different loads were collected using a lineal encoder to obtain the F-V profile variables (F0, V0, Pmax and FV slope) in addition to the repetition maximum value (1RM).

RESULTS: We found significant differences in F0 and 1RM in pull-ups ($p<0.05$) between level groups after performing a two-way ANOVA. However, we found no significant differences between groups in any of the variables obtained from the squat F-V profile. After performing a Pearson correlation, we found significant ($p<0.05$) and strong correlations between running time and 1RM (pull-ups and squat) and F0 and FV slope in pull-ups.

CONCLUSION: Climbers with better climbing performance showed a higher F0 despite no difference in peak power, therefore strength training in national climbers should be focused on improving the F0 (i.e., lifting heavy weights rather than ballistic movements with light weights (4)). Moreover, there was significant correlation between performance (time) and squat 1RM, but without significant differences between groups, so it does not appear to be an indicator of speed climbing performance.

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TIME-MOTION ANALYSIS OF OLYMPIC WRESTLERS

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INTRODUCTION: Training scheduling cannot be separated from what happens in competition. Understanding the demands of competition allows training content to be better adapted and individualised [1]. In this sense, computer is a great tool to achieve this. It allows us to collect information as faithfully as possible while being non-intrusive [2]. The objective of this work is to determine the tactical demands by weight category and then to model the duration of the fight according to the style of wrestling.

METHODS: Computer vision has made it possible to build the dataset made up of 5280 fights since 2019 automatically annotated with the point score, the associated time as well as the name, the competition round, the weight category and the wrestling style. The non-parametric Kaplan-Meier estimator was applied to estimate the time remaining before the end of the bout. The Cox proportional hazards model estimates the duration of the fight by taking into account independent covariates.

RESULTS: The log-rank test confirms a significant difference between the duration of the fights of women (women wrestling) and men (freestyle (32.74 ; p$<$0.005) and greco-roman wrestling (26.49 ; p$<$0.005)). On the other hand, the Cox proportional hazards model gives us the information that the duration of the fight increases as the competition progresses with a significant difference between the preliminary and final rounds for each style (GR : 87.11, FS : 39.42, WW : 8.62 ; p$<$0.005).

CONCLUSION: These preliminary results make it possible to lay the foundations of competitive expectations in Olympic wrestling. They can provide benchmarks for coaches to use during training or for athletes to achieve. Further work will focus on adding qualitative variables to improve the various results.

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PHYSIOLOGICAL DEVELOPMENT OF JUNIOR WINDSURFERS TO PREPARE FOR THE CHANGE OF OLYMPIC RACE CLASS FROM RS:X TO IQFOIL

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INTRODUCTION: In November 2019, the World Sailing Council has approved Starboard iQFoil to replace RS:X as the windsurfing equipment for Olympic Games from Paris 2024 [1]. After this decision was made, competitive windsurfing around the world has gradually transit their program to iQFoil focus, with the first iQFoil Senior and Youth World Championships being held in 2021. One of the main differences between iQFoil and RS:X is that iQFoil have foil instead of fin under the board which allow a faster speed in the same wind conditions [2]. Coaches and athletes have therefore applied different training strategies to adopt the changes. The aim of this study was to investigate the difference in physiological development for junior windsurfers in preparing to race in iQFoil class when comparing with the RS:X class.

METHODS: Athletes from Hong Kong Junior Windsurfing National Team participated in fitness testing batteries twice a year, which included height and weight measurement, 20-meter shuttle run to estimate VO2max and 1-minute modified pull up. iQFoil group consist of 17 athletes (age 14.9±0.8), whom at least participate in 1 fitness test in year 2018-19 as pre-test, and also year 2021-22 as post-test for pairwise comparison. These athletes transfer from training with RS:X to iQFoil right after the announcement of equipment change in 2019. RS:X group consist of 15 athletes with similar age (age

16.0±1.8) whom at least participate in 1 fitness test in year 2015-17 as pre-test, and also year 2018-19 as post-test for pair-wise comparison. These athletes trained with RS:X equipment throughout the whole study period. Repeated measures ANOVA was used to detect changes of pre and post-test, effect sizes expressed as partial eta-squared (n2). Significance was set at $p<0.05$.

RESULTS: Both iQFoil (Pre-test: 59.1±8.2 kg; Post-test: 67.3±10 kg)(p=0.00, n2=0.66) and RS:X (Pre-test: 63.0±5.9 kg; Post-test: 65.4±6. 2kg)(p=0.00, n2=0.32) groups has significant increase in body weight, with the effect in iQFoil group was twice as strong as the RS:X group. RS:X group has significant improvement in VO2max (Pre-test: 49.9±6.9 ml/kg/min; Post-test: 53.5±5.8 ml/kg/min)(p=0.00, n2=0.19), but not for iQFoil group (Pre-test: 51.5±5.7 ml/kg/min; Post-test: 51.5±5.7 ml/kg/min)(p=0.98, n2=0.00). iQFoil group has significant improvement (Pre-test: 27.4±7.3; Post-test: 41.1±7)(p=0.00, n2=0.59) in 1-min modified pull up but not for RS:X group (Pre-test: 31.8±8.3; Post-test 29.2±6.1) (p=0.39, n2=0.02).

CONCLUSION: The results suggest that the physiological development of junior windsurfers have been changed, since iQFoil replaced RS:X to be the official racing equipment for Olympics. Athletes training for iQFoil has more significant increase in body mass, and significant increase in 1-min modified pull up. Athletes training for RS:X, on the other hand, has significant increase in VO2max. However, it is still unclear if these changes affect performance with difference equipment.

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CLUSTERING TECHNICAL APPROACHES OF WORLD CLASS POLE VAULTERS

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INTRODUCTION: Pole vault performance has been mainly biomechanically investigated to point out performance determinants [1]. Several key parameters were highlighted such as speed, grip, size of athletes or take-off (TK) angle. From this, many coaches and scientists published studies describing ideal technical approaches of pole vaulting for performance [2]. Today, observations of top vaulters raise questions about the classical technical model that is well-documented. The goal of this study was to identify potential technical profiles using actual measurements taken during official competitions and to examine these profiles from athlete's characteristics and mechanical perspective.

METHODS: Data were collected during more than 80 official competitions with same experimental setup. Best jump from 98 men with personal best between 5.10 and 6.21 m were analyzed. Spatiotemporal parameters and horizontal speed were collected during the run-up using Optojump Next system (Microgate, Italy) synchronized with radar gun (Applied Concept, USA). Kinematic (pole bending) and dynamic (mechanical energy gain) analyses were done by means of 2-dimensional video analysis on sagittal plan (100 Hz, Panasonic HC-V770, Japan). Pole vaulters were divided into an optimal number of non-overlapping subgroups using the k-means clustering method based on two technical parameters allowing identification of technical styles independent of morphology or level: TK angle and Under (horizontal distance between TK foot and upper hand).

RESULTS: K-means method pointed out 4 clusters with distinct behaviors. Cluster 1 (C1) was composed of athletes with high to moderate Under with higher TK angle (over 12.5 °). C2 was composed of athletes with lower Under-values and higher TK angle. C3 included athletes with high to moderate Under and lower TK angle. Finally, athletes of C4 had low Under-values with the lowest TK angle. C4 was composed with smaller athletes, running with the smallest contact time, and an increased the last stride while others tended to reduce this one. C4 athletes performed with higher TK distance and produced the biggest pole bending ratio. C2 athletes performed with stiffer pole, higher grip distance and produced the smallest pole bending. C1 and C3 produced their performance using smaller grip and TK distance than another clusters. We did not identify any differences in speed or energy gain between clusters.

CONCLUSION: This study pointed out that different pole vault styles can be highlighted at world class level based on technical parameters. We observed that each cluster produces performances with similar speed and energy net gain level as input but had various behaviors when interacting with the pole (TK phase, pole bending and trajectory). Therefore, it is of interest to describe more accurately these technical approaches for teaching this discipline and improving coaching process.

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KNEE INJURIES IN SPORT CLIMBING: A SYSTEMATIC REVIEW

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INTRODUCTION: Previous research in sport climbing was dominated by studies focusing on climbing-specific upper extremity injuries, especially finger injuries. No last systematic review has examined the prevalence of knee injuries in sports climbers. Our objective was to establish the prevalence and risk factors for knee injuries resulting from sport climbing activity in both professional and recreational athletes.

METHODS: A systematic review was conducted to determine the injury rate and risk factors for knee injury from a biomechanical point of view during sport climbing. The literature search was performed from January 2000 to January 2023 in the PubMed (Medline) and Scopus databases. The following keywords were used: injury AND sport climbing OR rock climbing, OR lead climbing OR bouldering OR speed climbing. Original, peer-reviewed, full-text articles published in scientific journals in the English language were included. Papers in non-climbers, mountain climbers, papers concerning climbing intervention in climbers and non-climbers, review articles, conference papers, case studies, animal studies, studies published in other languages, and studies with incomplete statistics data were excluded. Reference lists of review articles were reviewed for additional relevant articles. The following descriptive data were extracted from studies: study type, cohort, and knee injury information (structure and mechanism). The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement and checklist were used to guide this systematic review.

RESULTS: A total of 849 studies were retrieved from this research. Finally, 13 studies were selected after the full-text review. 339 knee injuries were found in the analyzed studies, accounting for 1-18.9% of all climbing-related injuries. The most common injury was to the meniscus. Most knee injuries result from falls, overtraining or traumatic mechanisms of injury, e.g., heel hook, high step, or drop knee techniques.

CONCLUSION: The growing sport climbing popularity is associated with a higher incidence of knee injuries. Specific climbing-related training of the knee stabilizers for improved joint control and stretching techniques may reduce the risk of a knee injury during falls and climbing-specific knee techniques.

PERFORMANCE DETERMINANTS IN JUNIOR- AND ELITE-LEVEL AIR-RIFLE ATHLETES

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INTRODUCTION: Sport shooting is an accuracy and precision sport, in which multifactorial processes occur simultaneously and sequentially, requiring many factors to be controlled at once [1]. Especially in air-rifle shooting, previous studies examined various factors and their influence on shooting performance [1]. So far, the influence of different factors in one comprehensive model has only been examined across technical factors [2]. Therefore, the aim of this study was to identify the role of technical, coordinative, physiological and psychological factors that best predict shooting performance of both junior-level and elite-level air-rifle athletes.

METHODS: Federal squad athletes of the German Shooting Federation participated in the study (n = 18 junior- and n = 18 elite-level athletes). Participants performed a simulated air-rifle competition of 60 shots according to the ISSF regularities. Based on a systematic review [1], the following performance factors were assessed during shooting: the aim point trajectory of the weapon via SCATT (technique), postural balance in ML- and AP-direction via a 3D force plate, as well as muscle activity and heart rate via EMG (coordination). Before the competition started, athletes completed a questionnaire on their current psychological well-being. On two other consecutive days, athletes performed a steps-test, a computer-based diagnostic instrument to measure shooters' coordination and concentration. Further, maximum isometric strength of the trunk and thigh muscles were tested using a force measuring chair. Athletes also performed a laboratory-based incremental endurance test on a treadmill to assess endurance capacities (both physiology). Principle component analysis was used to form orthogonal linear combinations for each test variables. Stepwise multiple regression analysis (MRA) with principle components (PC, PCs with the highest explained variance from each test were used for MRA) were used to test for variance explained in shooting score.

RESULTS: Shooting results differed between skill levels (617,8 ± 4,6 vs. 621,3 ± 5,5 rings). MRA revealed four factors to be relevant for junior-level athletes: PC1: holding ability and cleanness of triggering (β = 1,58), PC2: maximum strength of leg abduction muscles (β = - 2,71), PC3: COP sway in AP-direction (β = - 2,05) and PC4: reaction and anticipation (β = 2,12). These variables accounted for 76,9 % of variance in shot score, whereas PC1 provided the highest contribution (technique). Four factors were relevant in elite-level athletes: PC1: concentration (β = 2,14), PC2: holding ability (β = 2,28), PC3: heart rate (β = - 2,94), PC4: COP-sway in AP-direction (β = - 3,08). These variables accounted for 86,8 % of variance in shot score.

CONCLUSION: The results show that, depending on the skill level, a different combination of technical, coordinative, physiological and psychological factors is important for achieving a high shot score in air-rifle shooting.

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THE INTERPLAY OF BIOMECHANICS AND BODY COMPOSITION IN KAYAK SPRINT PERFORMANCE: AN EXPLORATIVE STUDY

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INTRODUCTION: Sprint kayaking is a dynamic sport that requires a combination of strength, power, and endurance. Sprint performance in kayaking is influenced by various physiological and biomechanical factors [1], including body composition, muscle strength, stroke rate, stroke force and paddling technique [2]. There is, however, still a lack of knowledge on how the interplay of different factors impact performance [3]. This study aims to fill this gap by conducting a comprehensive evaluation of kayak sprint performance by examining multiple biomechanical and physiological variables simultaneously

METHODS: 13 highly trained male kayakers (Age 22.92 ± 6.25 years, body weight 84.80 kg ± 7.29, height 1.80 ± 0.44 m) were recruited. The following variables were recorded during a 100 m all out on-water test: paddle force (E-kayak, AP-

Lab), footrest force, kayak velocity. Furthermore, 1 repetition maximum in bench press, bench pull, pull up and a specific kayak strength test measured on a custom-made single arm machine (SAM) were tested. Body compositions were measured using a DEXA scanner (GE Lunar iDXA).

RESULTS: The results from on water showed: 100m sprint time: 20.32 ± 0.74s. Paddle mean stroke force: 280.34 ± 67.95 N, paddle peak force: 563.28 ± 69.82 N, footrest mean stroke force: 288.45 ± 105.99 kg, footrest peak force: 588.45 ± 210.38 kg. The results from the strength tests were: Bench press: 113.46 ± 12.39 kg, bench pull: 104.65 ± 8.25 kg, pull ups 39.80 kg ± 10.12 kg, SAM: 63.07 ± 13.09 kg.. The results from DEXA scan showed: body fat percentage: 18.59 ± 3.97 %, lean body mass: 66.15 ± 5.78 kg

CONCLUSION: This study aimed to comprehensively evaluate kayak sprint performance by examining multiple biomechanical and body composition variables simultaneously. The kayakers in the study demonstrated similarities in levels of paddle and footrest force compared to the literature [4], along with high levels of lean body mass and moderately body fat percentages, not as low the ones found in the literature [1]. The results of the study showed that kayak sprint performance is influenced by a combination of different factors, including muscle strength, stroke force, and body composition. These findings suggest that to improve kayak sprint performance, athletes should focus on developing their strength and optimizing their body composition to a certain degree. The interplay between the biomechanical variables should be investigated further.

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RELIABILITY OF THE MAXIMAL LACTATE ACCUMULATIONS RATE (VLAMAX) IN SUB-ELITE ROWERS

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INTRODUCTION: During a 2000-meter rowing race, rowers mostly depend on their aerobic energy metabolism, but also rely to a certain amount on their anaerobic capacities including lactate accumulation. While most performance diagnostics in competitive rowing aim to evaluate the aerobic capacity, diagnostics determining anaerobic capacities are uncommon and rarely used. One promising parameter is the maximum lactate accumulation rate (VLamax), which indicates anaerobic capacities. While positive results in other sports are already investigated, including running and cycling, studies based on rowing are missing, but crucial within sport specific performance testing. Thus, this study aims the verification of reliability of VLamax in rowing. Positive results might expand performance diagnostics in rowing and therefore optimise training plans and sport performance.

METHODS: In a between day design with repeated measurements, seventeen competitive male (n=9) and female (n=8) rowers (age: 19.8 ± 5.3 years, height: 176.7 ± 7.8 cm, and weight: 70.8 ± 8.7 kg, VO2max: 54 ±13 ml/min/kg) were asked to undergo a 20-seconds all-out sprint on the Concept 2 rowing ergometer. Those two different measurement days were separated by 5-10 days. VLamax, peak lactate concentration, time to lactate peak and mean rowing power were measured.

RESULTS: Good to excellent intraclass correlation coefficients (ICC), low standard error of measurement (SEM), and acceptable level of agreements (LoA) for VLamax (ICC = 0.85; SEM = 0.02 mmol/Ls; LoA ≤0.09 mmol/Ls), peak lactate (ICC = 0.88; SEM = 0.3 mmol/L; LoA ≤1.4 mmol/l), time to lactate peak (ICC = 0.92; SEM = 0.1 min; LoA ≤0.5 min), and mean rowing power (ICC = 0.98; SEM = 3 min; LoA ≤39W) were observed. In addition, VLamax was highly correlated ($r = 0.96$; $p \leq 0.001$) to the rowing power.

CONCLUSION: Those results verify a good reliability of measuring VLamax and sprint performance parameters including lactate peak concentration, time to peak lactate and mean rowing power using this sport-specific sprint test protocol in rowing. These findings affiliate with earlier research in cycling and running with similar high reliability markers. In conclusion, determination of VLamax can be used as a reliable tool in rowing to identify anaerobic capacities and thresholds. In addition, correlations between VLamax and rowing power indicated a promising parameter of anaerobic lactic power testing. Therefore it can expand the performance diagnostics in rowing and help optimising training plans and performance.

FLYING HIGH: THE INFLUENCE OF A SIX-WEEK RESISTANCE TRAINING PROGRAMME ON ELITE TRAMPOLINE ATHLETE PERFORMANCE

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INTRODUCTION: There are few data on training interventions in elite athletes, particularly in gymnasts. In trampoline gymnastics, the ability to attain and maintain high time of flight (ToF) is an important component in competition for two reasons: 1) it is directly scored, and 2) it allows gymnasts to perform routines at greater heights and potentially execute more

complex skills. The purpose of the study was to investigate the effects of a 6-week isometric training programme on time of flight (ToF) in highly trained gymnasts.

METHODS: Fourteen national level trampoline athletes (10 females, 4 males, age = 15 ± 2 years; mass = 55.0 ± 8.2 kg; stature = 163.7 ± 6.5 cm) volunteered to participate. In a parallel group design, athletes were allocated to either an intervention; INT (6 weeks of maximal isometric strength training incorporated into normal training) or control; CON (normal training) group. The INT consisted of 3-5 sets of 5 repetitions of maximal isometric contractions at 3 joint angles (150, 120 degree knee joint angle and plantar flexion at full knee extension) twice per week. Participants performed a battery of tests consisting of counter movement jump (CMJ), isometric squat (ISO at 150 and 120 degrees knee flexion; 180 degrees being full extension), and 20-max trampoline (20-max) test before and after the intervention.

RESULTS: There was a significant interaction where the INT group increased ToF in the 20-max test by 2.8% compared to a 0.2% increase in CON (P = 0.021). Only isometric strength at 150 degrees changed differently between groups, where the INT group increased by 27% vs 5% in the CON (P = 0.02). No other changes were observed in CMJ.

CONCLUSION: The improvements in ToF highlight the applicability of joint-specific isometric training to enhance a fundamental performance index (maximal ToF) for highly trained trampoline athletes. This simple, but effective intervention, illustrates the translation of strength training to a sport-specific performance index.

Conventional Print Poster

CP-AP25 Resistance Training II

INTRA- AND INTER-DAY RELIABILITY OF INERTIAL LOADS WITH CLUSTER SETS WHEN PERFORMED DURING A QUARTER SQUAT ON A FLYWHEEL DEVICE

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INTRODUCTION: Flywheel iso-inertial training (FIT) has become increasingly popular as a training modality. To date, only one study has examined the reliability of the flywheel quarter-squat (Sabido et al., 2018). The aims of this study were to i) estimate the intra- and inter-day reliability of mean concentric (CON) and eccentric (ECC) power at different inertial loads during a flywheel quarter-squat using a cluster set approach; and ii) to determine the acute effect of internal and external attentional focus on mean power when performing the flywheel quarter squat.

METHODS: Twelve collegiate field sport athletes attended four cluster-set testing sessions separated by 7 days. Sessions consisted of 4 sets of 15 repetitions of a quarter- squat flywheel exercise with varying moments of inertial (0.025, 0.050, 0.075 and 0.100 kg·m2) in an ascending or descending order (Sabido et al., 2018). The cluster set protocol consisted of 5 repetition clusters, including "momentum repetitions" (3 x 5+5+5). Mean concentric (CON) power output, mean eccentric (ECC) power output, and ECC overload were recorded for both internal and external attentional focus groups

RESULTS: Mean power output showed lighter inertial loads (0.025 kg·m2) produced greater CON force. Alternatively, heavier inertial loads (0.050, 0.075 and 0.100 kg·m2) produce greater ECC force and subsequently, greater ECC overload. The external instructional group attained familiarisation (outcome stability) after two flywheel sessions (ES = 0.03 – 0.15) with little volatility between performance measures (CV% = 3. 39 – 9. 22). In contrast, the internal group had a significant difference between day-2 and day-3 using the 0.075 kg·m2 load (p = 0.017). In addition, the internal group saw large differences in mean power output between all inertial loads from day-2 to day-3 (ES = 0.59 – 1.25).

CONCLUSION: Familiarisation proceedings underpin the efficiency of flywheel iso-inertial training (FIT). This study offers an alternative cluster-set approach to familiarisation for FIT, in addition to examining the impact specific coaching instructional cues in FIT. Both instructional groups reported positive performance measures, albeit the external group reached stability at an earlier stage. In addition, the cluster approach as a mode of flywheel training showed no significant drop-offs in performance.

EFFECTS OF LOW-INTENSITY TORQUE-MATCHED ISOMETRIC TRAINING AT LONG AND SHORT MUSCLE LENGTHS OF THE HAMSTRINGS ON MUSCLE STRENGTH AND HYPERTROPHY

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INTRODUCTION: Utilizing passive muscle tension at muscle-lengthened position may be useful to induce muscle hypertrophy for those who cannot or do not like to exert high intensity contractions such as older people and patients. The total torque at the joint generated during isometric contraction is divided into active torque generated by voluntary contraction and passive torque generated by stretching the muscle. In terms of training effects, the amount of active torque exerted during training is often focused; however, as previous animal studies have reported an increase in muscle volume or the rate of protein synthesis after passive muscle stretching, it is possible that the passive torque, as well as the active torque, would contribute to hypertrophy. This study aimed to investigate the effects of low-intensity isometric training with

matched total torque at long (LL) and short muscle lengths (SL) of the hamstrings on muscle hypertrophy and strengthening.

METHODS: Thirty participants (16 males and 14 females, 25.2 ± 3.4 years) were randomly assigned either to LL or SL group, in which trained at 30° or 90° of knee flexion, respectively. They performed isometric knee flexion training (30% of maximal voluntary contraction (MVC) × 5 s × 20 repetitions × 5 sets × 3 times/week × 8 weeks). The cross-sectional areas (CSAs) of the hamstrings were assessed before and after 8 weeks by scanning transverse panoramic images at the proximal 1/3, 1/2, and 2/3 points of the ischial tuberosity to the lateral epicondyle (proximal, intermediate, and distal hamstrings, respectively). The MVC torques at 30° and 90° of knee flexion were measured before and after the training period. The active torque was calculated by subtracting the passive torque at rest from the total torque during training.

RESULTS: Twenty-eight participants (14 males and 14 females) completed the program. The active torque was significantly lower in the LL group than in the SL group ($p<0.01$), whereas there was no between-group difference in total torque during training. For the CSA of the proximal, intermediate, and distal hamstrings and the MVC torque at 30° knee flexion, a split-plot analysis of variance showed no significant time × group interaction; however, it did show a significant main effect of time ($p<0.05$), indicating a significant increase after training intervention. As for the MVC torque at 90° knee flexion, there was a significant time × group interaction ($p<0.05$) and a significant simple main effect of time in both the LL ($p<0.01$; Cohen's d effect size [ES]=0.36) and SL ($p<0.01$; ES=0.64) groups, which indicated a greater increase in the SL group than the LL group.

CONCLUSION: Low-intensity isometric training at LL can induce hypertrophy, even in cases where the active torque production is lower than that at SL. Muscle strength increased after both LL and SL training; whereas SL training may be more effective for increasing MVC at SL position (90° of knee flexion).

THE EFFECTS OF COLD-WATER TRAINING ON GRIP STRENGTH AND PERCEIVED COMPETENCE AMONG STUDENTS

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INTRODUCTION: Cold-water training is becoming more prevalent in physical education programs. However, little is known about how students perceive and respond to these training regimes, or the physiological responses and associated risks of typical cold-water training regimes. And if these responses are evenly distributed among students.

METHODS: This study aimed to investigate the student's perceptions prior to cold-water training and their perceived competence after. The effects of short duration cold-water immersion on grip strength were assessed as well. Participants performed 2-4 minutes of cold-water immersion in a lake and performed activities such as treading water, swimming short distances, and floating. Assessments of students' fears, worries (7-point Likert-scale, 1 being most worried/fearful), and grip strength were assessed before and after immersion, while perceived competence (4 items, 7-point Likert scale, 1 being most competent) was assessed after immersion.

RESULTS: The results showed that most participants were not worried prior to cold-water immersion (Mdn = 5, IQR = 4-6), but some heterogeneity was observed. The fears experienced during immersion was even less pronounced (Mdn = 7, IQR = 6.75-7). The 50% strongest participants experienced a mean reduction in grip strength following cold-water immersion of -5.4 kg (-8.1 %; $p < 0.001$), while the 50% weakest participants did not (-0.7 kg, -2.3 %; $p = 0.604$). Perceived competence after cold-water training was considered high (Mdn = 2, IQR = 1.3-3.9).

CONCLUSION: These findings suggest that some students are worried prior to cold-water training, but also that these worries largely dissipate during cold-water immersion. The results also show that even short duration immersion can lead to reductions in grip strength, but only among participants with high baseline grip strength. This reduction in grip strength may increase the risk of drowning accidents or other dangerous situations during cold-water training and accidental cold-water immersion for these individuals. Students generally perceive themselves as competent after a non-comprehensive cold-water training regime.

EFFECTS OF IMPROVEMENT IN TAKEOFF MOTION ON LOWER LIMB STRETCH-SHORTENING CYCLE ABILITY

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INTRODUCTION: The stretch-shortening cycle (SSC) ability of the lower limb is important in several sports and evaluated using the and SSC ability is evaluated using the rebound jump (RJ) test. In addition to the RJ index, which is the jump height divided by the contact time, an evaluation focusing on the kinetic variables of the three lower-limb joints has been proposed for the RJ test. In contract, it is difficult to calculate the kinematic variables of the three lower limb joints in real-time coaching. Therefore, investigating effective takeoff motions is imperative. Furthermore, knee joint flexion movement prior to landing on a jump influences performance variables and lower limb extension force. However, the effect of improved takeoff motion on RJ performance and lower limb force exertion remains unclear. Thus, we aimed to investigate the effect of improvements in RJ takeoff motion on performance variables, three lower limb joint kinematics and kinetics.

METHODS: Twenty-one female university athletes (training group:11, control group:10) performed the RJ test before and after training. Performance variables (jump height, contact time, and RJ index), kinetics (torque and power), and kinematics (joint angle and amount of flexion) of the three lower limb joints (ankle, knee, and hip) were calculated. The training group received training for eight weeks (two days/week) based on previous studies: i) Jumping on a 10-cm platform and stopping with the knees flexed. ii) Jumping onto the platform and then jumping up. iii) Jumping off the platform and then

jumping up. In the first week, all participants performed only task i). After mastering tasks i) and ii), they performed tasks iii). Two-factor analysis of variance (pre-post × between-groups condition) and effect size was performed to test for differences in each group ($P < 0.05$).

RESULTS: In the training group, the RJ index significantly increased, while the contact time significantly shortened and knee flexion angle significantly decreased. In addition, the ankle joint power significantly increased in the training group. Negative knee joint power significantly increased in both groups, whereas, the eccentric torque showed an increasing trend (medium effect) only in the training group.

CONCLUSION: It is thought that the takeoff motion training inhibited the knee flexion, indicating that the lower limb was no longer more flex against gravity may have positively affected takeoff and increased the RJ index. Moreover, negative knee joint power and eccentric torque were exerted in the eccentric phase of takeoff to counteract the lowering of the center of gravity. The training group was able to exert greater eccentric torque by acquiring a movement that inhibited negative knee flexion. Therefore, landing motion training enables the lower limbs to effectively receive the landing impact, which may improve the power exertion ability at the ankle and knee joints during takeoff and the SSC ability of the lower limbs

DOES POST-ACTIVATION POTENTIATION AFFECT AGILITY PERFORMANCE?

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INTRODUCTION: Agility is widely accepted as being critical to sporting success, particularly in team invasion sports such as football, basketball, rugby and hockey. Agility, unlike planned change of direction speed, is a rapid whole-body movement with a change of velocity or direction in response to a stimulus. It is a complex motor skill that is made up of cognitive, physical and technical factors. However, the relative importance of each factor is understudied. Post-activation potentiation (PAP) is a phenomenon within muscle contractile history which can acutely enhance short-duration athletic physical performance. PAP has been harnessed to improve vertical jump height, straight sprint speed and planned change of direction speed. The aim of this study was to investigate the effect of PAP on agility performance.

METHODS: Sixteen participants (nmale= 10, nfemale=6) completed three days of testing, each starting with a standardised dynamic warm up. Day 1 for all participants consisted of 3RM back squat testing and Speedlight agility Y-test familiarisation. On day 2 and day 3 participants either completed a PAP or control preloading conditioning activity (CA) followed by agility testing. at set time intervals of 4, 8-, 12-, 16- and 20-minutes post CA. The PAP CA consisted of performing the 3RM back squat that was calculated on day 1, the control CA consisted of three body weight squats. There was a minimum of 48 hours between testing days.

RESULTS: Agility performance was quantified as the total time to complete the agility Y-test. A Friedman two-way ANOVA showed a non-significant ($p>0.05$) effect of preloading condition on agility performance. A Mann-Whitney U test showed that the test direction (left or right) and the time elapsed between pre-load stimulus and agility testing had a non-significant ($p>0.05$) effect on agility test time. Overall, there was no potentiated effect evidenced in this study.

CONCLUSION: The results of this study indicate that completing 3RM back squats prior to agility testing causes no potentiation in agility Y-test performance. The prior CA also showed no detrimental effect to Y-test performance. For practitioners, this suggests that it may be feasible to complete both strength testing and agility testing within the same testing session, without the prior impacting the latter. However, more research is needed to confirm this.

Though not tested, researcher observations during testing found that some participants seemed to be pre-empting the direction of the light stimulus based on their previous runs. Future research should include more than two agility directions to avoid this issue. Further agility research should include cognitive and biomechanical outcome measures as agility is multifaceted.

RESPONDERS AND NON-RESPONDERS TO ECCENTRIC CYCLING TRAINING IN MUSCLE SIZE AND PERFORMANCE MEASURES

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INTRODUCTION: Eccentric cycling training has been reported to increase muscle mass and function at low efforts [1], but the optimal protocols for eccentric cycling training are yet to be established. Previous studies prescribed eccentric cycling based on heart rate, oxygen consumption, or perceived effort [1-3]. However, a protocol based on maximal power may better standardize mechanical stimulus to the muscle. We investigated the effects of 8-week eccentric cycling training with incremental increases in power on several outcome measures to test the hypothesis that the protocol would significantly increase muscle mass, strength, and other performance measures.

METHODS: A total of 15 healthy men (24.3±4.8 y; body mass 84.1±19.0 kg; height 178±7.4 cm) underwent 3 training sessions a week for 8 weeks. Participants performed 10-s maximal concentric cycling, and 33% of its average power output was used for the intensity of the first 3 sessions. The intensity increased by 10% every 6 sessions to 40% in week 8 (7-10 min per session). Outcome measures included whole-body (WBLM) and lower-limb lean mass (LLLM) by DEXA, vastus lateralis cross-sectional area (CSA) and thickness (MT), knee extensor maximal voluntary isometric contraction (MVIC) torque, cycling-specific performance (peak and average concentric cycling power, braking strength), and squat and counter-movement jump height.

RESULTS: Significant improvement (9.2-26.2%) in cycling-specific performance was evident from pre- to post-training, but MVIC torque and jump heights did not change (P>0.05). Large inter-participant variability was observed for changes in WBLM, LLLM, CSA, and MT such that 8 participants had increases in WBLM (3.4±2.6%) and LLLM (4.3±3.0%), but 7 participants had no changes or decreases (WBLM: -1.3±1.3%; LLLM:-0.9±4.2%). This was also found for CSA and MT. No significant differences between LLLM responders and non-responders were found for average total work (107±21 vs 111±19 kJ) or cycling intensity (207±40 vs 216±36 W) of 24 sessions. The only significant predictor for muscle hypertrophy was the perceived effort (0-10 scale) during cycling (R=0.9; P=0.03). Participants who reported higher efforts in sessions 19-24 (6.8±0.8) showed no changes or decreases in WBLM, LLLM, CSA, and MT, but those who reported lower efforts (5.5±0.8) showed increases. However, the effort did not predict the changes in other measures.

CONCLUSION: The training protocol did not increase MVIC torque and jump height, and muscle hypertrophy was induced in 8 participants only, although all participants showed increases in peak and average cycling power. It should be noted that muscle hypertrophy was induced in the participants whose perceived efforts in the training were lower. Optimal prescription and progression of eccentric cycling training require further investigation.

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BOTH CONTRAST AND CONSTANT INERTIAL FLYWHEEL LOADING IMPROVES JUMP PERFORMANCE, THROUGH ENHANCED MUSCLE CONTRACTILE MECHANICS.

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UNIVERSITY OF STIRLING

INTRODUCTION: Acute flywheel priming strategies have positively impacted sports performance across multiple sports (1). Certain sports, such as swimming, have at least 20 minutes of waiting before athletes compete which can be sub-optimal for individuals, as most priming-related mechanisms tend to occur between 3-9 minutes post-exercise cessation. However, flywheel-based priming evidence is limited regarding priming time decay and underlying mechanisms (3). Therefore, our study aims to investigate acute neuromuscular changes to constant and contrast load flywheel squats on jump performance and residual effects lasting up to 24 minutes.

METHODS: Very strong males (n = 10, height = 178.7 ± 3.8 cm, body mass= 86.2 ± 9 kg, relative strength in the barbell back squat = 2.1 ± 0.6 kg/kg) completed two flywheel squat loading conditions. The constant load condition involved using medium inertia for three sets of 6 repetitions. While the contrast load condition involved three sets of 4 repetitions at high inertia followed by 4 repetitions at low inertia. Each set was separated by 3 minutes of rest. Tensiomyography (TMG) assessment of the participant's right leg vastus lateralis and rectus femoris were taken after every set and at 4 minutes post-exercise cessation, followed by a measurement every 4 minutes until 24 minutes. TMG variables used for analyses were muscle displacement (Dm, units: mm) and normalised response speed (Vrn, units: mm/s/mm). TMG assessments were followed by countermovement jumps recorded on a force plate, and the variables used were jump height (cm) and peak power (W).

RESULTS: There was an increase in Vrn of the rectus femoris across time in both flywheel loading conditions (P<0.01), while Dm was altered only in the contrast condition (P<0.01). In the vastus lateralis, only the contrast loading condition saw an increase in Vrn (P < 0.05). Additionally, there was an increase in jump height in both loading conditions (P<0.05), but no changes in peak power (P>0.05).

CONCLUSION: The increases in jump performance indicate that either of the loading conditions can be valuable for improving acute performance in very strong individuals. This initial work also explains underlying mechanisms of performance enhancement, based on changes in muscle contractile mechanics.

Conventional Print Poster

CP-SH17 Team Sport Psychology

SPORTS SCHOOLS AND THE CREATION OF CHAMPIONS: FOLLOWING 10 FEMALE HANDBALLERS FOR A DECADE

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The number of secondary sport schools and high schools in Norway is increasing and presumably resulting in earlier sport specializing and increased training volume among the young athletes. How do the athletes respond to the total load? The sport school system can be a valuable resource to develop for young aspiring athletes, in particular in national sport such as handball in Norway, but extra pressure is also put on young athletes that chase an Olympic dream.

Methodology

This qualitative multidisciplinary study, a combination of psychology, physiology and management, followed a group of 10 female student-athletes from the age of 13 to 23 to closely monitor their physical and mental development as well as their understandings of ups and downs at a sport school in Norway. The handballers also provided us with physical data so we could monitor their physical and psychological development. Thematic analysis was used for the complete data material, several measures was taken to protect the athlete's anonymity in addition to ensure trustworthiness by prolonged engagement, reflexivity and discussion of results with participants and collegues.

Results

When we first started following them at age 13, the importance of sleep, growth and stage of puberty needs to be taken into consideration in the total workload. However, parental support, support from teachers/trainers at school and rest are mentioned as main coping mechanisms that contribute to effective coping. Evidence of competition-related stressors, organizational stressors (sport and school balance) and personal stressors (social life and sport balance, lack of sleep and severe injuries) was recurring themes in the annual interviews with the handballers. After ten years, only three were playing at the elite level. They had also taken part in the injury preventive program, they had stamina, and they always had a good relationship with their coach. However, all three had gone through serious long-lasting injuries, and their return to sport provided interesting information. This is necessary as talking about pain in the context of handball, where players are expected to be tough and push through pain, was hard.

Discussion

It is important to be aware that young athletes need time to adapt to a high workload, high expectations and the huge demands of elite sport. Together this will create a constant 'need' to cope with new and different sources of strain. After a decade, importance of the coach-athlete relationships, emerged as a parallel narrative to that of injuries. Being seen was the common denominator for healthy and sustainable development among our participants. We would recommend teaching athletes in contact sports to talk about pain and injuries in order to protect them. This is vital to preventing them from developing long-term and career-ending injuries. To conclude, miscommunication or lack of communication and not feeling seen when they struggled where the reason why half of them ended their career prematurely.

LEARNING BASKETBALL TACTICS BY IMAGINATION: INVESTIGATING THE EFFECTS OF TIME OF TESTING AND EXPERTISE LEVEL

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Introduction

To better communicate tactical instructions in basketball training sessions, coaches verbally present tactical instructions to the players so that they know their role and position on the field. However, due to the complexity and interplay of the game elements, verbal instructions are not always an effective method. Therefore, asking players to imagine while listening to the tactical instructions could be a possible solution to avoid this problem and optimize tactical learning (Khacharem et al., 2020). Thus, the aim of the present study was to examine the effect of imagination on the learning of basketball tactics and to determine whether this effect remains stable over time and in players with different levels of expertise.

Methods

Eighty participants (40 basketball experts and 40 novices) participated in this study and were recruited based on their previous experience with basketball. The learning material consisted of audio recordings on the development of an offensive tactical system. The test consisted of two phases: immediate and delayed. Participants were assigned to one of two conditions, in which they were instructed to either listen and learn the material ("N-I": "No imagination") or listen and imagine the learning material ("I": "Imagination"). Immediately afterward, they rated their mental effort and drew the game system they had learned on a sheet of paper. After one week, they were instructed to draw the same learned material.

Results

In the immediate phase, novices showed lower recall scores and higher investment of cognitive load in the "I" condition compared to the "N-I" condition. However, experts showed higher recall score and lower cognitive load in the "I" condition compared to the "N-I" condition. In the delayed phase, novices and experts benefited more from the "I" condition by achieving higher recall score compared to the "N-I" condition.

Discussion

The findings revealed that for novices in the immediate phase, imagining while listening is not an effective teaching method. Based on cognitive load theory, asking learners who lack of prior knowledge to imagine could overload their working memory and this might result in several mistakes in initial learning. However, in the delayed phase, imagining and investing more cognitive load led to more traces of learning material over time which is explained by the desirable difficulties. For experts, the integration of information in long term memory is easier to them and this is due to their prior knowledge, therefore imagining resulted in retaining more traces of the game elements in the short and long term. Results suggest that coaches need to consider players level of expertise when using imagination.

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RELATIONSHIP BETWEEN COACH-RATED PERFORMANCE, PHYSICAL FITNESS, SKILL PERFORMANCE, AND MENTAL SKILLS IN YOUTH SOCCER PLAYERS

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Introduction

Coach-rated player performance has been considered as an important performance indicator in youth soccer. However, soccer is a multifaceted sport and various technical, physical, and mental skills can contribute to overall performance and development in the context of youth sport. Accordingly, this study sought to investigate the link between coach-rated performance and various factors such as physical fitness, technical skills, executive function, and creative thinking in youth soccer players.

Methods

This study included 28 elite youth soccer players aged 9-11 years. They were administered a battery of tests including standing long jump, 20-m sprint, Illinois agility test, motor coordination test, and aerobic capacity to measure physical fitness, Illinois agility dribble test to measure soccer technical skill, Dimensional Change Card Sort task to measure executive function, and Alternative Uses Test to measure creative thinking. The players performance was rated by three certified coaches from the Asian Football Confederation based on eight soccer-specific skills: ball control in dribbling, passing and trapping, duel tackles, rapidity of actions, finding appropriate solutions under pressure, taking relevant decisions situationally, and studying group/team plays. The relationship between these variables was analyzed using the Pearson product-moment correlation coefficient, controlling for age, body mass index, and socioeconomic status.

Results

Our results showed that coach-rated performance was significantly correlated with all physical fitness [standing long jump ($r = .51$, $p = .011$), 20-m sprint ($r = -.48$, $p = .017$), Illinois agility test ($r = -.59$, $p = .003$), motor coordination test ($r = -.88$, $p < .001$), and aerobic capacity ($r = .74$, $p < .001$)] and soccer technical skill tests [Illinois agility dribble test ($r = -.59$, $p = .002$)]. In addition, fluency ($r = .42$, $p = .046$) and flexibility ($r = -.52$, $p = .009$) indicators of the creative thinking test were correlated with coach-rated performance, but originality was not ($r = .24$, $p = .25$). However, executive function performance was not correlated with coach-rated performance ($r = -.17$, $p = .44$).

Discussion

Our findings suggested that coaches and talent development professionals should consider the importance of physical fitness, technical ability, and creative thinking when evaluating and developing elite youth soccer players. Furthermore, these findings highlight the need for a multidimensional approach to assessing player performance, as coach ratings may not always align with measures of mental skills such as cognitive function. Further research is needed to validate these findings in youth soccer players at different levels of competition.

TACTICAL LEXICAL KNOWLEDGE OF SOCCER BY AGE 15 AND 18

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Introduction

According to the theory of the development of lexical knowledge (Lieury & Lorant, 2013), the lexicon is built progressively over the course of life through different stages and experiences. The objective of this study is to measure the effect of age on the size of the football tactical lexicon.

Method

We tested 164 participants: 82 soccers, aged 15 (U-15) with 10 years of practice and 82 soccers aged 18 (U-18) with 10 years of practice. Both groups are elite soccer in their category. The test consists of answering a selfassessment

questionnaire on the degree of lexical knowledge (Deplus S, Grégoire J, Van Broeck N, 2013). The task is to indicate the degree of familiarity and frequency of use in relation to 40 tactical words in football: 1 (I have never heard); 2 (I have already heard, but don't know what it means); 3 (I often hear but don't know what

it means); 4 (I know) and 5 (I know and practice it on the field).

Analyse and results

A t student test was used. The analysis plan includes a VI: Age (U-15 and U-18). The significance level (α) has been set to 0.05. The main results show a significant effect of age ($t = -9$ $df = 162$; $p < .001$). In addition, the results show intersections of word nucleus between groups but also words that appear in one category and not in the other and vice versa.

Discussion and conclusion

Our results: (i) confirm the effect of age on players' lexical knowledge. U-18 soccers know more tactical words than U-15 soccer. (ii) The most important and original result reveals that soccers lexical knowledge does not appear in a linear manner as in a conventional scheme but is random. These results suggest that lexical knowledge is influenced by other fac-

tors. (iii) Finally, these results show that none of the categories reach a knowledge of all the words. Our study suggests that practical coaches work on the lexical knowledge of tactical words to optimize the understanding and performance of players on the field.

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DIFFERENCES IN DYNAVISION D2 COGNITIVE AND MOTOR SKILLS ASSESSMENTS AMONG VOLLEYBALL REFEREE LEVELS

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INTRODUCTION: Sport refereeing demands attention, accuracy, and fast response to ensure the fairness and quality of sporting competitions. Assessing and training referees cognitive and motor skills using convenient training programs and equipment is essential. Dynavision D2 assessments have been proven to be validated and expedient. The study aimed to assess Jordanian Volleyball Referees Cognitive and Motor function using Dynavision D2 tests among three official Volleyball Refereeing levels (Provincial, National, and International).

METHODS: Data collection was obtained throw Dynavision D2 assessments of performance accuracy, cognitive, and reaction time for 30 Jordanian officials registered volleyball referees grouped (n=10) depending on Volleyball Refereeing levels (Provincial age (26.2±4years), National age (37.7±3.2years), and international age (M= 38.3±7years)) for each level included 10 participants. OneWay -ANOVA and linear regressions between referee levels and selected Dynavision D2 tests were completed.

RESULTS: There were statistically significant differences between the refereeing levels performance of the selected Dynavision D2 tests. The Provincial level group achieved better reaction times, and no significant differences were found between the national and international levels. The international referee level showed higher accuracy and attention focus than the other groups.

CONCLUSION: Training referees cognitive skills could be as essential as physical training. In contrast, the contusions assessments can provide crucial data that enhance the skills and capabilities of volleyball referees.

THE IMPACT OF GAME SCORE AND PITCHER HANDEDNESS ON BATTING DECISIONS IN BASEBALL PLAYERS

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Skilled players outperform their less skilled counterparts in the action anticipation ability thanks to their higher proficiency in detecting the crucial advance kinematic information of the observed action. Recent studies showed that contextual information also has an impact. Specifically, the impact of game score remains unclear. Moreover, the left (L)-handers have shown advantages in sports. However, the understanding of the cognitive and neural underpinning remains limited. Hence, the aim of this study was to investigate the effect of contextual information, particularly the game score, on anticipating the batting decision to a pitch thrown by a L- and right (R)-handed pitcher, respectively, in baseball batters, using electroencephalography (EEG). We recruited 27 male collegiate skilled batters (SBs) and 29 controls. Participant was either presented with the information of game score (far-ahead and even/slightly-ahead or slightly-behind [Even]) or not, and then the video of a L- or R-handed pitcher throwing a pitch (strike vs. ball). While viewing the video, participant had to predict his batting decision to the observed pitch. After all the trials within one condition were performed, they had to indicate their confidence as well as stress level across their responses within the given condition. Separate four-way (2 groups x 2 pitcher handedness x 2 pitch results x 3 game score conditions) mixed-model ANOVAs were used for accuracy and event related potential (ERP: N1 and P3) data analyses. Results revealed that SBs had higher rate of swinging decision for R-handed pitcher than for the L-handed one, no matter at strikes or balls, whereas controls only showed this tendency at balls. Both groups showed higher self-rated stress level when the score was Even compared to the other two score conditions. The average N1 ERP across occipital sites (O1, Oz, and O2) was significantly higher when participants viewed the pitching videos preceded with the score information compared to videos without preceding score information. The average N1 ERP across same sites was higher for L-handed pitcher than the R-handed one. On the contrary, the average P3 ERP at parietal regions (P3, Pz, and P4) was higher for the R-handed pitcher than the L-handed one. Our behavioral results indicated that both baseball players and individuals with limited baseball-playing experiences were influenced by the contextual information of game score, and the greater N1 ERP might be related to the greater attention allocated to observing the pitching videos in such conditions. Our participants were less tended to swing at the pitches thrown by the L-handed pitcher than those thrown by the right-handed one. The lower N1 at occipital regions and then the greater P3 at parietal regions might be associated with the greater attention induced but less attention selected to the L-handed pitcher than the R-handed pitcher due to lower familiarity.

GROWTH MINDSET BELIEFS AND PERCEPTIONS IN ELITE YOUTH SOCCER PLAYERS

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THE MINDSET ASSESSMENT PROJECT

Introduction

In the realm of education, Dweck and her colleagues have found that students with growth mindsets are more likely to engage in their studies, invest effort, persevere for longer periods through more challenges, be more self-motivated, and achieve greater academic success (Dweck, 2007). However, very little has been done to study the relationship between growth mindset and performance in sport. Instead, much of the research on the construct has dealt with the relationship between growth mindset and other psychological constructs. Our study seeks to address these deficits.

Methods

The study measured players' own growth mindset beliefs (e.g., reverse score of "I have a certain degree of soccer ability and I cant really do much to change it") and players' perceptions of their teammates', and coaches' growth mindset beliefs about players' soccer abilities (e.g., reverse score of "My teammates/coaches seem to believe that I have a certain amount of ability and I cant do much to change it") in a sample of over 5,000 elite youth soccer players between the ages of 13 and 19. Given the lack of previous research on the role of growth mindset in sport performance, we used validated measures from education research and adapted them to the context of elite youth soccer.

Results

We first demonstrated the validity and reliability evidence of the four scales to establish them as legitimate measures of the construct. Descriptive analyses then revealed players' perceptions of their teammates' and coaches' growth mindset are more correlated with key performance outcomes (e.g., goals scored among attackers) than players self-reported growth mindset. Similarly, we found that when players are "unsure" about their coaches' and teammates' growth mindsets, they tend to report lower growth mindset beliefs themselves. We also explored the interactions between player growth mindset and perceptions of coaches' and teammates' growth mindset using linear multiple regression. Attacking players with more of a growth mindset especially benefited from perceiving their coaches and teammates to have a growth mindset about them, as they tended to score more goals than their peers. Interestingly, when attacking players with more of a growth mindset reported that their coaches and teammates did not have a growth mindset about them, they tended to score fewer goals.

Discussion

Our data highlight the importance of player perceptions of their teammates and coaches, which can provide insight into how we can better support players to succeed in the future. Following these findings, we recommend implementing growth mindset interventions with players and coaches to examine effects on growth mindset beliefs and performance outcomes in future studies. Assessing changes in players' mindsets over time, more proximal performance outcomes, and physiological markers in tandem would propel forward our understanding of psychological factors and their impact on performance.

PSYCHOLOGICAL RISK FACTORS OF A FIRST HAMSTRING STRAIN INJURY IN SOCCER: A QUALITATIVE STUDY

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INTRODUCTION: The Hamstring Strain Injury (HSI) is one of the most burdensome injuries in amateur and professional soccer teams. Numerous HSI risk factors have been identified, but few studies have considered the psychological risk factors. Although several theoretical models of sports injury psychology have been developed, they have not yet been applied to the context of HSI in soccer. The objective of this study was to determine the psychological risk factors of a first HSI in competitive males' soccer players.

METHODS: In this qualitative study, we conducted semi-directive interviews with ten male competitive soccer players (age=19.8±2.6 years) who had sustained their first HSI within the past 6 years. The interview guide was based on the comprehensive model of injury causation of Barh & Krosshaug (2005). We investigated the dispositional, contextual and situational factors of the soccer players before their first HSI. Interviews were led by the same researcher who ensured the confidentiality of the data. Interviews were verbatim transcribed, coded line-by-line and first deductively organized into the guide's main categories by two of the authors, ensuring trustworthiness. Next, using an inductive approach, all authors triangulated the data and brought out new subcategories.

RESULTS: Participants had common dispositional psychological risk factors, including at-risk personality traits (e.g., perfectionism, external health locus of control), an obsessive passion for soccer with competitive motivational goals, strong athletic identity, poor health literacy, and maladaptive health-related behaviors. They were exposed to a controlling coaching context with a fear of negative staff evaluation, and had recently undergone injuries or life stressors. When injured, all athletes were in positive psychological states. They faced different situational factors (e.g., match, training overload), experienced positive or negative physical states, and were highly engaged in the activity (e.g., sprint).

CONCLUSION: These results helped to specify the comprehensive model of Barh & Krosshaug (2005) in the context of HSI in soccer, while providing a broader identification of psychological risk factors. From a preventive perspective, results suggest the need to moderate the controlling coaching style and thus lower the fear of negative staff evaluations, enhance the players' health literacy, and build their autonomy.

CRICKET COACHES PERSPECTIVES ON PROVIDING AUGMENTED FEEDBACK TO THEIR PLAYERS

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INTRODUCTION: Coaches play an important role in developing skilled athletes. In sports like cricket, augmented feedback has traditionally been conceptualised as a tool coaches can modify to elicit learning and development [1]. However, little is known about how and why coaches choose to provide augmented feedback in cricket and how they operationalise this [2]. This study explored cricket coaches conceptualisation of feedback, and their underpinning knowledge and reasoning.

METHODS: An online questionnaire (Qualtrics) consisted of closed and open-ended questions, exploring demographic/coaching experience and attributes of feedback (role, content and provision). Closed-responses were analysed exploring associations (frequencies, chi-square with adjusted alpha) or differences (Mann-Whitney U) between two coaching groups (lower-level vs higher-level cricket players); identified following silhouette and k-mode cluster analysis. Thematic analysis [3] examined open-ended questions to explore coaches understanding and provision (how and why) of feedback.

RESULTS: 134 coaches (94% male, 6% female) aged 18-69 years from 12 countries responded to the questionnaire; 86% with coaching accreditation and 55% with over 10 years experience. Results were explored for two coaching groups; those coaching at lower-level (mostly community cricket; Group 1 (Gp1), n=84, 63%) and at higher-level (mostly sub/elite; Group 2 (Gp2), n=50, 37%). There were significant differences between the two groups; Gp2 were more credentialed and experienced. Additionally, they reported greater self-efficacy around feedback, albeit with a small effect size ($p=<0.001$, $r=0.29$). No significant association existed for how coaches provided feedback. Thematic analyses identified both similar ideas, and different pedagogical approaches [4] to feedback by each group. Emerging themes about the role of feedback were: (i) benefits (improving skilled behaviour) and (ii) disadvantages (inhibiting learning/performance); with comments on the role of feedback in encouraging cognitive reflection (Gp1) vs active search for movement solutions (Gp2). Coaches reported providing group feedback for consistent messaging (Gp1) and to enable emergent group discussion/ideas (Gp2). Further, coaches used technology to 'highlight deficiencies and errors' (Gp1) and 'explore and adapt technique to improve outcomes and strategy' (Gp2).

CONCLUSION: The current study provides insights into cricket coaches conceptualisation of augmented feedback, and reasons underpinning choices. Findings depict the complexity of feedback within cricket coach-athlete systems; with coaching groups sharing both similar notions to feedback, and different pedagogical approaches to providing feedback. Results contribute to the limited cricket feedback research [2] and may also assist with identifying effective use of feedback and technology use as part of coach education.

1. Orth et al. (2019) 2. Tissera et al. (2022) 3. Braun & Clarke (2006) 4. Smith et al. (2022)

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CP-SH18 Psychobiology

EFFECTS OF LONG-TERM RUNNING ON BRAIN STRUCTURE AND FUNCTION IN COLLEGE STUDENTS: A 2-YEAR FOLLOW-UP STUDY

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Introduction

Existing studies have documented differences in brain structure and function in endurance exercise participants. However, there is still a lack of conclusive evidence on whether this difference is due to nature or training. This study adopted a long-term follow-up research paradigm to investigate the changes in brain structure and functional activity before and after 2-year endurance training.

Methods

A group of 16 college students was included in this study. Eight subjects (22.5 ± 3.1 years old) were recruited from the college Marathon club. They experienced a systematic running training year of 2.6 ± 1.6 years. The other eight subjects (18.1 ± 0.3 years old) were healthy college students without any systematic running training. All subjects were right-handed and had no history of neurological disorders. Two fMRI tests were performed before and after the follow-up using a Philips 3.0T Trio scanner with a standard 32-channel head coil. Structural T1-weighted images and blood oxygen level-dependent (BOLD) data were acquired. Subjects were told to relax without thinking about anything and remain awake with their eyes closed. Voxel-based morphometry (VBM) was used to calculate gray matter volume(GMV). The fractional amplitude of low-frequency fluctuation (fALFF) and degree centrality(DC) was used to evaluate the intensity of regional spontaneous brain activity and network connection, respectively. Age was included as a covariate. Paired-sample t-tests were used to compare the changes in brain structure (GMV) and function (fALFF and DC) during two years(RESTplus).

Results

(1) In a follow-up questionnaire two years later, participants in the running group reported that they had basically completed endurance training in the past two years with a weekly exercise frequency over 3 sessions and 1 to 1.5 hours in each session. While the control group reported no systematic long-distance running or endurance training over the two years.

(2) In the running group, GMV was significantly increased in the bilateral prefrontal brain regions, bilateral medial frontal lobes, right insula, right putamen, and right fronto-parieto-occipitotemporal regions and decreased in the bilateral posterior cerebellum. Meanwhile, DC was significantly increased in the right temporal lobe and bilateral dorsolateral prefrontal lobe and decreased in the left thalamus. The fALFF of the right precentral gyrus was significantly increased ($p < 0.001$, FWE corrected).

(3) In contrast, no significant changes were found in brain structure or function in the control group ($p < 0.001$, FWE corrected).

Conclusion

2-years of running can improve the structure and function of runners brain regions related to episodic memory, spatial attention, motor regulation, motor execution, rhythm coordination, and sensorimotor integration. The current results may provide new insights into the neuroplasticity induced by exercise.

EFFECTS OF COMBINED PHYSICAL AND COGNITIVE TRAINING ON EXECUTIVE FUNCTION OF ADOLESCENT SHOOTING ATHLETES: A FUNCTIONAL NEAR-INFRARED SPECTROSCOPY STUDY

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Individual executive function improvement through physical and cognitive training is a research hotspot in physical education and cognitive science. However, few studies have evaluated whether combined physical and cognitive training (CPCT) has greater benefits for executive function performance and cerebral oxygenation in adolescent athletes than cognitive training alone. This study randomly assigned 33 adolescent shooting athletes to a CPCT (n = 17) or computerized cognitive training (CCT, n = 16) group and compared their executive function after six weeks of training. All subjects were assessed using the 2-back, task-switching, and Stroop tests before and after training. The prefrontal cortex oxygenated hemoglobin (Oxy-Hb) activation level was monitored while executing the three tasks using functional near-infrared spectroscopy. Our results showed that the CPCT and CCT groups similarly improved their updating function as indicated by the 2-back task accuracy. The CPCT group significantly improved the switching function in the task-switching test accuracy, while the CCT group did not. However, both groups did not improve in behavioral performance as indicated by the inhibition function in the Stroop task. Cerebral oxygenation, indicated by the oxy-Hb activation level in the frontal pole area of the prefrontal lobe, significantly improved in the CPCT group during the three cognitive tasks, whereas the CCT group showed no change. These findings indicated that CPCT endowed greater advantages in task-switching in the behavioral performance of the executive function than CCT. Moreover, CPCT was superior to CCT in increasing task-efficient cerebral oxygenation during activation of the prefrontal cortex in adolescent shooting athletes.

RELATIONSHIP BETWEEN THE RESTING-STATE EEG BRAIN OSCILLATIONS AND ARCHERY SHOOTING PERFORMANCE

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INTRODUCTION: Resting state before exercise has been shown to reflect sporting performance in previous studies (1,2,3). However, such evidence was mostly based on data collected from one single resting state session, either with eyes open or closed, correlated with the following sporting performance. To overcome these limitations, the current study recorded the resting-state electroencephalography (EEG) at multiple sessions in both eyes open and closed conditions in a longitudinal design, and investigated the relationship with the following archery shooting performance in one skilled archer.

METHODS: We recruited a collegiate archer who has seven years of archery shooting experience and was currently active in competitions. In each experiment, the resting-state EEG activity, with eyes opened and closed for three minutes respectively, was recorded with a 32-channel EEG system (Brain products LiveAmp) with 250 Hz sampling rate. Next, the participant was asked to shoot 12 rounds of 6 arrows at a 122-cm target face at 70 m. 6 experiments were performed. Standard preprocessing and removal of noise identified using independent component analysis (ICA) was performed with eeglab (v2021.0). Then, the mean power density in each frequency band (delta, theta, alpha, beta, and gamma) in frontal (Fz), central (Cz), parietal (Pz), and occipital sites (Oz) was computed. Pearson correlation coefficient was used to examine the relation between the power density in each frequency band in the four sites with the mean (M) and standard deviation (SD) of the shooting scores across the six experiments. The level of significance was set at $\alpha = .05$.

RESULTS: For eyes-open states, a positive ($r=.814$, $p<.05$) and a negative correlation ($r=-.814$, $p<.05$) was found in the power of the alpha band at Oz with the M and SD of scores, respectively. Whereas the delta power at Pz was negatively correlated with the M of scores ($r=-.825$, $p<.05$). For eyes-closed state, gamma power at the Fz ($r=.827$, $p<.05$) and Oz ($r=.820$, $p<.05$) was positively correlated with the M of scores.

CONCLUSION: Generally, our results were in agreement with the notion that pre-performance resting state brain oscillations could reflect the latter sporting performance. However, resting state EEG with eyes open and closed might reveal different brain oscillations from specific bands at specific brain regions correlated with the shooting performance. Whether resting state EEG with eyes open or closed might need to be considered when correlating the performance in different sport types.

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BIGOREXIA AND CONFRONTATION WITH SOCIALLY PROMOTED AESTHETIC IDEALS

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ABSTRACT

Introduction: Bigorexia is characterized by an obsession with the appearance of one's body, fear of not having enough muscles, and the urgent need to exercise excessively. This discomfort affects the individuals mental and physical health and damages his or her relationship with sports and physical activity. The research aims to describe possible individual and environmental elements that may promote the development of bigorexia and exercise addiction, with the intent to identify the prevalence of this distress among young individuals.

Materials and Methods: The research involved a group of 1662 male individuals aged 18-30 years. Questionnaires were administered online and then analyzed using research software. The test battery included the following questionnaires:

- Sociocultural Attitudes Towards Appearance Questionnaire: an instrument consisting of 22 items that assesses thin and muscular-ideal internalization as well as appearance-related pressures from peers, family, and media by distinguishing between pressures to achieve socially promoted aesthetic standards and internalization of such ideals. It comprises five subscales: Internalization: Thin/Low Body Fat; Internalization: Muscular/Athletic; Pressures: Family; Pressures: Media; Pressures: Peers. Items are rated on a 5-point Likert scale ranging from 1 (definitely disagree) to 5 (definitely agree)

- Muscle Dysmorphic Disorder Inventory: consisting of 13 items, a total score and three subscales: Measurement Concern (5 items, range 5-25), Outward Appearance Intolerance (4 items, range 4-20), and Functional Deterioration (4 items, range 4-20).

Descriptive statistics and frequency of occurrence were calculated.

Results: Data analysis shows that participants' body image is not predominant: for 16.1% looking athletic is important, for 13.8% not at all. As for thinking about appearing muscular, 10.6% think about it often, while 24.4% never think about it. 26.4% do not spend much time on activities that make them look athletic, while 12% put a lot of effort into it. Concerning the perception of being under pressure in their daily lives regarding improving their physical appearance, 68.6% do not feel this pressure from their family, while 4.2% feel it importantly. 17% perceive peer pressure in contrast to 5%. Finally, 45.1% do not feel any pressure from the media while 2.5% feel it significantly.

Conclusions: The research highlights that approximately 10-12% of the analyzed sample shows to possess predictive aspects of bigorexia and exercise addiction which are determined by a number of interacting individual and environmental factors. Among these factors, the study shows that a prominent role is played by the individuals confrontation with the aesthetic ideals that the family, social and media context proposes or shows appreciation for.

Keywords: Body satisfaction, Bigorexia, Exercise addiction

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A NEW EEG NEUROFEEDBACK TRAINING APPROACH IN SPORTS: THE EFFECTS FUNCTION-SPECIFIC INSTRUCTION OF EEG AND MOTOR SKILL PERFORMANCE

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INTRODUCTION: Neurofeedback training is a technique used to train brain activity using real-time feedback. The results of traditional electroencephalography (EEG) neurofeedback training (NFT) protocols for changing EEG activity and improving sports performance have been inconclusive. These traditional approaches mainly rely on nonfunctional directed verbal instructions. This means that traditional training does not provide participants with a specific strategy (i.e., how to regulate a certain brain region) for change their mental state. However, a new approach to EEG NFT, namely the function-specific instruction (FSI) approach, may provide an more effective way to change EEG activity and impact sports performance. The FSI approach is based on the idea that the verbal instructions that consider the meaning of the brainwave function in the target region and the EEG power magnitude can induce mental states. To test the effectiveness of the FSI approach, we replicated Wang et al., 2022's study which partially failed to show a significant relationship between changes in Mu power activity that has been associated with motor control and golf putting performance in the traditional approach.

METHODS: To do so, thirty novice golfers were randomly assigned to either the traditional increased Mu rhythm approach group (T), increased Mu rhythm FSI group (FSI), or sham group (S). In addition, we used EEG-NFT to manipulate Mu rhythm during a golf putting task (complex visuomotor skill).

RESULTS: We mainly found that only the FSI group showed a slightly increased Mu rhythm and decreased motor performance after training.

CONCLUSION: We suggest that the function-specific instructional approach may be more effective in guiding participants to change their state of mind in EEG-NFT.

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CP-AP26 Team Sports II

ANALYZING THE WATER POLO EGGBEATER: RELIABILITY AND VALIDITY OF A NOVEL APPROACH

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INTRODUCTION: Water polo players benefit from greater odds of scoring a goal when positioned directly in front of the net (1). Therefore, the abilities to gain tactical positions in front of the net and to defend invading teams from doing so are key performance factors in this sport. These abilities require a strong capacity to push against their opponent's resistance (2). This project aimed at evaluating the reliability and validity of a water-based strength test.

METHODS: 14 elite female and 19 sub-elite male Canadian water polo players participated in this study. Data were collected during regular training sessions using a force gauge (DFS II R-ND, Ametek, 100Hz) to instrument a weight stack resistance by the pool. After a warm-up, female and male participants executed two pushing tasks (based on the team average 1RM): one four-second push task (80lbs and 140lbs) and one ten-second (120lbs and 180lbs) push task. The tests were repeated, in reverse order, one week later in a subset of 12 female and 15 male players. Performance parameters were defined using a Python script. Variables included overall mean force, mean peak and stroke forces, mean stroke duration and variability, number of strokes, total impulse, loss of force index, and time to first peak. Test-retest reliability was assessed using intra-class correlations (ICC3,1). Comparisons between elite female and sub-elite male players were explored with student t-tests and Wilcoxon tests to evaluate validity (normality evaluated with Shapiro-Wilk tests). Effect size (ES) with Hedge's g describes the size of the group differences.

RESULTS: For the four-second task, the reliability findings were very high for the mean force, mean peak force, and total impulse (ICC 0.92-0.95, $p<0.01$). Time to first peak was the only non-significant variable, with an ICC of 0.03 [95% CI 0.00-0.41]. For the ten-second task, the reliability findings were high for mean force, mean peak force, mean stroke force, total impulse and loss of force index (ICC 0.74-0.89, $p<0.01$). All variables were significantly correlated in this ten-second task. Group comparisons for the four-second task showed significantly greater values in elite females for mean force ($p<0.01$, ES=1.794), mean peak force ($p<0.01$, ES=1.161) and total impulse ($p<0.01$, ES=1.597). Group comparisons for the ten-second task showed significantly greater values for elite females for mean force ($p<0.01$, ES=0.948), mean peak force ($p=0.05$, ES=0.747), and total impulse ($p<0.01$, ES=1.066).

CONCLUSION: These preliminary findings show that the test-retest reliability of the main variables explored were either highly or very highly related. However, a larger sample size will be necessary to confirm the importance of variables related to stroke assessments and time to first peak. The ten-second task alone may be sufficient to inform coaches about athlete performances.

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THE CURRENT COACHING PRACTICES IN THE FEMALE GAELIC FIELD SPORT OF CAMOGIE

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INTRODUCTION: Camogie is a Gaelic female field sport, akin to hurling. Camogie research is growing, with physical characteristics, and locomotive demand research now available. No research currently exists on camogie coaching practices, however. This research aimed to address this and add to the body of literature on female athletes, with a lack of female sports science research currently available [1].

METHODS: 33 camogie coaches from elite developmental and adult squads completed an online survey on their current session sequencing, session design, and monitoring practices, across pre and peak season. Coaches reported on their use of specific training components such as drills, small-sided games, and training matches across the season, as well as their use of objective measures to monitor their players and training practices.

RESULTS: Camogie coaches seem to sequence their sessions using a traditional drill-to-game approach. Coaches reported primarily using training form activities in pre-season, moving towards playing form activities in peak season. A reduction in both drills and running from pre (41.21%) to peak season (27.27%), and an increase in training matches from 22.58% to 32.58%, may explain the shift from training to playing form across a season. Despite this, a similar percentage of small-sided games were reportedly used in pre (21.21%) and peak (25.45%) season. 5 coaches reported using objective measures to monitor their players and training practices.

CONCLUSION: Coaches reported using traditional session sequencing in preparing their players. Furthermore, coaches reported a shift to more game-specific training in peak season compared to pre-season, due to a reduction in drills and running, while increasing their use of training matches. The use of small-sided games across a season may be an area for further research. Coach education programmes may look to develop current camogie coaching practices to utilise more game-specific methods throughout the season, given training matches and small-sided games equal or surpass the relative camogie match-play running demands [2]. Objective measures would seem to be scarcely used in elite camogie at present. Future research may look to investigate the lack of monitoring practices in camogie.

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TEST-RETEST RELIABILITY OF POWER, PINCH, AND TRIPOD GRIP STRENGTH IN BASEBALL PLAYERS

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INTRODUCTION: Grip strength is paramount for baseball players to grip and pinch the ball; therefore, current grip-type assessments must be more comprehensive. This study evaluated different handgrip strength test-retest reliabilities utilizing a dynamometer to smartphone apparatus.

METHODS: We selected sixty secondary (middle and high schools) and college student baseball players 12-22 years of age as participants. A dynamometer and smartphone application evaluated power, pinch, and tripod grip strengths. Overall grip strength measurements slightly decreased across all tests and increased alongside academic grade level.

RESULTS: Tests 1 and 2 demonstrated good-to-excellent retest reliability for the three grip strength positions by calculating their intraclass correlation coefficients or ICCs (middle school power grip: 0.917 [0.644-0.973]; collegiate pinch grip: 0.920 [0.770-0.970]; high school tripod grip: 0.929 [0.728-0.976]). Furthermore, we verified moderate reliability regarding the other grip strengths (middle school tripod grip, Tests 1 and 2: 0.779 [0.428-0.914]; collegiate power grip, Tests 2 and 3: 0.738 [0.360-0.895]).

CONCLUSION: We confirmed these grip strength tests as reliable measurements for childhood to adulthood baseball players with an acceptable margin of error. Thus, these handgrip strengths are sufficient normative values for helping discipline and rehabilitate baseball players and other athletes.

RELATIONSHIP BETWEEN PROTEIN INTAKE RECORDS AND PHYSICAL COMPOSITION AND PHYSICAL STRENGTH IN JAPANESE HIGH SCHOOL BASEBALL PLAYERS

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INTRODUCTION: High school athletes and their families have few opportunities to acquire knowledge about nutrition, and their understanding of the importance of diet is insufficient. In particular, students who are part of high school baseball teams in Japan bring lunch from home or purchase it. Students and their parents may be interested in protein intake but may not be aware of its correlation to physical fitness and the importance of simultaneously consuming carbohydrates with it. This study aimed to examine changes in physical fitness and body composition through records of protein intake by students during the training period prior to the district qualifiers.

METHODS: The participants were 16 high school boys who belonged to baseball teams at the district tournament level. Measurements were taken in January before the season and in June during the season. Body weight, body fat percentage, fat mass, lean mass, and muscle mass were measured using TBF-310 (Tanita). In the physical strength evaluation, grip strength (Takei), back muscle strength (Takei), vertical jump (DKH), and medicine ball back throw (MB) were considered indicators of muscle strength. In terms of dietary education, lectures on carbohydrates were given from April to June, and we asked participants to record the frequency of their intake of main dishes as a guideline for protein intake. They were divided into groups that were recorded (RG, n=8) and those that were not (NRG, n=8). Statistical differences were determined using two-way factorial analysis of variance. Differences were considered statistically significant at $p<0.05$.

RESULTS: In terms of body composition, lean mass did not differ. However, a significant difference was detected in body weight and fat mass. The body weight and fat mass of the RG were considerably higher than those of the NRG (weight: $p=0.039$, fat mass: $p=0.019$). Body weight (63.0±8.3kg, $p=0.022$) and fat mass (8.7±3.8kg, $p<0.001$) were substantially lower in June than in January. In contrast, lean mass (54.4±5.1 kg) was considerably higher in June than in January. Physical fitness was assessed using MB values, and the RG showed significantly higher values than the NRG ($p=0.025$). Re-

gardless of whether it was recorded, grip strength (41.5±8.5kg, p<0.001), back muscle strength (138.8±30.5kg, p=0.020), and vertical jump values (42.0±4.6cm, p=0.015) were substantially higher in June than in January.

CONCLUSION: Male baseball team players lost weight and fat mass. In addition, their lean mass and physical strength improved prior to the district qualifiers, regardless of whether they recorded the frequency of the intake of main dishes, which was a guideline for protein intake. Those who kept records gained more weight and fat mass and had higher values in MB; hence, it was inferred that body weight was related to MB. Overall, the recording did not affect physical fitness improvement.

SAME, SAME OR DIFFERENT? ANALYSIS OF COMPLEX SPORT PROFILES IN BASKETBALL, ROWING AND TENNIS.

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INTRODUCTION: What are the similarities between the various sports disciplines? And where do they differ more specifically? Within an international project aiming to determine similarities and differences between sports, highly qualified coaches were surveyed. The questionnaire aims to draw up sport profiles and for this purpose the Differentiated Model of Giftedness and Talent [1] was used as a guide. The research question is twofold and focuses on the differences between the three sports on the one hand, and on the other hand whether there are differences in required skills/abilities of youth athletes to develop successfully and characteristics of elite athletes.

METHODS: Using the online survey "I need 2.0" (based on "I need 1.0" and Flemish Sports Compass [2,3]) via Qualtrics XM, highly qualified coaches (A-License, Diploma, International License) rated 88 total items within 8 categories. They were asked either how important each item is for youth athletes to successfully develop towards a potential elite senior level athlete (Y) or for elite athletes to successfully perform at international level (E).

In total 127 complete surveys (44 basketball (Y: 30, E: 14), 55 rowing (Y: 25, E: 30) and 28 tennis (Y: 17, E: 11)) were collected. Data were analyzed using a MANOVA with the two factors sports and context (Y) or (E) in SPSS 23 for each category.

RESULTS: The results show that the three sports differ within each category ($p < .05$; Partial η^2 .371 - .891). Regarding the factor context, profiles for „youth" and „elite" only differ within the two categories anthropometrics and physical condition ($p<0.05$ and Partial η^2 .151 - .154). There is a significant interaction effect sports*context within the category intellectual abilities ($p<0.05$; Partial η^2.098).

CONCLUSION: The analyses show that the profiles of the three sports show differences and similarities. The results of the tests of the between-subjects effects and the post-hoc-tests are logical in terms of content and prove the face validity of the sport profiles. The three sports represent different sport families, in the next step of the project, comparisons of sports within a sport family will be made.

The identified differences between youth and elite for physical condition may be due to the high trainability of the characteristics. The fact that, except for anthropometry, there are no differences between the profiles in all other categories may also mean that the sensitivity of the method is not high enough for this question. The results are only a partial result of an extensive analysis of the sport profiles, further analyses will follow.

Clarifying differences and specificities of sports can help practitioners to give sport orientations. Similarities could be the starting point to design a broad and versatile development of junior athletes and eventually a tool for talent transfer programs.

1. Gagné (2003) 2. Pion et al. (2020) 3. Teunissen et al. (2021)

THE EFFECTS OF AGE AND TRAINING PRESCRIPTION ON THE ACUTE RESPONSES TO TRAINING IN YOUNG ITALIAN RUGBY UNION PLAYERS

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INTRODUCTION: Questionnaires and scales are often used to monitor training loads and training effects in elite sports (1). The purpose of the present research was to understand the moderating effect of age on the internal training load and acute responses to two different training prescriptions in young high-level rugby union players.

METHODS: Acute responses to High Intensity Training (HI) and Low Intensity Training (LI) in 3 groups (U15 n=8, U17 n=10 and U19 n=9) of young Italian rugby players have been measured. HI training consisted of breakdown and wrestling activity alternating with aerobic power exercise, with small-sided games at the end. LI training consisted entirely of small-sided games with non-contact for technical and tactical objectives. Both the training prescriptions were 90 minutes total, warm-up and cool down included. The 2 workouts were part of the normal weekly training routine. The present research was done by strictly applying the procedures of an ecological experimental design. The following validated questionnaires were used to monitor the acute training effects: Foster's CR10 modified Rating of Perceived Effort scale (RPE) (2), Total Quality Recovery scale (TQR), Main and Grove (MG) questionnaire that monitors training distress in athletes, Fatigue (FAT) and Fatigability (FAB) scales. Repeated measure analysis of variance (2x3 ANOVA) was used to analyze RPE, FAT and FAB with respect to Age and Training type, while a 2x2x3 mixed ANOVA was used for MG and TQR questionnaires to further analyze the interactions of Time, Age and Training type. All post hoc analyses were performed following the Bonferroni correction procedure, setting the significance at a p value <0.05.

RESULTS: Only a significant Training type by Age by Time interaction for the Sleep Disturbances subscales was found. Perceived effort was significant for age by training type interaction. Follow up tests revealed that the U17 group was statistically different for both conditions, while in the U19 group was just near to the threshold. The main effect of training type was statistically significant for the FAB scale. Only in post training conditions we found significant main effects of Training type and Age for the Physical Symptoms subscale.

CONCLUSION: The RPE and FAB scales are most sensitive to acute effects of training load for group U17 and U19, while under the age of 15 these scales do not seem to provide valid ratings of session RPE. With the possible exception of the Physical Symptoms subscale of the MG questionnaire, TQR and the other MG subscales are not sensitive to acute differences in training load. Although some instruments have proven to be more sensitive and valid than others, the Training Monitoring strategy used in the present research represents a valid approach to control training sessions acute effects in young rugby union teams.

COMPARISON OF THREE "ACUTE:CHRONIC" WORKLOAD RATIO METHODS TO MONITOR PROFESSIONAL RUGBY UNION PLAYERS' WORKLOAD AS A FUNCTION OF POSITIONS DURING PRE-SEASON PERIOD

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ÉCOLE NORMALE SUPÉRIEURE DE RENNES

INTRODUCTION: The quantification of workload (WL) is based primarily on forwards and backs in rugby union (RU)1, necessitating a more refined division to clarify the function of each position. In addition, as a common method of analyzing data in team sports2, no scientific research has reported to quantify the variability of all acute chronic workload ratio (ACWR) models in pre-season training for RU. Therefore, this paper aims (i) to investigate the differences in external workload (EWL) of players at five positions after eight weeks, (ii) to compare the variations in ACWR for players at various positions, as well as (iii) to analyze the substitutability of the three ACWR approaches in professional RU players.

METHODS: Fifty-seven professional RU players (25.07±4.82 years old) participated in 8-week pre-season training. They were divided into 5 groups : Tight 5 (T5), third-row (3R), number 9 (N9), center, third line defence (3L) . During training sessions, ETL was monitored using wearable 10-Hz GPS (Vector X7, Catapult Sports®, Melbourne, Australia) to characterize WLs by total distance (TD), player load (PL), the number of accelerations and decelerations (ACC+DECnum > ± 2.5 m/s²), the number of accelerations (ACCnum >2.5 m/s²), acceleration distance (AD > 2 m/s²), high-speed running (HSR >15 km/h), very high-speed running (VHSR >21 km/h), sprint running (SR >25 km/h) distance. Coupled/uncoupled rolling average and exponentially weighted moving averages was used to calculate ACWR. Statistical assessments were one-way and multi-way analysis of variance with Tukeys multiple comparisons test.

RESULTS: Throughout the pre-season, the WL of the 3L was always higher than T5 on ACC+DECnum, ACCnum, AD, HSR, VHSR and SR ($P < 0.001$). For both TD and PL value, the group of number 9 was the highest and significantly greater than that of forwards (T5 and 3R, $P < 0.001$). When quantifying PL, AD and HSR, the three approaches for estimating ACWR are interchangeable. Furthermore, no matter what calculating method was utilized, the ACWR of the center of the backs had the maximum value.

CONCLUSION: Tracking differences in positional WLs during pre-season allows coaches and training staff to evaluate player preparedness and organize future training sessions more individualized. In addition, ACWR is still a reliable and effective tool for evaluating WL, it is sufficient to use one of the three methods in some cases.

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GPS AND SUBJECTIVE DATA DO NOT CORRELATE WITH MUSCLE DAMAGE ASSESSED BY BLOOD CREATINE KINASE LEVEL FOLLOWING INTERNATIONAL WOMENS RUGBY UNION GAME

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INTRODUCTION: Rugby is an intermittent, high-intensity contact and running sport that causes muscle damage. Biological markers such as creatine kinase are currently used to adapt the training protocols and follow the recovery of athletes after a game. However, the evolution of biological markers follows specific kinetics which peaks up to 48h after the game and delays the choice of the recovery protocol. Therefore, developing new strategies to identify earlier exercise-induced muscle damage would be interesting. With the development of current technologies, a multitude of data is available from the field, such as GPS or subjective questionnaires. The study aimed to identify whether GPS parameters and/or subjective questionnaires will reflect muscle damage values determine using biological assessment.

METHODS: Twenty-six french womens rugby union players (mean age: 26.1 ± 3.4 years, mean body mass: 75.5 ± 11.6 kg, mean height: 172± 6.9 cm) were monitored using GPS during five matches of the Rugby World Cup in October 2022. Questionnaires and CPK were monitored 36 hours after the match. Only players who played at least 50 minutes of the match were included in the study. At the end of each match, 11 GPS parameters were studied: playing time, total distance, percent walking, maximal aerobic speed percent activity, number of accelerations and decelerations, high-intensity dis-

tance, very high-intensity distance, sprint distance, and maximum speed. A video analysis allowed us to quantification 13 high-intensity rugby action parameters: total number of high-intensity actions and number per minute, number of jumps and lifts, first, second and third row pushes, number of mauls, number of times carrying the ball, number of offensive and defensive rucks, number of tackles, tackle assists and accelerations in the game. The rate of perceived exertion (RPE) was measured using Borg Scale modified by Foster.

RESULTS: Sixty-nine data were recorded for comparison. The mean CPK post 36h of the match was 350±273 UI/L and a delta of 308±250 UI/L compared to basal values was measured. Among the 35 parameters, only two parameters, tackle and activity, were correlated with CPK level but the relations were characterized by low coefficients of determination (<0.1).

CONCLUSION: The physical strain of a rugby match induces muscle damage. These results suggest that GPS data and subjective surveys do not reflect muscle damage and, on a larger scale, tools to investigate fatigue in international female rugby players. Further study with other time point measurements of CPK kinetic and other biological parameters needs to be investigated to determine whether there are of interest.

THE AUTONOMIC NERVOUS SYSTEM RECOVERY AFTER EXERCISE IS DIFFERENTLY AFFECTED BY INCREMENTAL VS. ALL-OUT TESTS

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INTRODUCTION: By investigating steady-state exercises at different percentages of maximal aerobic power, it has been reported that the time required for the autonomic nervous system to recover grows with exercise intensity (Michael et al., 2017; doi: 10.3389/fphys.2017.00301). However, little is known about this recovery after exhausting protocols in which the load changes over time, nor is it clear whether training to a specific aspect of the exercise (e.g., power vs. endurance) may differently contribute to the autonomic recovery. Therefore, we aimed to compare incremental and all-out exercises, starting with a population of athletes mainly trained for power output.

METHODS: ECG was recorded in fourteen semi-professional rugby players (male Italian League, second and third divisions) who accomplished two tests on the cycle ergometer, randomized and separated by at least 72 h. One was an incremental test (INC) requiring a regular load increase of 30 W every minute till exhaustion; the other was an all-out effort (AOU) against the subject's maximal cycling load. Tests were preceded by a 10 min resting period and followed by a 10 min recovery period. In the last 5 min of each period, the sympathovagal balance was assessed by measuring HRV power in the low (LF) and high-frequency (HF) bands, together with the mean value of heart rate (HR). Moreover, the post-exercise exponential decay of HR was evaluated to calculate the time constant Tau.

RESULTS: A treatment x exercise ANOVA confirmed that HR increased after both exercises, but to a larger extent for INC than AOU (+35% and +24%, respectively; interaction $p = 0.007$). In parallel, a paired t-test indicated a longer Tau after INC than after AOU (109.8 vs. 65.7 sec; $p = 0.002$). From the sympathovagal balance standpoint, the ratio LF/HF (in log units) increased similarly after both protocols (about +13%; exercise $p = 0.013$; no interaction).

CONCLUSION: The higher HR value and the longer Tau observed after INC suggest that this exercise is more stressful for the autonomic nervous system. However, the parallel increase in log LF/HF after both tests suggests that INC and AOU induced similar changes in both the sympathetic drive and the vagal tone. The different response to INC vs. AOU exercise might be due to the higher external work exerted in the former test (about 90 vs.21 kJ). Indeed, despite the significantly lower peak power (on average 306 W in INC vs. 927 W in AOU), the INC protocol had a longer duration than AOU (563 vs. 23 sec). A second possibility is that this difference may stem from the training program, which mainly targeted power output in rugby players. It will be of interest to complete these results with those obtained in endurance-trained athletes.

Conventional Print Poster

CP-AP27 Football II

EFFECTS OF 5-WEEK SOCCER TRAINING ON THE AEROBIC PERFORMANCE OF ELITE WOMEN SOCCER PLAYERS

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INTRODUCTION: Pre-season changes in the physical performance of elite women soccer players are scarce. So, the aim of the study was to evaluate the effects of 5-weeks of specific soccer training (4-6 sessions/week), during the preparatory period, on the aerobic performance of elite women soccer players.

METHODS: The sample was composed by 24 elite women soccer players with an average of 22 years of age. It was applied the Yo-Yo intermittent recovery level 1 test for the evaluation of aerobic performance. A paired sample t-test was used to compare differences between pre and post preparatory period. The level of significance was established at $p \leq 0.05$.

RESULTS: After 5-week specific soccer training the women soccer players significantly improved the Yo-Yo intermittent recovery level 1 test performance ($p<0.001$; $\Delta\% = 23.3$).

CONCLUSION: It was recently demonstrated that it is possible to develop aerobic and power abilities of elite women soccer players during 8-weeks of pre-season using an equalized ratio of soccer training and strength-power training schedules (Kobal et al., 2021). The same authors found an improvement of 28,5% in aerobic performance in the Yo-Yo intermittent recovery level 1 test. An improvement in Yo-Yo intermittent recovery level 1 test performance was also observed in U12-U16s pre-post season (Emmonds et al., 2020). It can be concluded that 5-weeks of specific soccer training allowed a significant increase in the aerobic performance of elite women soccer players. Future studies should analyze seasonal changes in the neuro-muscular performance of elite soccer players.

INTERRELATIONS BETWEEN AEROBIC CAPACITY AND ANAEROBIC POWER IN SOCCER PLAYERS UNDER 17 YEARS

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INTRODUCTION: The high pace and intensity of the soccer and the long distance (over 10 km per game), require a specific adaptation of soccer players to both aerobic and anaerobic energy expenditure [1,2]. On the other hand the aerobic and anaerobic capabilities have ontogenetic differences [3]. This study aimed to investigate: -whether the adolescent players with higher aerobic capacity (AC) have lower anaerobic power (AnP); and -to evaluate the age related differences in both types of performance.

METHODS: Adolescent male soccer players (n=16), in two age groups (14 years-G14,n=7; 15-16 years -G15-16, n=9), participated. For assessing of the AC a maximal test to exhaustion was used on a treadmill (HP Cosmos). AnP was evaluated by Wingate Anaerobic Test (WAnT) on a cycle ergometer (Monark 828 E) to determine Peak power (PP), Average Power (AP), and Relative Total Work (RTW). Data were analyzed with Descriptive statistics, Mann-Whitney U test and Pearson coefficient ($p<0.05$), using Prism (ver. 3.2).

RESULTS: The values of VO2max (ml/min.kg-1) reveal high AC (59.3±4.3 for G14; 59.2±2.6 for G15-16) for all players, with no significant differences between age groups for the metabolic, ventilator and cardiovascular parameters. The indices of AnP: relative PP, AP and RTW were higher ($p<.05$) for the players from G15-16 (9.6±.9W/kg, 450±83W and 210±16J/kg, respectively) compared with G14 (8.3±.6W/kg, 352±32W and 181±12J/kg, respectively). Furthermore for all participants, a moderate correlations were established between age and PP ($r=.57$, $p=.022$), as well as between AP and RTW ($r=.50$, $p=.047$ and $r=.50$, $p=.046$ respectively). No relationships were found between VO2max and any anaerobic variables investigated. However, very high positive correlations were established in G15-16 between peak VO2/HR, an aerobic parameter, with PP ($r=.92$; $p=.0005$), AP ($r=.96$; $p<.0001$) and RTW ($r=.96$; $p=.0001$). The only negative correlations observed, were for HRmax with relative AP and RTW ($r=-.62$; $p=.03$ and $r=-.62$; $p=.03$, respectively) in G15-16 and with relative PP and relative AP ($r=-.72$; $p=.03$ and $r=-.67$; $p=.04$, respectively) in G14.

CONCLUSION: The high AC of tested soccer players was not associated with low anaerobic performance. The increase in AnP, between 14 to 15-16-years old soccer players is significant, as opposite to AP. The strong correlations between peak VO2/HR and parameters of WAnT designate that: -a higher AnP does not indicate a greater anaerobic capacity; and -the WAnT is not a proper approach for assessing the interrelations between aerobic and anaerobic energy expenditure. Negative relationships of HRmax with parameters of WAnT probably could be a sign for anaerobic capacity.

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THE EFFECT OF SPECIFIC HIIT TRAINING WITH AN INTENSITY BETWEEN THE ANAEROBIC THRESHOLD AND THE PSYCHOMOTOR FATIGUE THRESHOLD ON THE PHYSIOLOGICAL PARAMETERS OF YOUNG SOCCER PLAYERS

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INTRODUCTION: Effective HIIT training requires determining the individual intensity that optimally stimulates the development of exercise capacity [1]. To achieve this, it is necessary to determine the minimum intensity at the anaerobic threshold (TAN) and the maximum intensity at the psychomotor fatigue threshold (PFT) [2,3]. The aim of the study was to assess the effect of specific HIIT training, performed between the TAN and the TPF on the physiological parameters of young soccer players. In addition, the aim of the study was to determine whether in 4x4 games on a 25x35 m pitch, the tested players exceed the anaerobic threshold and are able to achieve TPF intensity.

METHODS: Fourteen young U-17 soccer players from a professional sports club competing in the second Polish league took part in the study. Physical activity of all field players was analyzed. Goalkeepers were excluded from the analysis due to the specificity of the effort. The project consisted of four stages of research: first, an exercise test with increasing load was applied in the laboratory, second six 3-minute 4 x 4 games were played with goalkeepers and with a break between games lasting 3 minutes, third of the experiment was to perform an additional program of three specific HIIT exercises twice a week on Tuesday and Thursday in a training microcycle lasted 4 weeks, fourth repeated first stage - an exercise test with increasing load, performed on a running treadmill in the laboratory. Lactate (LA) was analyzed to determine the anaerobic threshold, choice reaction time (CRT) to determine the psychomotor fatigue threshold and selected physiologi-

cal parameters. External loads were determined using GPS (Catapult Sports, Melbourne, Australia). Repeated-measures ANOVA was used to compare mean values for the examined variables.

RESULTS: It was found that after 4 weeks of specific HIIT training significantly increased VO2 and running speed on TAN and TPF and HR on TAN. The tested players realized 4x4 games on a 25x35 m pitch exceed the intensity of effort on TAN, but do not reach the intensity on TPF.

CONCLUSION: The proposed specific HIIT training, carried out between the anaerobic threshold and the psychomotor threshold of fatigue, consisting of three exercises, each subsequent one generating greater intensity, greater variability of the stimulus and longer duration, is a practical proposal that effectively increases the exercise capacity of football players.

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ACUTE FATIGUE EFFECTS OF SOCCER TRAINING SESSION IN YOUNG PLAYERS: ANALYSIS OF THE FUNCTIONAL PERFORMANCE

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INTRODUCTION: Soccer training includes efforts performed at different intensities leading to physiological and neuromuscular fatigue and a decline in physical performance (1). Young players are reported as a group with more variable and specific risk factors than older players (2). Considering the additional increased risk of injuries towards the end of the match (3), this study examined the acute fatigue effects of a soccer training session in young players.

METHODS: Eighteen male soccer players (15.6 ± 1.7 yrs) from a training center performed a test protocol immediately before and 8 min after a common soccer training of 75 min. Each test session included capillary blood samples (HCO3-, Lactate, pH), subjective ratings of muscle soreness and fatigue perception (Visual Analogue Scale). Three functional tests were performed at maximal intensity: a drop Jump (DJ), a 30 m sprint and a horizontal force-velocity (HF-V) test under four resistive conditions. Using 2 force platforms, unilateral and bilateral values of force, velocity and power were calculated (4). The mechanical Force-Velocity-Power profile was also computed (5). To test the training effect, a linear mixed model was used. The Kmean method was applied to the first two dimensions of the PCA analysis based on the DJ and H-FV changes. Only bilateral data are presented.

RESULTS: After training, blood markers and increased subjective sensations revealed significant fatigue effects. Sprint time increased (2±1 %, $p<0.001$, d=0.32) and velocity at take-off in DJ decreased (-8±9 %, $p<0.001$, d = 1.46). In DJ, mean push-off velocity and power also decreased (-9±9 %, p = 0.04, d = 0.42 and -6±16 %, $p<0.05$, d = 0.23, respectively). No change was found in the HF-V test. However, the clustering analysis revealed two opposite fatigue profiles (n = 9 for each). In the first cluster, velocity decreased in both tests (DJ: Vpush-off = -12±10 %; $p<0.001$, d = 1.44; H-FV: V0 = -23±9 %; $p<0.001$, d = 1.03) while force increased in the H-FV (F0 = 18±12 %; $p<0.001$, d = 0.72). In the second cluster, force decreased in both tests (DJ: Fpush-off/BW = -6±5 %; $p<0.01$; d = 0.86; H-FV: F0 = -13±6 %; $p<0.001$, d = 0.91) while velocity increased in the H-FV (V0 = 44±17 %; $p<0.001$, d = 2.5).

CONCLUSION: The training-induced fatigue was reflected by a combination of blood marker changes, muscle soreness and perceived subjective fatigue. The battery of tests was of interest as the combination of the H-FV and DJ tests revealed 2 opposite profiles of functional loss in young soccer players. This battery is considered as a useful non-invasive tool for the coach and medical staff to individually adapt the recovery and/or the training process, in an attempt to potentially reduce the risk of injury.

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MANIPULATING TRAINING LOAD 48 HOURS AFTER A MATCH: EFFECTS ON RECOVERY RESPONSES IN ELITE YOUTH SOCCER PLAYERS

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INTRODUCTION: Manipulation of training load represents the starting point in any recovery strategy to increase or decrease fatigue over the microcycle [1]. Soccer match-play has the highest load of the week and 48 hours after a match youth players are not fully recovered [2]. It is therefore important that early in the microcycle, training-based interventions favour both regeneration and exposure to optimize youth player development. However, no information exists on the effect of modifying soccer-specific training load on recovery responses. This study investigated two training load-based recovery interventions following a match, and observed recovery responses up to 72 hours post-match in elite youth soccer players.

METHODS: Thirty-three elite youth soccer players (under-16: n = 15; under-15: n = 18) from an Italian Serie A team completed an 80-minute match (MD) and were assessed before (baseline) and after (+0.5h, + 48h, +72h) the match. Countermovement jump (CMJ), isometric posterior-chain (IPC) and muscle soreness (VAS) were used as neuromuscular and perceptual recovery indicators. Using a parallel group design, on the second day after the match (MD+2) participants were randomly assigned to either a complete training (CT: 105min session) or a reduced training group (RT: 75min session). Training and match loads were quantified using global positioning systems, heart rate sensors and RPE. For each squad, differences between training groups at MD and MD+2 were analysed using an independent t-test and Hedge's g effect size (g). Differences between training groups and time points were analysed using a two-way mixed (group x time) ANOVA for each recovery measure, with Bonferroni post-hoc correction.

RESULTS: Verification of the intervention showed that both groups were exposed to similar match demands ($p > 0.05$; g: trivial to small) and that the CT group had significantly greater training loads on MD+2 compared to RT ($p < 0.05$; g: moderate to very large). There was a significant interaction (group x time) effect on CMJ, IPC and VAS in the under-16, while in the under-15 a significant interaction effect was only observed in IPC ($p < 0.05$). CMJ, IPC and VAS significantly declined at +0.5h ($p < 0.05$), recovering at +48h after the match. Following the training load interventions, at +72h CT showed significant decrements in CMJ and IPC compared to +48h in under-16 players ($p < 0.05$), while no significant changes were observed in under-15 players between +48 and +72h ($p > 0.05$).

CONCLUSION: Neuromuscular and perceptual status declined immediately after the match, recovering to baseline levels at 48 hours. A complete training session, characterized by higher training loads on MD+2, may negatively influence neuromuscular recovery at 72 hours. Modifications of training load early in the microcycle may be applied as a strategy to promote the desired recovery and acute training effects in elite youth soccer players.

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CORRELATION ANALYSIS OF EXPLOSIVE POWER AND SPECIAL PHYSICAL FITNESS IN ELITE WOMENS SOCCER PLAYERS

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INTRODUCTION: Football is a comprehensive sport that requires basic physical fitness. The lower limbs are used to generate the strength needed to quickly achieve sprints and change in direction [1]. The explosive power of the lower body is a necessary core ability. From a strength and conditioning perspective, explosive power is an important ability that contributes to various aspects of physical fitness. Researchers have often used vertical jump height as one of the indicators of maximum explosive power. [2] However, the relationship between maximum explosive power and the special ability output of women players in football has not yet been studied. As such, our purpose in this study was to explore the correlation between explosive power and the physical fitness of outstanding women football players.

METHODS: We recruited 20 college womens elite football players as voluntary participants. All experimental participants fully warmed up after the various test procedures were explained to them. We recorded body composition measurements, and the participants performed vertical jump, standing long jump, 505, pro agility, Illinois, 10 m sprint, 40 m sprint, 300 yard shuttle, and yo-yo tests. The experimental equipment included: Inbody 370s, Opto jump, Witty, starting pistol. We used SPSS 20.0 for Pearson product difference correlation analysis.

RESULTS: The results show a significantly positive correlation between vertical jump and standing long jump, showed a significant positive correlation between vertical jump and standing long jump ($r = 0.694$; $P = 0.001$) and significantly negative correlation between the 10 meter sprint, ($r = -0.629$; $P = 0.003$),40 meter sprint ($r = -0.547$; $P = 0.013$),pro agility ($r = -0.527$; $P = 0.017$) ,300 yard shuttle test ($r = -0.397$; $P = 0.083$)

CONCLUSION: The results of the correlation analysis show that the vertical jump was significantly positively correlated with the standing long jump, followed by the 10 meter sprint, 40 meter sprint, pro agility, and 300 yard sprint. The vertical jump is a short-term explosive power output movement and requires explosive power. In the 300 yard turn-back test, the participant must turn back every 25 yards; explosive movements are also required for the direction change. Therefore, the contribution of explosive power is also related to anaerobic ability during the return run test. Our findings demonstrate that explosive power affects athletic sprint performance, agility, and anaerobic capacity. The results of this study can be used as a guideline of vertical jump height as an indicator of specific sports performance and to help players and coaches more effectively and purposefully monitor training results.

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THE INDEPENDENT EFFECTS OF MENSTRUAL CYCLE PHASE, MATCH LOCATION, MATCH RESULT AND THE QUALITY OF OPPOSITION ON SELF-REPORTED WELLBEING IN PROFESSIONAL FEMALE SOCCER PLAYERS: A SQUAD CASE STUDY

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INTRODUCTION: Poor subjective wellbeing is associated with injury, illness, and decreased performance in team-sport players. Previous studies show that in male soccer players, situational match variables (such as match location, opposition quality, and match result) influence self-reported wellbeing, independent of training load. These situational match

factors have not been investigated in female soccer players; in addition, no study has examined the effects of menstrual cycle phase on wellbeing. Therefore, the aim of this study was to assess the effects of match location, opposition quality, match result, and menstrual cycle phase, on self-reported wellbeing before and after professional female soccer matches across a season.

METHODS: Twenty-two professional female soccer players (25±5 years) from a squad in the Women's Super League in England self-reported their muscle soreness, sleep, stress, mood, and fatigue on a 1 (positive) to 5 (negative) Likert scale on the morning of match day (MD), and the subsequent three days (referred to as MD+1, MD+2, MD+3, respectively). Twenty-six matches in total were used for the analyses. Internal and external load (assessed by 1-10 rating of perceived exertion [RPE], and total distance covered via GPS), match location, match result, opposition quality (determined by final league-table position) and menstrual cycle phase were recorded for each match. Linear mixed models were used to examine for match-day x variable interactions (statistical significance was $P<0.05$; effect sizes were Hedge's g).

RESULTS: Situational match factors and menstrual cycle phase had no influence on the distance covered during matches or RPE ($P>0.05$). After away matches, sleep was rated ~60% worse on MD+1 ($P<0.001$; g=1.59) and ~29% worse on MD+2 ($P=0.005$; g=0.98). Stress and mood were >28% worse after playing against top vs. middle and bottom table opposition at MD+1 ($P\leq0.047$; g=0.8-0.94); likely because they lost most of these matches, which worsened stress and mood compared to winning and drawing at MD+1 ($P\leq0.001$; g=0.20-2.95) and MD+2 ($P\leq0.017$; g=1.42-1.77). Soreness, sleep and fatigue were most affected at MD+1 during menstruation (2.6-3.2); stress and mood were most affected during ovulation (~2.8); however, menstrual cycle phase (menstruation, follicular, ovulation, luteal) had no significant influence on post-match wellbeing ($P<0.05$).

CONCLUSION: In professional female soccer players, menstrual cycle phase did not influence wellbeing, but subjective sleep quality was impaired after away matches and losing matches negatively affected stress and mood. Coaches and sports science practitioners should be aware of, and take into consideration, the potentially negative effects of playing away from home and losing matches on self-reported wellbeing and consider strategies to mitigate the impact of these variables.

EFFECTS OF 3D MULTIPLE OBJECT TRACKING TRAINING ON FRONTAL EEG'S IN PROFESSIONAL SOCCER PLAYERS

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INTRODUCTION: In sports, physical training is essential to achieve the optimal performance. However, cognitive ability is also an important factor. In the case of professional athletes who already possess a high degree of physical competence, advantages in perceptual and cognitive abilities can become key superiority .

A method to improve the cognitive abilities of the brain is a 3D multiple-object tracking (3D-MOT) task. NeuroTrackerX (NTX; Neuro Tracker Inc, Canada) has been used for the task. It is performed on a PC the trainee's having 3D glasses. There are some previous studies indicating that 3D-MOT training could improve attention, working memory, and visual information processing speed, accelerate the processing speed, and also producing quantitative changes in the resting-state EEG of the university students [1]. We conducted the study on four professional soccer players currently active in the Japanese League. We measured EEG at the frontal region of the brain with their eyes open after training using NTX . As a result, theta rhythm power at mid-frontal region (Fmθ) showed a significant increase [2]. In this study, we studied whether θ rhythms changed at the other frontal regions after 3D-MOT task of the Japanese League athletes.

METHODS: Thirteen J-League players with the age of 23.7 ± 1.1 (mean ± SD) years, and the measurements were performed during the J-League season. NTX was used for evaluating the ability of 3D-MOT and training. The training period was about two months. Before and after the training, the cognitive tasks of trail-making test (TMT)-A, and B, and 1-back test were performed. At the same day EEG was measured with the subjects' eyes open for 15 seconds after the NTX task. It was measured at the frontal F3, Fz, and F4. Average power values of θ, α, β, and γ waves were calculated using MATLAB R2020b (Mathworks Inc, USA). In the statistical test, paired student's t-test was performed.

RESULTS: There was a significant increase in NTX scores by the training ($p < .001$). The increased rate of the score significantly positively correlated with the number of training sessions and (Pearson correlation coefficient $r = 0.57$; $p = .04$). The score of TMT-A, and B significantly increased after the training (A; $p = .004$, B; $p = .03$, respectively). θ powers at F3, Fz, and F4 significantly increased after the training (F3; $p < .001$, Fz; $p < .001$, and F4; $p = .02$).

CONCLUSION: NTX scores increased with the training accompanying with the significant increase in the scores of TMT-A, B. The results suggest that NTX training will improve the working memory ability in the professional soccer players.

θ rhythms not only at mid-frontal region, but also at the right and left frontal regions significantly increased after the training. Frontal θ rhythm is related to the working memory function. The result suggests that NTX training influences working memory ability throughout the increase in the θ rhythm at the frontal lobe.

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VALIDITY AND RELIABILITY OF A NEW WEARABLE CHEST-STRAP DEVICE TO MEASURE RESPIRATORY FREQUENCY IN ELITE SOCCER ATHLETES

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INTRODUCTION: The assessment of the respiratory frequency (fR) has practical importance in monitoring training progress in competitive athletes, especially during exercise. This study aimed to validate a new wearable chest-strap (wCS) device to measure fR against ergospirometry as a criterion device in healthy adults. The gold standard for performance evaluation remains the cardiopulmonary exercise test. However, it remains a test that cannot be applied in daily training practice

METHODS: A total of 26 elite professional soccer players (23.6±4.8 years; 180,6±5.7 cm; 77.2±5.4 kg) from three Italian Serie A League teams participated in this cross-sectional study. The sample included attackers, midfielders, and defenders. All participants were free of injuries at the time of testing. Participants were equipped with a heart rate sensor (Polar H10, Polar, Kempele, Finland); they wore a face breathing mask connected with a fast-responding gas analyzer (Vyntus Vyaire medical, Chicago, ILL, USA). In addition, they wore a wCS equipped with sensors to read HR and RF and with the newly designed device that tests breath frequency and heart rate, i.e., a belt strap (similar to Polar or Garmin) made of elastic and inelastic materials, and with two internal electrodes, to check the heart rate and with a strain gauge sensor, only with resistive functions, that is used to record the breathing act; it is mechanically and electrically connected, through four snap contacts to a device; hardware cyclically reads the analogic signals created by the internal sensors of the belt and transmit them, after an appropriate collecting filtering to a remote station. The subject underwent an incremental symptom-limited exercise test wearing gas analyzer and chest band simultaneously

RESULTS: A total of 16529 comparisons were performed after collecting data in the maximal incremental exercise test. No significant differences were found for both methods (P<0.05). Correlation among devices was statistically significant and very large (r [95% CI]: 0.970 [0.970, 0.971], P<0.01; aR2 [95% CI]: 0.942 [0.942, 0.943], P<0.01). Similarly, a high concordance was found (ρc [95% CI]: 0.970 [0.969, 0.971], bias correction factor: 0.999). However, the VyntusTM CPX, as a standard criterion, showed moderate agreement with wCS after Bland-Altman analysis (bias [95% lower to the upper limit of agreement]; % agree: 0.170 [-4.582 to 4.923]; 69.9%). A strong association between measurements (rrm [95% CI]: 0.960 [0.959, 0.961]), a high absolute agreement between methods (ICC [95% CI]: 0.970 [0.970, 0.971]), and a high inter-rater reliability (rF: 0.947) was found

CONCLUSION: The new wCS device is an in-field valid and reliable method to evaluate fR compared to a breath-by-breath gas exchange analyzer. The statistical parameters analyzed show a high correlation between the two methods. We are already testing the device in a larger sample. Notwithstanding, caution is advised if methods are used interchangeably while further validation occur

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CP-SH19 Cognition

MULTI-DOMAIN ASSESSMENTS OF COGNITIVE FUNCTIONS IN ELITE ATHLETES ACCORDING TO THEIR SPORT TYPE AND SEX: PRELIMINARY RESULTS

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Cognition is crucial for high performance sports. Consistent evidence has demonstrated that cognitive abilities, in particular executive functions (EF), are superior in experts. These studies have been recently challenged for the magnitude of their effect, contradictory evidence towards a superior development of EF in experts, and their rapid endorsement of cognitive evaluation for talent identification. Similarly, considering that different sports require variable cognitive demands, cognitive performance between sports has been explored with inconsistent findings, which can be mostly attributed to poor classification. Lastly, there is a general lack of female representation and assessments of multi-domains of cognitive functions in the literature. Therefore, the objectives of this study were to compare multiple domains of cognitive functions: 1) between a homogenous sample of expert athletes and representative norms; and 2) between sport types and sex.

Two hundred and thirty athletes (F=124, M=106; mean age 21.35 ± 3.8 years) classified as elite level (Tier 4) from a national sport institute were divided across three sport categories (team [n=91], precision-skill dependent [n=63], speed-strength [n=76]) according to a clear classification framework. Athletes were tested on a validated computerized neuropsychological test battery (Vienna Test System, Schuhfried) during pre-season by a sport neuropsychologist in standardized conditions. Six multi-domain assessments were performed including tests of EF (cognitive flexibility, planning, inhibition, working memory), selective and sustained attention. Reaction time and accuracy were used to measure test performance. T-scores were employed to compare athletes to a representative normative sample of the general population. Two-way ANOVAs were performed on each test (factors: Sex, Sport category) and Bonferroni corrections were used for multiple comparisons. The significant level was set at p<0.05.

Experts performed in the average range compared to a normative sample on all six domains of cognitive functions. There was no significant interaction between factors but a significant main effect of Sport category on cognitive flexibility accuracy ($F[2, 204]=4.621$, $p=0.011$, $\eta^2=0.045$) and selective attention reaction time ($F[2, 228]=3.265$, $p=0.040$, $\eta^2=0.029$) where speed-strength sports performed better than team sports ($p=0.010$ and $p=0.035$ respectively). There was a main effect of Sex on reaction time of selective ($F[1, 228]=30.078$, $p<0.001$, $\eta^2=0.119$) and sustained attention ($F[1, 224]=12.916$, $p<0.001$, $\eta^2=0.056$) where males performed faster compared to females.

The advantage of experts on general multi-domain cognitive tests was not evident from these preliminary results in this sample of 230 elite athletes. However, sport-specific demands may place greater demands on specific cognitive functions such as EF and selective attention, especially in sports where high speed and decision making are intertwined.

VISUAL PERCEPTION AND DECISION MAKING IN DYNAMIC ENVIRONMENTS. AN EXPERIMENTAL STUDY IN BEACH VOLLEYBALL

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High athletic performance requires an optimized interaction of perception and action. In beach volleyball, two athletes must compete on each side of an uneven 16 x 8 m court, defending and hitting balls at speeds of up to 130 km/h from a distance of 4-10 m. From this point of view the anticipatory ability, the defenders can be seeing as crucial for performance. Our study aims to gain insights into the relationship between perceptual strategies and decision making in beach volleyball and to investigate the differences in this between novices and advanced players. We hypothesized that (1) advanced players would make faster and more accurate decisions, as reflected by reduced RT and a higher number of correct decisions; (2) there would be fewer fixations and longer fixation durations for advanced players in comparison to novices and different gaze patterns between novices and advanced players (e.g., Williams & Jackson, 2019; Klostermann et al., 2020)

Using a video-based visual occlusion paradigm, 32 participants, with n = 18 novices and n = 14 advanced players in beach volleyball or volleyball, were shown 48 randomized beach volleyball attacks from a defender perspective. Participants were asked to classify the attacks as smashes or shots as quickly and accurately as possible. Reaction times and number of correct decisions were measured by keyboard entries (CMC; Heinen, 2010). Gaze behavior was scrutinized using SMI® eye tracking glasses (120Hz).

Advanced players showed a lower response time and higher response accuracy compared to novice players. However, these differences were not significant (response time: $t(27.978) = -1.068$, $p = .147$; number of correct decisions: $t(28.319) = -1.209$, $p = .118$). Both groups showed similar gaze behavior. Besides advanced players making significantly more fixations in total than novices ($t(21.831)$, $p = .018$), there was no significant difference in the total duration of fixations [$t(28.035) = 0.521$, $p = .303$], suggesting shorter fixations for advanced players than for novices.

The results of the present study are only partially consistent with previous studies and cannot support our hypotheses. Advanced players showed more, shorter fixations than novices, but similar gaze patterns, response time, and accuracy. Further studies with mixed-method designs are needed to better understand cognitive and attentional processes during visual search strategies (e.g., peripheral perception when looking into empty space). Beyond its limitations, particularly the sample size and the lack of expert-level participants, the study provides an initial foundation in the study of decision making and gaze strategies in beach volleyball.

EFFECTS OF EXERGAME TRAINING ON COGNITIVE AND CARDIAC AUTONOMIC FUNCTIONS IN HEALTHY MIDDLE-AGED AND OLDER ADULTS

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Introduction

Previous studies have shown that regular exercise is effective in improving cognitive function, and in preventing or delaying the onset of dementia [1]. Some studies also suggest that open-skill exercise appears to be more effective than closed-skill exercise in improving executive function [2]. Recently, exergame has become widely popular and is considered a mode of open-skill exercise. However, few studies have investigated the effect of exergaming on cognitive function. Additionally, researchers have proposed that cardiac autonomic control, assessed via heart rate variability (HRV), is associated with cognitive function. Yet, the effect of this proposed mechanism remains largely unknown. The purpose of this study was to investigate the effects of 10-week exergame training on cognitive function and HRV in middle-aged and older adults. The relationships between HRV and cognitive function were also examined.

Methods

This study was a randomized controlled trial. Ninety participants who met the study criteria were recruited and randomly assigned to exergame training group or control group. The training program was 50 minutes per session, twice per week for 10 weeks. The control group was instructed to maintain their usual lifestyle. All participants filled out questionnaires and received assessments of executive functions (digit span test, Tower of London test) and electrocardiography at baseline and post intervention.

Results

After 10 weeks, all three digit span test parameters improved in the exergame group and these changes were significantly better than the control group (all $p<0.05$). The total initiation time (TIT) of the Tower of London test also improved significantly in the exergame group and this change was significantly better than the control group ($p=0.035$). No significant change was observed in HRV and there was no significant correlation between the cognitive function tests and HRV.

Conclusion

A 10-week exergame training program was effective in improving cognitive functions of attention, alertness, auditory memory, working memory, and the ability of planning in healthy middle-aged and older adults.

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THE EFFECT OF ATTENTIONAL BIAS CAUSED BY INCREASED ANXIETY ON AVOID AND APPROACH BEHAVIORS

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INTRODUCTION: The negative effects of anxiety on motor performance may, in part, be due to attentional bias toward threatening stimuli that elicit performance anxiety, such as when a penalty kicker faces a goalkeeper in football (Wilson et al., 2009). The relationship between attentional bias and motor performance has been severely neglected in the sport science research field. Against this background, the present study examined the effects of attentional bias on both avoid and approach motor executions in anxiety-producing situations.

METHODS: Thirty-two participants performed either an avoid or an approach task. Attentional bias was manipulated using the visual-probe paradigm (Mogg & Bradley, 1999), in which a threat or nonthreat emotional cue accompanied by a neutral cue (an angry or happy face with a neutral face, intended to represent fan emotions) was briefly displayed before presenting a probe-target (a shadow figure representing a teammate or opponent). In the avoid task, the participants were asked to push a target button on the opposite side of the probe target as quickly as possible. In the approach task, the target button was on the same side as the probe target. The participants' anxiety levels were manipulated using an electric shock method. Previous studies determined that if a participant has a bias to direct their attention toward the threatening cue, their response times to the probe target will change. We hypothesized that the execution of the avoid task would be more affected by the threatening cue with increased anxiety than that of the approach task.

RESULTS: For both types of task, the perceived level of anxiety, as measured by a visual analog scale questionnaire, significantly increased under threat conditions (random electric shocks) as compared to safe conditions (no electric shocks). The cue stimuli (angry vs. happy) were found to have a significant effect for the approach task, whereas they had no effect in either the safe or threat condition and no interaction effect. Reaction times significantly decreased when the threat cue stimuli were presented on the same side of the probe target than when presented on the opposite side. In contrast, the avoid task had significant effects from the cue stimuli and a significant interaction effect. Reaction times significantly increased when the threat cue stimuli were presented on the same side of the probe target than when presented on the opposite side under the threat condition, but this was not the case under the safe condition.

Discussion & Conclusions:

The results from the approach task were consistent with previous findings, suggesting that threat cues can evoke attentional bias toward threatening stimuli. Results from the avoid task suggest difficulty releasing attention from the threat stimuli when anxiety levels increase. Our findings are likely useful for the development of a method to improve performance under high psychological pressure.

THE EFFECT OF A SUPERVISED 9-WEEK EXERCISE PROGRAM ON EXECUTIVE FUNCTION IN COLLEGE STUDENTS

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INTRODUCTION: Executive function (EF) encompasses a set of cognitive skills that help students plan, prioritize, and manage their academic tasks [1]. Research suggests that exercise can lead to improvements in EF [2]. Our aim was to determine whether a 9-week exercise program improved EF in college students.

METHODS: The study-design consisted of an experimental group (EG: n=15, ♀=8) that participated in a 9-week exercise program (3x50min/week), and a control group (CG: n=16, ♀=5). We collected this data as part of a larger study that also incorporated mental health outcomes. We applied a ANCOVA model (using pre-intervention scores, age, and sex as covariates) to determine between-group post-intervention differences in EF (assessed via Digit Span [3], Stroop Colour-Word [4], and Part B of the Trail Making Test [5]) and VO2max (assessed via Yo-Yo Endurance test [6]) and Pearsons product-moment correlation coefficient to investigate the relationship between VO2max and EF.

RESULTS: After adjusting for sex, age, and pre-intervention scores, post intervention scores for the Digit Span (EG: 26.4±4.7, CG: 27.8±3.3, $p = 0.509$), Stroop Colour-Word (EG: 52.7±15.6, CG: 50.6±14.9, $p=0.240$), Part B of the Trail Making test (EG: 48.1±23.7, CG: 37.0±15.1, $p=0.292$), and VO2max (EG: 35.4±8.6, CG: 39.9±12.5, $p=0.905$) did not significantly differ be-

tween EG and CG. We observed a significant positive association between VO2max and Stroop Colour-Word (r=0.422, p<0.05) and Digit Span scores (r=0.411, p<0.05).

CONCLUSIONS:

The 9-week exercise program did not significantly impact EF or VO2max in our sample of college students. The observed association between VO2max and EF measures (i.e., Stroop Colour-Word, Digit Span) suggests that exercise-induced improvements in EF are likely dependent on concomitant improvements in VO2max.

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THE RELATIONSHIP BETWEEN BELIEFS ABOUT ERRORS AND THE IMPACT ON POST-ERROR PERFORMANCE DURING MATCHES

SUDO, R., SEKIYA, H.

HIROSHIMA UNIVERSITY

Introduction

Errors cause various impacts on subsequent plays (Sudo & Sekiya, 2022), such as performance decrements (Harris et al., 2021). However, no study has examined the factors that influence the impact of errors. Therefore, this study investigated the relationship between beliefs about errors and the impact of errors on post-error performance.

Methods

Participants responded to 50 items asking about the impact of errors made according to Sudo & Sekiya (2022) using a 5-point scale (1: never happened to 5: always happened), and 42 items asking about their beliefs about errors made according to Shibahara et al. (2019) using a 5-point scale (1: strongly disagree to 5: strongly agree).

Results

An exploratory factor analysis on the beliefs about errors revealed three factors: negative image, inevitable image, and positive image. The positive image refers to the belief that errors increase motivation. An exploratory factor analysis on the impact of errors revealed five negative-impact factors: performance decrements, confusion, movement deterioration, desire to avoid, and safety-oriented strategy, and one positive-impact factor: beneficial impacts. Cluster analysis on the factor scores for the beliefs about errors revealed five clusters; Cluster 1: high negative, high inevitable, and high positive beliefs about errors (n=65), Cluster 2: low negative, moderate inevitable, and moderate positive beliefs (n=39), Cluster 3: high negative, moderate inevitable, and moderate positive beliefs (n=73), Cluster 4: low negative, high inevitable, and high positive beliefs (n=75), and Cluster 5: low negative, low inevitable, and low positive beliefs (n=15). Cluster 1 experienced moderate negative and positive impacts. Clusters 2 and 4 often experienced positive impacts and rarely negative impacts. Clusters 3 and 5 often experienced negative impacts and rarely positive impacts.

Discussion

Individuals whose beliefs about errors were negative or not inevitable often experienced negative impacts and rarely positive impacts. Individuals whose beliefs about errors were inevitable and positive rarely experienced negative impacts, and often experienced positive impacts. However, individuals whose beliefs about errors were high negative, high inevitable, and high positive experienced moderate negative and positive impacts. In other words, inevitable and positive beliefs about errors may counteract the effect of negative beliefs.

TO JUMP OR NOT TO JUMP – DECISION MAKING IN HIGH-STRESS SITUATIONS

FRÜHAUF, A., WILHELM, M., WACHHOLZ, F., NIEDERMEIER, M., KOPP, M.

UNIVERSITY OF INNSBRUCK

Background:

Decision-making under stress, which is influenced by multiple variables such as affective and behavioral factors, is mostly investigated in controlled laboratory settings with reduced transferability to real-life situations. Therefore, the present project aimed to compare affective, behavioral and decision-making variables between a real-life high-stress situation (bungee jump) and a control condition in physically fit adults.

METHODS: Using a within-subject crossover design, 19 university students (47% female, mean age: 23.0 SD:2.1 years) without prior experience in bungee jumping, completed both a 192m bungee jump and a 1m control jump in a randomized starting order. Decision-making tests (BART, Go/No-Go), affective states and behavioral variables were assessed before and after the jumps. Condition-by-time fully repeated measures analyses of variances were used for the statistical analyses.

RESULTS: Average number of pumps (BART) showed significantly higher values pre and post bungee jump compared to the control jump, p=.044; part.eta-squared:0.21, without showing a significant condition by time interaction p=.511; part.eta-squared:0.02. Accuracy and average reaction time according to the Go/No-Go task, were similar across conditions and time points, p>.116. Pre-action self-efficacy (transfer to the next relevant study task) was significantly higher after the bungee jump compared to the control jump, p=.031; part.eta-squared:0.23. Affective valence showed a significant condition by time interaction, p<.001; part.eta-squared:0.33 with the lowest values immediately before the bungee jump followed by an increase after the bungee jump whereas no changes were seen in the control condition. Arousal did not show a significant condition by time interaction, p=.416; however, it was significantly higher in the bungee jump condition compared to the control jump, p<.001; part.eta-squared:0.60.

Discussion:

Exposure to a real-life high-stress situation as induced by a 192m bungee jump was shown to potentially impact risk-taking but not inhibition and impulsiveness in decision-making. The present study showed heightened arousal and increased affective valence in the bungee jump condition which was not induced by a similar study design by Castellà et al. (2020), who further found divergent results in decision making. Thus, the role of affective states in high-stress situations requires further research. Students were more confident to reach their next study task after performing the bungee jump compared to the control condition. We conclude that high-stress situations could have potential implications for increasing pre-action self-efficacy, although a potential riskier decision-making should be taken into account.

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EFFECT OF COACHS POINTING GESTURES AND PLAYERS EXPERTISE ON VISUAL ATTENTION AND MEMORIZATION OF TACTICAL SCENES IN BASKETBALL

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Introduction

Learning tactics from a static diagram has been shown to increase learning among basketball players, as it is the preferred tool for coaches to convey tactical information (Khacharem et al., 2013). In addition to the verbal presentation, coaches make pointing gestures to direct players' attention to the key elements of paly and to optimize teaching of tactical combination. The aim of this study was to examined the effect coaches' of pointing gestures on the memorization of tactical scenes and whether this effect can be modulated by player experience.

Method

Ninety-six participants (48 expert basketball players and 48 novices) took part in the experiment based on predetermined criteria. They were instructed to watch one of two experimental conditions, in which the coach either described the development of an offensive play system (no-gesture, No-G), or described the same play system while making pointing gestures (with-gesture, W-G). After visualisation, participants were instructed to rate their mental effort and reconstruct the game elements on a sheet of paper. Total fixation duration on the diagrams of play was measured using eye tracking.

Results

The results showed that novice players in the W-G condition achieved higher recall scores, lower investment of mental effort and more fixation time on the diagrams of play than novices in the N-G condition. However, expert players achieved the same recall scores, same investment of mental effort and the same fixation time on the diagrams of play in both experimental condition.

Discussion

The findings revealed that for novice players, incorporating pointing gestures into speech when presenting game information is an effective technique to direct their attention to the game elements mentioned in the speech and improve their performance. Based on the cognitive load theory, learners cognitive resources are limited and attention can only be paid to a part of the incoming information a particular moment. Another explanation is that pointing gestures add a visual modality to the auditory modality (speech), which has a positive effect on learning, as explained by the modality effect. However, experts showed the same results under the two experimental conditions. These players do not need external guidance to learn the tactical knowledge because their prior knowledge provides complete guidance. The results can be explained by the expertise reversal effect, which suggests that an instructional design that is effective for novices can reverse and be ineffective for experts. The results suggest that the inclusion of pointing gestures in the learning material depends on players' level of expertise.

References

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16:15 - 17:30

Plenary sessions

PS-PL03 Tendinopathy – Why does it happen, and can it be prevented?

CAN TENDINOPATHY BE PREVENTED? WHERE ARE WE & WHERE DO WE NEED TO GO?

BAHR, R.

NORWEGIAN SCHOOL OF SPORT SCIENCES, NORWAY

It has been over 25 years since the 4-step injury prevention research model was introduced by van Mechelen et al., to combat the adverse effects of injuries resulting from sports participation. This fundamental model proposes four steps: 1. Identify the extent of the injury problem (incidence/severity), 2. Identify their risk factors and mechanisms, 3. Introduce preventative measures, and 4. Testing their effectiveness. Since then, substantial progress has been made for acute, traumatic injuries, while research on overuse problems like tendinopathy has been lagging.

The two main reasons for this are: 1. That injury surveillance methods mainly have been based a narrow injury definition, requiring time loss from sport, and 2. That only crude measures (e.g. hours of training) have been available to examine the effects of training and competition load.

Development of new methodology based on the Oslo Sports Trauma Research Center Questionnaire on Health Problems (OSTRC-H) has facilitated the capture of all complaints, including overuse complaints that result in frequent exacerbations and are managed with adjustments to training intensity, the typical cause for tendinopathies. Also, new technology like GPS-based systems and purpose-built accelerometers allow for granular capture of load data, e.g. the number and intensity of jumps, runs, accelerations and changes of direction.

Recent prospective studies using this methodology have documented that in several sports, previously thought to represent a low risk of injury, as many as 30-50% of all athletes report an injury problem at any given time. Importantly, depending on the sport, the burden of overuse problems like tendinopathy frequently far exceeds that of acute, traumatic injuries or that of illness. In this talk, prof Bahr will share data from prospective studies on diverse athlete populations, from youth athletes to the absolute elite, including unpublished data based on >35 000 weekly reports from Norwegian Olympic and Paralympic athletes.

There is ample clinical experience to document that specific loading patterns lead to an increased risk for specific injuries, as evidenced by the diagnostic labels established for some of these, such as jumper's knee, golf elbow, tennis elbow and runner's knee. What is not clear is why some runners develop runner's knee and some volleyball players jumper's knee - while others do not.

To better understand what causes tendinopathy (and inform prevention programs), there is a need for large, prospective studies capturing both relevant load and complete injury data, as well as athlete characteristics. As an example, Prof Bahr will present results from one such study. The aim of his lecture is to inspire future research to untangle the question: Who gets tendinopathy - and how and why? This is needed to advance to stages 3 and 4 in the van Mechelen model.

TENDON PHYSIOLOGY AND PATHOPHYSIOLOGY IN EXERCISE AND PHYSICAL TRAINING

KJAER, M.

BISPEBJERG HOSPITAL

Human tendon consists predominantly of collagen that has a general dynamic turnover rate during growth, but after adolescence (~17 yrs) only a minor fraction of this is turned over regularly (around 5%) and most fibril and fascicular structures (around 95%) remain stable. Collagen synthesis can be stimulated by physical exercise as well as by growth hormone or insulin-like growth factor I, and conversely collagen synthesis is inhibited by physical inactivity (e.g. 14 days). The drop in collagen synthesis with inactivity cannot be counteracted by blocking inflammation.

The dynamic part of the tendon matrix seems to be under circadian control, and with mechanical overloading, an accumulation of water - predominantly between fascicles - is observed and this contributes to tendon swelling in tendinopathy. Along with this, heavy mechanical loading and overloading of tendon results in increased tendon blood flow, as well as in increased pain and nociceptive signaling over the first months with subjective symptoms. In the later and more chronic phase of tendinopathy, stimulation of collagen synthesis and new matrix formation is observed leading to structural changes of the matrix in tendon.

The regulation of tendon matrix quality control is poorly understood, but evidence that autophagy regulates tendon homeostasis by controlling procollagen is documented. Further it has been demonstrated that cell-cell communication in tendon tissue is facilitated by extracellular vesicles - including exosomes - that are released by tendon fibroblasts, and that this control of communication is under circadian control. Further, exosomes derived from tendon fibroblasts differ

markedly in protein content from those derived from either myoblasts or muscle fibroblasts. This suggests a role for tendon fibroblast exosomes in tendon fibrosis.

Resistance training of a heavy or moderate nature is documented to be the preferable treatment towards tendinopathy, but exactly what molecular and cellular mechanisms are behind this is not described, but it is observed that individuals with chronic tendinopathy have had an increased matrix turnover for several years prior to the current tendinopathy, and this remains to be explained.

E-poster not debated

PP-UD01

EP-SE1 E-poster session

Biomechanics

CHARACTERISTICS OF THE MECHANICAL ENERGY CHANGES DURING THE SINGLE LEG JUMP MOVEMENT IN SPEED SKATERS

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1 JAPAN WOMENS COLLEGE OF PHYSICAL EDUCATION, 2 JAPAN INSTITUTE OF SPORT SCIENCES

INTRODUCTION: There are some imitating motions used in dry land training to develop the push-off movement required in speed skating (1). Particularly, the single leg jump movement is not only a dry land training motion but also a useful test for evaluating the power exertion needed in the lower limb. This study identified the characteristics of the mechanical energy changes during the single leg jump movement in speed skaters.

METHODS: This study enrolled 10 junior (17.2 ± 1.0 y) and 9 senior (21.8 ± 1.4 y) elite male Japanese skaters providing informed consent, and who had participated in the 500-m race of a domestic speed skating competition in Japan or a time trial. The skaters performed single leg skate jump test on a floor that required maximal effort to reach the maximal height. Two synchronized high-speed video cameras (250 fps) were used to record their performance using a direct linear transformation technique. Ground reaction forces (GRF) of the right support leg were determined using the force platform (500 Hz). The GRF and three-dimensional coordinates of the segment endpoints were determined to calculate the kinetic variables of the right support leg by using an inverse dynamics approach. Parameters related to mechanical energy of the right support leg were calculated to identify the energetic characteristics, and they were normalized from onset of push to take-off time.

RESULTS: Although goal time of the 500-m race for the senior group (36s 45 ± 0s 73) was significantly faster than that of the junior group (37s 96 ± 0s 65, $p < 0.001$), no significant difference in the maximal height of center of mass during the single leg junp movement was observed between the two groups. While mechanical energies of the thigh and shank slightly increased during the mid-phase of the single leg junp movement in both groups, the mechanical energies of the junior group were greater than those of the senior group. Significant differences were observed in the values of normalized time at 60, 70, and 80-% ($p < 0.05$-0.01). During the final phase of the single leg junp movement, mechanical energies of the thigh and shank greatly increased in both groups, and the mechanical energy of the junior group during take-off was greater than that of the senior group.

CONCLUSION: Results in this study indicate that speed skaters with high performance avoid increasing the mechanical energies of the thigh and shank of their support leg during the mid-phase of the single leg jump movement. Single leg skate jump movement could be a useful test to identify an effective technique in the support leg extension of speed skaters.

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THE IMPROVEMENT OF FREESTYLE STROKE IN PRESCHOOLERS BY THE STRUCTURED PROGRAM

SATO, K.

INTERNATIONAL CHRISTIAN UNIVERSITY

INTRODUCTION: There have been few studies of the effective swimming programs for infants. In preschool, the students are mostly free to play and walk in the pool. Also, those children can perform the motion of jumping and rock-paper-scissors in underwater. However, practice of breathing in water that leads to swim is hardly held (Fujita 2017). Therefore, in this research, we investigated the effects of the skill practice for freestyle in preschoolers, through our programs.

METHODS: The participants in this study were 14 children (8 boys & 6 girls, Age: 4.1±0.8 yrs old, Height: 107.3±7.6cm, Body mass:18.1±3.0kg, Swimming history 1.3±0.9 yrs). We designed originally the structured swimming program for improving skill level of preschoolers. We instructed the motions during 30-minute practice sessions at twice in two days. As for the measurement method, the motions were measured by two video cameras from poolside and underwater. The analyzing parameters were as follows: the swimming speeds, and the numbers of stroking & kicking times in freestyle. In the analysis, one way ANOVA was used to examine the effects of the structured program for improving swimming skill.

RESULTS: The significant effects were obtained in the freestyle swimming speed ($F(2.39) = 43.3$, $P=0.001$), the number of times freestyle stroke ($F(3.39) = 9.1$, $P=0.001$) by our practice program. On the other hands, the freestyle kicking times did not change through program.

CONCLUSION: It could be concluded that the motions of the freestyle could be improved effectively by our structured swimming program in preschoolers.

References

Fujita, K, and Nakano, M,(2017) School of Ohka Gakuen report (15), 127-135.

ANALYSES OF THE BILATERAL LOWER EXTREMITIES OF FEMALE BASKETBALL PLAYERS: A PILOT STUDY

TSENG, P.C., HSIAO, H.W., LEE, H.J.

NATIONAL TAIWAN NORMAL UNIVERSITY

INTRODUCTION: Female basketball players have the highest probability of lower limb injury, and the risk of injury is more significant than male basketball players [1]. Since basketball is a sport with unilateral dominance, it may cause asymmetry in strength and balance on landing between the dominant side and the non-dominant side of the lower limb. Therefore, the purpose of this study was to discuss the bilateral differences in lower limb strength and dynamic posture stability of female basketball players during single-leg drop jump landing by reactive strength index (RSI) and time to stabilization (TTS).

METHODS: There were 7 Division I female basketball athletes recruited in this study. Subjects had no severe head and lower extremity injuries or surgery within half a year. Within three months before the start of the experiment, subjects are without acute lower extremity injuries. During the experiment, kinetics data were collected by a Kistler force plate at 1000Hz and were used for data analysis during the single leg drop jump, including Jump height, RSI, Impact force, and TTS.

RESULTS: The results of this study show that the dominant side RSI is significantly greater than the non-dominant side ($p<.05$) during the single leg drop jump, but there were no significant differences in jumping height and landing impact force. The dominant side of ML-TTS was significantly shorter than the non-dominant side ($p<.05$), but there was no significant difference between AP-TTS and V-TTS.

CONCLUSION: Jumping injuries are common in basketball, especially when landing on a single leg. However, there was no significant difference in jumping height between the dominant and non-dominant sides. The difference in RSI showed that the dominant side could reach the same jump height with a shorter movement time, which may be related to specific movements of basketball patterns, such as unilateral jumping.

The symmetry of the lower limbs helps reduce the risk of injury [2]. Landing in the ML direction is a complex movement for humans, and poor dynamic postural stability is a known risk factor for ACL injury in athletes. Therefore, the difference in the RSI and TTS-ML between the dominant and non-dominant sides of the womens basketball players in Division I may be one of the potential injury risks. There are currently only seven subjects in this study, and the experiment will continue in the future. After enough subjects, the results will be more convincing.

REFERENCES:

1) Agel, J et al., J Athl Train, 2007

2) Niksic, S. R et al., Int J Res Ex Phys, 2019

BIOMECHANICAL CHARACTERISTICS AND ANECDOTAL REPORTS OF LOW BACK PAIN DURING ACTIVITIES OF DAILY LIVING IN INDIVIDUALS WITH CENTRAL OBESITY: A PILOT FEASIBILITY STUDY PROTOCOL

NAHORNA, A., BAUR, H.

BERN UNIVERSITY OF APPLIED SCIENCES

INTRODUCTION: Based on limited existing knowledge on the description and evaluation of the movement patterns of people with low back pain and central obesity, a study is proposed that aims at evaluating the feasibility to quantify whole-body motion during activities of daily living in individuals with central obesity.

METHODS: 20 individuals with central obesity will be invited for a single visit to the Bern Movement Lab at Bern University of Applied Sciences. Participants will be equipped with 39 retro-reflective skin markers according to the Plug-in Gait full body configuration. They will be asked to perform five repetitions of level walking, chair rising and object lifting and to stand and sit upright for a duration of 10 seconds. Kinematics will be recorded using a 16-camera motion capture system (Vicon, Oxford, UK; sample rate 200 Hz). Ground reaction forces and trunk/thigh muscle activity (PICO®, CometaSystems, Milano, IT) will be measured using two embedded force plates (AMTI, Watertown, MA, USA). Motion and force data will be processed using the Nexus software (Vicon, Oxford, UK). This includes marker reconstruction, filtering of marker trajectories, setting of relevant temporal events, as well as joint angle and moment calculation based on the Plug-in Gait full body model. Body composition will be assessed and processed using the body composition analyzer Tanita (Tanita Europe GmbH, MC 780 MA P, Japan). Low back pain status within the preceding 6 months will be assessed using a short self-developed questionnaire. Comparative data from individuals without central obesity will be taken from a previous study (KEK Bern Project ID: 2017-00820). Inclusion criteria are aged between 18-60 years, central obesity (waist–hip ratio: ≥ 0.85 in females, ≥ 0.90 in males; waist-to-height ratio: ≥ 0.50) (1,2), ability to perform the required tasks. Exclusion criteria are pathologies, diseases, injuries, surgeries or pain limiting activities of daily living like normal movements of the spine and lower extremities, known current pregnancy or breastfeeding mothers, psychological impairments to follow instructions, any comorbidities or circumstances limiting lifting capabilities.

RESULTS: -

CONCLUSION: Obtained results will be generated a pilot dataset that can serve as a basis in the planning of a larger study.

COMPARISON OF RATE OF TORQUE DEVELOPMENT DURING SINGLE-LEG AND DOUBLE-LEG WEIGHTLIFTING DERIVATIVES

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1: GIFU UNIVERSITY, 2: JAPAN INSTITUTE OF SPORTS SCIENCE

INTRODUCTION: Weightlifting derivatives such as hang power clean (HPC) are resistance training used to improve explosive strength and power development in the lower extremities (1). System-level rate force of development (RFD) during the single-leg hang power clean (SHPC) has been found to be greater than double-leg hang power clean (DHPC) when using 60% and 90% of the estimated one repetition maximum (1RM) (1). System-level and joint-level kinetic characteristics may not necessarily correspond (3). The purpose of this study was to compare the rate of torque development (RTD) of the three lower extremity joints during SHPC and DHPC.

METHODS: Ten male track and field athletes performed the SHPC and DHPC using external loads of 30%, 60%, and 90% of 1RM. The 1RMs in SHPC and DHPC were measured separately, and the external loads at 30%, 60%, and 90% of the 1RM used were determined based on the different 1RMs in SHPC and DHPC. We calculated the joint moment of three lower extremity joints of the SHPC and DHPC, using a motion capture system (250 Hz) and force platforms (1,000 Hz). The RTD was calculated as delta joint moment/delta time (0.004 s). Maximum RTD during the concentric phase was calculated and compared between SHPC and DHPC for each joint. Two-way ANOVAs (2 exercises, 3 loads) were used for comparison.

RESULTS: The analysis showed no significant interactions for all joints. There was a significant main effect of the load factor on the hip joint (extension-flexion) ($p < 0.05$), but the results of the post-test showed no significant difference. A significant main effect was found for the exercise factor at the hip joint (abduction-adduction) ($p < 0.05$); the RTD during the SHPC was shown to be significantly greater than the DHPC for all external loads ($p < 0.05$). In addition, a significant main effect was shown in the load factor at the ankle joint (planter flexion-dorsiflexion) ($p < 0.05$); the RTD of 90% 1RM was shown to be significantly greater than the 30% 1RM for both HPCs ($p < 0.05$).

CONCLUSION: The novelty of the study findings is that the RTD of the lower extremity does not differ between SHPC and DHPC in the flexion-extension axis at all loads, whereas the RTD of SHPC is greater than that of DHPC in the abduction-adduction axis at the hip, regardless of the load. In addition, the RTD of the ankle joint may be load-dependent for both SHPC and DHPC. These results suggest that when using heavy external loads, the RTD around the flexion-extension axis of the three lower extremity joints is similar for SHPC and DHPC, but the RTD around the hip abduction axis is greater for SHPC than for DHPC.

REFERENCES:

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STROKE IMBALANCE OF CHINA ELITE SHORT-DISTANCE FREESTYLE ATHLETES

SHANG, M.

BEIJING SPORT UNIVERSITY

INTRODUCTION: In freestyle, the bilateral imbalance of stroke arm restricts the improvement of swimming skills, which not only destroys the streamline of the body and makes athletes lose their best mechanical advantage, but also brings injuries. Therefore, exploring the causes of bilateral imbalance in freestyle and how to evaluate and correct training are the contents that cannot be ignored in swimming training.

METHODS: In this study, the problem of bilateral imbalance in short-distance freestyle of five elite women in China was explored by inertial measurement unit. After the standard warm-up procedure of daily training, the 15× 200m freestyle test was carried out, and the athletes speed was required to be kept at 80-90% of the maximum heart rate (monitored by polar), and the contribution rate (ICV) of bilateral movement speed was evaluated by inertial measurement unit (Tritonwear, Canada). Using Excel software to explore the swimming data output by the swimming inertial measurement unit, evaluate and record the left and right ICV, so as to obtain the speed contribution value of the right upper limb and the left upper limb in each cycle. The data is corrected by calculating the average speed, and the speed contribution of each swimmers two upper limbs is estimated. At the same time, the swimming speed and the athletes heart rate (Polar) are captured.

Using Excel software to explore the swimming data output by the swimming inertial measurement unit, evaluate and record the left and right ICV, so as to obtain the speed contribution value of the right upper limb and the left upper limb in each cycle.

RESULTS: The data is corrected by calculating the average speed, and the speed contribution of each swimmers two upper limbs is estimated. At the same time, the swimming speed and the athletes heart rate (Polar) are captured.Evaluating two upper limbs is called index (SI)(Robinson, Herzog, &Nigg, 1987):

SI(%)=(X_d-X_nd)/(1/2(X_d+X_nd))×100

Where Xd and Xnd are the average values of peak forces recorded by dominant upper limbs and non-dominant upper limbs, respectively. As recommended by the author, 10% < SI< 10% means symmetry, while Si < 10% and SI>10% means asymmetry.Where Xd and Xnd are the average values of peak forces recorded by dominant upper limbs and non-dominant upper limbs, respectively. As recommended by the author, 10% < SI < 10% means symmetry, while SI < 10% and SI>10% means asymmetry. Left and right ICV Mean±SD and (SI=Mean±SD): 0.05±0.17m/s（SI=2%±9%）、0.16±0.14 m/s（SI=5%±5%）、0.04±0.17 m/s（SI=2%±6%）、0.02±0.37 m/s（SI=3%±4%）、0.02±0.37 m/s(SI=6%±21%).

CONCLUSION: The research and analysis show that: 1. The imbalance of swimmers strength, posture, stroke efficiency, joint mobility and stroke path constitutes the main cause of the bilateral imbalance of freestyle; 2. The female short-distance freestyle athletes did not appear unbalanced expansion in the process of gradual fatigue; 3. There are two female short-distance freestyle athletes in the research object, and their asymmetry is above 10%.; 4. Freestyle breathing does not seem to affect the size of athletes bilateral imbalance; 5. The application of swimming special inertial measurement unit and wearable equipment is an effective means to evaluate the bilateral imbalance of freestyle at present.

EFFECT OF FOUR-WEEK PLYOMETRIC TRAINING ON DELAYING MUSCLE FATIGUE IN ROWERS

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INTRODUCTION: Rowing is an Olympic sport based on distance, which is characterized by repetitive muscular cycles and high demands on several components of physical fitness, such as cardiorespiratory endurance, muscular fitness, and maximal strength (1,2). In many exercises training, plyometric training (PT) is an effective way to improve muscle strength and power, even in a short period of time (<10 weeks). It is a type of physical training that can be used to improve the stretch-shortening cycle (3,4). However, only a few studies in the past have demonstrated that PT can increase rowing power and related strength parameters in rowers. There is no clear evidence to support whether PT can delay the timing of muscle fatigue in rowers during time trials. The purpose of this study was to investigate the effects of PT on delaying muscle fatigue in rowers after 4-weeks of training.

METHODS: Twelve male rowers were randomly assigned to the PT group (n=6) and the general strength training group (GST, n=6) and trained for 4-weeks at the same time. A 2000m rowing time trial was conducted before and after the training session. The EMG signals of the vastus medialis of the dominant limb were collected by surface electromyography during rowing time trials. The EMG signals were used to calculate the slope of the median frequency (MDF) to quantify the fatigue rate (5). We calculated the slope using the MDF of each 500th-meter (e.g., 0km, 0.5km, 1km, 1.5km, and 2km) EMG signal (6). Two-way ANOVAs were used to compare the difference in fatigue rate between the two training methods.

RESULTS: The results revealed that in the pre-test 2000m time trial (before four weeks of training), the MDF of vastus medialis in GST decreased from 103.49±8.77 Hz to 87.69±4.06Hz, and its fatigue rate was -7.51±2.98%. The MDF of vastus medialis in PT decreased from 113.81±19.14Hz to 95.72±14.68Hz, and its fatigue rate was -7.56±2.71%. In the post-test 2000m time trial (after four weeks of training), the MDF of vastus medialis in GST decreased from 98.51±5.32Hz decreased to 85.81±5.02Hz, and its fatigue rate was -6.14±4.12%; the MDF of vastus medialis of PT decreased from 104.72±16.38 Hz to 95.88±14.90 Hz, and its fatigue rate was -3.13±0.95%. ANOVA results showed that different training methods significantly interacted with fatigue rates (P=0.046). In PT, the fatigue rate was significantly reduced between pre- and post-test (P=0.006); however, in GST, the fatigue rate did not reach a significant reduction between pre- and post-test (P=0.211).

CONCLUSION: Rowing is a repetitive muscular cycling movement and a highly physiologically demanding competitive sport. The quadriceps muscle group experienced more than 220 repetitions of the rowing cycle during the 2000m time trial (1). How to effectively delay the generation of fatigue is critical. According to the results, four weeks of plyometric training can significantly reduce the fatigue rate of the rowing time trial compared with the general strength training.

THE EFFECTS OF FUNCTIONAL MOVEMENT TRAINING ON BAT-HEAD SPEED, BATTING KINEMATICS, AND FUNCTIONAL MOVEMENT SCREEN IN ADOLESCENT BASEBALL PLAYERS

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INTRODUCTION: Functional movement screening (FMS) and training have been used to assess and improve the ability of core control and fundamental movement patterns. Poor fundamental movement patterns may influence sports performance and increase injury risk in athletes. The effects of functional movement training in adolescents is not fully understood, and no study included kinematic measurement of the lumbopelvic-hip complex during sports activity. The aim of this study was to investigate the effects of 8-week functional movement training on bat-head speed, batting kinematics, and FMS score in adolescent baseball players.

METHODS: Twenty-six junior high school baseball players with the FMS score less than or equal to 14 were randomly assigned to either the experimental group or the control group. The experimental group performed functional movement training twice a week for 8 weeks while the control group performed routine training as usual. Outcomes were measured before and after the intervention period, including the bat-head speed, the rotation angles and velocities of the pivot hip, pelvis and lumbar spine, the inter-joint coordination, and the FMS score. Repeated-measures analysis of variance and chi-square tests were conducted to determine the effects of functional movement training on outcome measures.

RESULTS: The experimental group significantly improved the bat-head speed (95% confidence interval [CI] of mean difference 2.82 to 10.08, p=0.002) and FMS score (95% CI of mean difference 1.37 to 3.24, $p < 0.001$) than the control group after training; however, no significant changes were found in most kinematic data at the events of foot contact and ball contact during baseball batting ($p<0.05$). More participants in the control group than those in the experimental group changed their pivot hip and lumbar spine coordination pattern during the 3rd (51%-76%) and 4th (76%-100%) sub-phases of normalized baseball batting time after training; however, no consistent change pattern could be identified.

CONCLUSION: Eight-week functional movement training improves bat-head speed and FMS score but has limited effects on kinematics and inter-joint coordination in the lumbopelvic-hip complex of adolescent baseball players.

DIFFERENT EFFECTS OF KNEE BRACE AND KINESIO TAPING ON THE BIOMECHANICS OF LOWER EXTREMITIES ON PATELLOFEMORAL PAIN SYNDROME SUBJECTS DURING CYCLING

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INTRODUCTION: Cycling has relatively less load on the lower limbs, and it is also the first choice for many patients with knee injuries for rehabilitation after injury (1). However, long-term wrong riding posture may lead to other injuries (2). Knee brace or taping are often used as adjuvant therapy to relieve pain for Patellofemoral Pain Syndrome (PFPS) subjects. The purpose of this study was to investigate whether the intervention of knee brace and Kinesiology® Tape can relieve the pain of PFPS patients when riding, and EMG responses after the intervention.

METHODS: In this study, 19 females with 20-50 ages with riding experience were recruited including 10 healthy subjects and 9 subjects with PFPS. The riding resistance is 80W and 100W, the speed was fixed at 80 rpm, and the riding was for 4 minutes. The motion analysis system (Qualisys□, Sweden) was used to investigate the kinematics of the lower extremity joints and the electromyography system (Delsys□, USA) was used to detect the muscle contraction of the gluteus medius (GM), vastus medial oblique (VM), vastus lateral (VL), and rectus femoris (RF) during cycling.

RESULTS: The results found that the subjects feel pain were decreased, the abduction-adduction range of motion of the knee joint was decreased, the flexion-extension range of motion was increased, and the internal-external rotation was decreased after both of the interventions. Moreover, after the interventions, the maximum activation of muscles was all increased, the time point of maximum activation and the onset time was earlier, the total activation time was increased, and the iEMG was larger.

CONCLUSION: Wearing a knee brace or taping when riding can reduce the abduction or rotation angle of the lower limb joints, and can also activate the quadriceps and gluteus medius. By stabilizing the joints and increasing muscle activation, the symptoms of knee pain can be reduced during cycling.

NURSES' PHYSICAL BURDEN DURING REPOSITIONING OF BEDRIDDEN PATIENTS

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INTRODUCTION: Everyday nursing work is characterized to a large extent of heavy lifting, carrying, and standing activities, such as repositioning, transporting or mobilizing bedridden patients. The resulting forced postures pose a risk for the development of musculoskeletal complaints (Feyer et al., 2000; Nöllenheidt and Brenscheidt, 2013). The study focuses on the physical strain of the nurses during the transfer of bedridden persons to analyze phases of increased physical load. This study aims to answer the question which upper body posture is adopted during the repositioning process and in which sequences ergonomically poor upper body postures are being adopted.

METHODS: In a crossover study design, two trained nurses performed the 30° positioning with a total of N = 15 participants. The body angles of the nurses were measured via direct kinemetry for extension/flexion, rotation, and lateral flexion of the trunk (Xsens MVN 2018) for the phase of preparation with positioning to the edge of the bed until lateral positioning of the participant (sequence one), as well as the positioning of the assistive device in the back of the participant until final positioning (sequence two). In addition, an SPM (Statistical Parametric Mapping) analysis was performed to determine the change in upper body posture over time.

RESULTS: Both nurses showed a strongly pronounced upper body flexion during the whole positioning process. Furthermore, the second nurse showed strongly pronounced upper body lateral flexion during the start and the end of the positioning process, as well as strongly pronounced upper body rotation during the second sequence. SPM analysis showed significant differences between the two nurses in flexion in sequence one (51-100%; $p < 0.001$), sequence two (0-31%; $p < 0.001$), lateral flexion in sequence one (1-30%; $p = 0.001$), and rotation in sequence one (55-87%; $p = 0.003$).

CONCLUSION: In view of the increasing workload in the nursing profession due to the shortage of skilled workers and the rising number of people in need of care, physical relief must be established for prevention. Particularly in the second sequence of the positioning process, long-lasting extreme upper body postures defined according to the German guidelines of ergonomic posture (DIN EN 1005-4) were found in both nurses, which require special support to prevent nurses' physical overload.

EFFECT OF DIFFERENT BICYCLE WHEELSET DESIGNS ON AERODYNAMIC DRAG

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INTRODUCTION: During a bicycle competition, wheelsets account for 10-15% of total aerodynamic drag. Therefore, it is still possible to decrease the aerodynamic drag produced by the wheelset by improving its design. The aim of this study was to investigate the aerodynamic drag resulting from different wheelset designs.

METHODS: A computational fluid dynamics (CFD) simulation package, FLUENT 2019 R2 version, as well as the k-ε model with wall function and k-ω SST model have been implemented for simulation. Herein, a low-profile wheelset (diameter: 667mm, rim height: 388mm) and a high-profile wheelset (diameter: 667mm, rim height: 588mm) were used for simulation under multiple wind directions which includes parallel to the wheelset, 20 degrees relative to the wheelsets' direction. In addition, wind velocities simulated in this study ranges from 9.72 m/s (35 km/hr) to 15.27 m/s (55 km/hr).

RESULTS: Based on the results, wheel rim, hubs, and spokes accounted for 60%, 20%, and 20% of the total aerodynamic drag produced by the wheelset, respectively. Furthermore, larger wind direction relative to the wheelset increased the percentage of aerodynamic drag produced by the rim (up to 80%). Finally, high-profile wheelset has a 40% higher aerodynamic drag compared to the low-profile wheelset.

CONCLUSION: Among the three components, the wheel rim produced the highest aerodynamic drag. However, by improving the streamlined shape of the hub and spoke, it is able to reduce aerodynamic drag in a smaller wind direction relative to the wheelset. Cyclists are recommended to choose a wheelset based on wind direction to minimize the resistance from the wind.

THE INFLUENCE OF CARRY ON CLUB LENGTH AND LOFT ANGLE IN COLLEGE GOLFERS

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INTRODUCTION: Golfers hit distance differently depending on the loft angle and club length of iron club sets. Previous research have reported that carry is affected by loft angle by 80% and by club length by 20% （Tutelman D.2016）, but the influence of loft angle and club length on the actual human swing action is unknown. The purpose of this study was to clarify the effects of loft angle and club length on carry using single-length clubs and single-loft angle clubs in college student golfers.

METHODS: The subjects were eighteen right-handed college male golfers (age: 20.7 ± 1.4 years; height: 174.3 ± 4.0 cm; body mass: 69.6 ± 9.4 kg; Best score: 70.1 ± 3.9). The special club settings were a 37-inch single-length club with a loft angle of 26°to 46°and a single-loft club with a loft angle of 26° and a 35-inch to 37.5-inch loft angle. Subjects obtained five swings data using their own iron golf clubs and specially configured single-length and single-lofted clubs. Swing data was measured using the distance trajectory tracking system Trackman system. Ground reaction force and kinematic data during the swing were simultaneously acquired by motion capture system (VICON) to compare the three club conditions.

RESULTS: The carry of the single-length and normal clubs increased with decreasing loft angle, with an overall difference of 6.5 ± 5.9 yrds(%Diff.4.2%). The carry Gap was 12.1 ± 2.4 yrd for the normal clubs and 10.1 ± 3.8 yrd for the single-length clubs, with no statistically significant difference. On the other hand, the single-lofted clubs shows a difference of about 15 yards in the 2.5 inch range of club length variation. Compared to the normal clubs, the carry difference decreased with increasing club length, and the carry Gap was greater for the shorter clubs and decreased with increasing club length. The peak ground reaction force during the swing did not change significantly. Thus, it was shown that golfers might be adjusting their distances according to club length and loft angle.

CONCLUSION: The loft angle had a greater influence on iron club distance than club length, suggesting that a single-length club is an effective option for golfers to accurately distinguish distance.

LOADED COUNTERMOVEMENT JUMP EXERCISE USING ELASTIC BANDS POTENTIATES SUBSEQUENT JUMP PERFORMANCE FOLLOWING A COMPREHENSIVE TASK-SPECIFIC WARM-UP

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1: UOD , 2: ECU , 3: UOT , 4: D.U.TH , 5: ASPETAR , 6: UON

INTRODUCTION: Performing voluntary muscle actions using elastic bands (EB) to precondition the muscle in combination with free-weight (FW) resistance can alter the loading characteristics of these actions to impose a greater mechanical stimulus and increase subsequent performance [1]. Whilst these actions can precondition the neuromuscular system, the limited warm-up commonly utilised in these studies [2] could invalidate the findings of potentiation often reported. Thus, the impact of loaded countermovement jumps using elastic bands on subsequent jump performance requires further investigation. The aim of the present study was to examine the influence of EB resistance following a comprehensive warm-up on subsequent countermovement jump (CMJ) performance.

METHODS: Fifteen active men (age = 21.7±1.1 y, height = 1.8±0.1 m, mass = 77.6±2.6 kg) volunteered for the study. On two separate occasions, following a comprehensive warm-up consisting of 5 min cycling, 10 continuous unloaded squats, 5

continuous CMJs at ~70% of maximum, then maximal jumps every 30 s until 3 jumps were within 3% of maximum jump height, participants performed 5 repetitions of either EB- or FW-loaded CMJs at 50% 1-RM (35% of load generated from elastic resistance during EB). CMJs were then performed 30 s, 4 min, 8 min, and 12 min later, with jump height and electromyograms (EMG) of the vastus lateralis (VL), vastus medialis (VM), gluteus maximus (Glut) and gastrocnemius medialis (GM) recorded.

RESULTS: Compared to baseline, no significant ($P \geq 0.05$) changes in CMJ height (0.3-2.7%) or EMG activity (VL = 0.6-7.1%; VM = 0.8-1.6%; Glut = 3.1-8.7%; GM = 0.6-6.4%) were observed in the FW condition. Significant increases in CMJ height (4.6-8.0%) and peak concentric VL EMG activity (10.3-18.8%) were found at 30 s and 4 min in the EB condition; no changes in jump height (0.3-0.9%) or EMG activity (VL = 6.0-7.9%; VM = 2.1-4.4%; Glut = 3.2-5.3%; GM = 1.8-7.1%) were found at 8 min or 12 min.

CONCLUSION: The lack of change in CMJ performance in the FW condition is consistent with previous research [1] and indicative that the comprehensive warm-up induced significant potentiation that subsequent FW contractions provided no further improvements. However, the further improvements in CMJ height in the EB condition at 30 s and 4 min, associated with increases in peak vastus lateralis (VL) concentric EMG activity, is indicative of further potentiation through alteration of the motor control strategy to improve jump performance. These data suggest the use of elastic resistance may provide a superior warm-up protocol for athletes to provide short-term improvements in strength and power performance under some conditions.

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MUSCLE FIBER CONDUCTION VELOCITY AND SELECTED BIOMOTOR ABILITIES IN SOCCER PLAYERS

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INTRODUCTION: Higher muscle fiber conduction velocities (CV) were related to the training status. Within trained participants, sprinters showed higher CV than endurance runners. Based on the muscle fiber CV, the cross-section of the muscle fibers can be estimated. Muscle fibers with a larger cross-sectional area would suggest a higher distribution of type II (fast-twitch) fibers. The aim of this study was to examine the selective influences of muscle fiber CV on strength, speed, and endurance test results in soccer players.

METHODS: Sixteen professional male soccer players (age: 17-29 years, BMI: 20-25 kg/m²) participated in this cross-sectional study. Muscle fiber CV of the vastus lateralis muscle was recorded in monopolar mode (EMG-USB2+, OT Bioelettronica, sampling rate: 2048/s) using a linear electrode array (ELSCH004, Spes Medica) concurrently with the isometric force (SM-2000N, Forza, gain: 200). Linear sprinting time was measured indoors with photoelectric timing gates at 10 meters (best of two trials). Endurance performance was determined via an incremental test on a treadmill (Saturn, h/p/cosmos) using a gas analyzer (Metalyzer 3B, Cortex). All tests were performed at the beginning of the pre-season period. The maximum voluntary torque (MVT) of the knee extensors and the maximum oxygen uptake (VO2max) were normalized to athletes' body mass. Athletes were divided into "slower" and "faster" groups according to their vastus lateralis muscle fiber CV outcome using the median split method. Differences between groups were estimated using Student's unpaired t tests and effect sizes (d), respectively.

RESULTS: The lower CV group revealed on average similar MVT (4.0 Nm/kg) as compared to the higher CV group (4.1 Nm/kg, $t(14) = -0.29$, $d = -0.15$). Likewise, the groups did not differ in their sprinting times (either: 1.8 s, $t(14) = -0.08$, $d = -0.04$). There was a moderate effect of the muscle fiber CV ($t(14) = -1.16$, $d = -0.58$), with the higher CV group demonstrating higher VO2max (55.6 ml/min/kg) compared to the lower CV group (53.1 ml/min/kg).

CONCLUSION: Soccer players with lower muscle fiber CV at the vastus lateralis muscle are equally able to generate maximum knee extensor torque and linear sprint over 10 m as their counterparts with higher muscle fiber CV. However, they appear to show a higher endurance capacity. In turn, these findings confirm that in soccer players with higher muscle fiber CV and thus a larger fast-twitch fiber proportion the endurance capacity is not adversely affected.

RELATIONSHIP BETWEEN LOWER LIMB AND TRUNK ANGLES DURING THE ROWING MOTION AND MUSCLE STRENGTH IN HIGH-SCHOOL CANOE SPRINT ATHLETES

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INTRODUCTION: In this study, we investigated the relationship between motion analysis results and trunk and lower limb muscle strength measurements in Japanese high-school students. We hope that this will serve as a starting point for future feedback to athletes based on motion analysis results and physical function results.

METHODS: The subjects were eight high-school canoe sprint athletes who primarily compete in kayaking and had both motion analysis and physical function test results (mean age: 15.8 ± 0.6 years, five males and three females).

During motion analysis, an inertial measurement unit, myoMOTION (Noraxson), was used to measure the acceleration and angles of each body part. The motions were measured on a kayak ergometer (Dansprint DNK), with rowing motions at a pitch of 80 bpm and at the individuals maximum speed for 60 s. From the data obtained, data for five strokes were extracted 10 s after the start, and the average value was used as the representative value. The extracted angles were total rotation angles of the thoracic spine, lumbar spine, pelvis, and hip joint, as well as flexion angles of the knee joint. For the hip and knee joints, the ratio of the percentage of flexion angles between the right and left sides was calculated (LR ratio).

Muscle flexion and extension strengths of the trunk and lower limbs were measured at two angular velocities, 60° and 180°, using the isokinetic muscle function evaluation device, BIODEX System4 (Biodex Medical Systems, Inc.). For knee flexion muscle strength, the LR ratio was calculated.

Spearmans correlation coefficient was calculated as the correlation between the LR ratios of each lower limb angle and muscle strength, as well as the thoracic spine, lumbar spine, and pelvis angles and each trunk muscle strength.

RESULTS: The lumbar spine, pelvis, hip, and knee joint values at 80 bpm and maximum speed velocity all had strong correlations, but the thoracic spine had none (lumbar spine, $r = 0.86$; pelvis, $r = 0.97$; hip, $r = 0.74$; knee, $r = 0.88$; thoracic spine, $r = 0.082$). The LR ratio of knee extensor strength at 60° angular velocity and the LR ratio of hip rotation at 80 bpm had a moderate positive correlation ($r = 0.62$), whereas the LR ratio of knee extensor strength at 180° angular velocity and the hip rotation at maximum speed had a strong positive correlation ($r = -0.79$). Moreover, the trunk flexor strength at 60° angular velocity and pelvic rotation angle at 80 bpm had a moderate negative correlation ($r = -0.55$), while the trunk flexor strength at 180° angular velocity and pelvic rotation angle at maximum speed had a moderate negative correlation ($r = -0.56$).

CONCLUSION: In inexperienced high-school kayakers, upper body movements may not be used as a smooth kinetic chain from the lower trunk to the pelvis to the lower extremities. Regarding the left-right difference, it is possible that the pelvis and hip rotation are influenced by knee extension and trunk flexion muscles.

AN ANALYSIS OF KEY PERFORMANCE INDICATORS DURING 50 AND 100 METER SWIM LENGTHS ACROSS FOUR SWIM STROKES

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INTRODUCTION: Key performance indicators (KPI's) are skill-based metrics used by coaches and athletes to adjust technique, track training, develop race strategies and predict performance times. The purpose of the study was to investigate the effect of swim-specific KPI's [stroke count (SC;#), stroke length (SL;cm), stroke rate (SR;#/s), and kick frequency (KF;#/s)] on total swim time (s) during 50m and 100m swim lengths across four swim strokes [butterfly, backstroke, breaststroke, and freestyle].

METHODS: Varsity-caliber competitive swimmers (n=12 males; 20yrs) were recruited. Anthropometric measures including height (182.1cm), seated height (146cm), leg length (98.3cm), wingspan (191.1cm), hand length (20cm) and weight (80.2kg) were recorded. Shoulder and ankle range of motion (ROM) measurements were obtained, and a Y-balance test was conducted to profile the athlete's upper and lower limb mobility. Athletes completed four swim sessions consisting of a standardized warm up, 50m kick, 50m pull, 50m swim and 100m swim distances per stroke. KPI data was collected using a portable device (TritonWear, ON, Canada) secured inside the athletes' swim cap. TritonWear measures SC(#), SL(cm), SR(#/s) and total swim time (s). A GoPro Hero 6 (GoPro, California, USA) collected underwater video to facilitate calculating KF(#/s).

RESULTS: Descriptives were calculated for all anthropometric, ROM and KPI variables across the two swim lengths and four swim strokes. Pearson product-moment correlations revealed significant relations between anthropometric measures and select KPI's; and between ROM measures and select KPI's ($p<0.05$) suggesting that both anthropometrics and ROM have the potential to influence swim technique and race strategies. A series of repeated-measures ANOVA's with Greenhouse-Geisser corrections revealed significant differences in select KPI's (SC, SL and KF) during the execution of 50m and 100m swim lengths across all of the four strokes ($p<0.05$), suggesting the technique employed by specific strokes had the potential to influence the KPI's per stroke. A series of repeated-measures ANOVA's with Greenhouse-Geisser corrections also revealed significant differences in select KPI's (SR, SL, KF) during the execution of 50m versus 100m swim lengths using butterfly, backstroke, breaststroke, and freestyle strokes ($p<0.05$), suggesting that swim length utilizes different KPI related strategies for strokes.

CONCLUSION: Data-driven metrics obtained from portable instrumentation during swim performances facilitated understanding the relationship between anthropometrics, ROM and KPI's and how to adjust select KPI's relative to an athlete's anthropometrics, technique and race strategy across four different swim strokes and two swim lengths. These sport specific skill-based metrics can empower coaches and athletes to use KPI's to optimize athlete potential and target performance goals.

TRADE-OFF RELATIONSHIP BETWEEN SPEED AND ACCURACY AT A SPECIFIC TIME EXAMINED USING A VERTICAL JUMP TASK

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INTRODUCTION: Human movement is governed by a tradeoff between speed and accuracy, demonstrated by experiments on hand movements (1,2). However, studies that have examined that during full-body movements (e.g., sports) have not reported uniform findings on how that is established. Schmidt explains that one of the two exceptions to that is "cases in which extremely rapid and forceful actions are involved" (3); however, in actual sports movements, there are cases that require high control while exerting max speed. Therefore, to analyze sports movements that require both speed and accuracy, this study confirmed this phenomenon and examined the mechanism of that by adding landing position control to a vertical jump task that normally does not require accuracy.

METHODS: 18 adults participated in this study. They performed 10 trials for each vertical jump on a single force plate under the following conditions: 1) normal condition (nc) trials, in which they jumped with max effort, and 2) adjusted condition (ac) trials, in which they jumped with max effort and landed in the takeoff position. Signal outputs from the force plate were digitized at 1000 Hz and captured on a computer. From the acquired force data, the mass (m) and 3D acceleration vector of them were calculated, and the 3D velocity and position vectors were calculated by the numerical integration of the accelerations. From these variables, the position vectors for takeoff (to) and landing (lan) and the jump height were calculated. Furthermore, the 3D velocity vectors were plotted, and the entropy of each condition was calculated using methods in a previous study (4).

RESULTS: A comparison of the jump height of their between conditions showed that it was significantly lower in the ac (0.46±0.02 m) than in the nc (0.50±0.02 m, $p<0.01$). The xz coordinates of their at lan and to were plotted for each condition, from which 95% probability ellipses were calculated to evaluate variability. In the nc, the values were almost the same for to (0.072 m2) and lan (0.074 m2), whereas in the ac, the values were lower for lan (0.068 m2) than for to (0.078 m2). It is possible that the speed was adjusted to accurately control the landing position because the jump height is determined by the takeoff velocity. The entropy was lower in the ac (2.50±0.62) than in the nc (2.61±0.09, $p<0.01$) for approximately 0.2–0.3 seconds after the start of sinking before to. Therefore, during this time, the smaller variation in the velocity vector for ac suggesting that the velocity was controlled to increase accuracy for lan.

CONCLUSION: Even in the vertical jump task, which is normally performed with max effort, increased accuracy and decreased velocity were observed when the landing position was the target of control. Furthermore, a tradeoff relationship between speed and accuracy may be established within a specific time.

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RELATIONSHIP BETWEEN BODY CENTRE OF GRAVITY VELOCITY AND LOWER LIMB JOINT ANGLES IN LUNGE MOVEMENT OF FENCING ATHLETES

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INTRODUCTION: The lunge in fencing is the most fundamental attack movement. Although previous studies investigated the relationship between lower limb joint (hip, knee, and ankle joints) angles and sword velocity during lunging [1], knowledge of body (centre of gravity) velocity, which determines lunge movement quality, is lacking. Therefore, this study aimed to clarify the relationship between the body centre of gravity (peak velocity) and lower limb joint angles in the lunge movement of fencing athletes.

METHODS: Fourteen right-handed male university student fencing athletes (mean competition history, 9.7±3.1 years) were included. Lunge distance was defined as the horizontal distance from the rear leg toe to the target during the engirdle, with the length set at 1.5× the height of each subject [2]. The subjects performed three lunge trials towards the target, and the trial with the highest peak body centre of gravity velocity was considered representative. A three-dimensional motion analysis system (Miqus M3) was used for the data collection. Eight high-resolution cameras were used to capture images. Three-dimensional coordinate values were measured by the analysis software, and the centre of body gravity and the centres of the hip, knee, and ankle joints were calculated based on the three-dimensional coordinates. The start of the lunge movement was defined as the toe-off of the front leg, after which the front leg swung forward in coordination with the rear leg, and heel contact with the front leg was defined as the end of the movement [3]. To determine the lower limb joint angles influencing the peak lunge velocity, multiple regression analysis was performed with the peak velocity of body centre of gravity in the lunge as the dependent variable and the lower limb joint angles (peak flexion angle, peak extension angle, and total joint range of motion) as predictor variables.

RESULTS: The peak velocity of the body's centre of gravity in the lunge was 1.88±0.16 m/s. Multiple regression analysis showed that the rear hip total range of motion ($\beta=0.592$) was significantly related to the peak velocity of body centre of gravity, with a coefficient of determination adj. $R2=0.297$.

CONCLUSION: The results of this study were similar to those of a previous study [1]; however, the knee joint findings differed. One possible reason for this is that the target distance in the present study was shorter than those in previous studies. The findings suggest that, when the target distance is longer, the knee joint is involved in addition to the hip joint; thus, the joint angle during lunge movement may be significantly influenced by both distance and velocity.

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ESTIMATIONS OF BODY SEGMENT PARAMETERS AND WHOLE-BODY COMPOSITION IN JAPANESE ADULT FEMALES USING MRI METHODS

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INTRODUCTION: Body segment parameters (BSPs) are one of the critical parameters in order to estimate the segment forces of movement in both sports and exercise. Whole-body composition (WBC) i.e., fat mass (FM) and skeletal muscle mass (SM) might be influenced for the predictions of BSPs. Recently, magnetic resonance imaging (MRI) methods has been reported to predict BSPs, WBC and Limb composition (LC) accurately. However, relations between BSPs and WBC as well as the reliability WBC assessments by MRI methods remained unclear. This study aimed to be estimations of BSPs and WBC in Japanese adult females using MRI methods.

METHODS: Whole-body MRI scans of 14 Japanese adult females were obtained using 1.5-T device. Thirteen tissue areas such as bone, muscle, fat and so on, were identified using Fiji/ImageJ software. WBC and LC were calculated to be multiplied by each area,10-mm slice thickness and respective tissue densities. Fourteen body segments such as head and neck, trunk, upper arm, forearm, hand, thigh, shank and foot were identified according to the anatomical landmarks. Air displacement plethysmography (ADP) method was used to measure whole- body FM and lean body mass. Data from ADP and MRI methods were compared by paired t-test as well as Pearson's correlation ($p<0.05$). Segment mass obtained from MRI (%M) was compared with previous studies.

RESULTS: Whole-body mass, volume and density obtained from MRI and ADP were almost identical in both absolute and relative values (%difference <1%). FMs obtained from MRI and ADP were highly correlated ($r = 0.981$, $p < 0.001$). On the other hands, significant absolute differences in the FM were found between the two methods (ADP; 12.0±4.5 kg vs MRI; 13.8±4.5 kg, $p < 0.001$). It was suggested that estimated FM equation of ADP method (Brozek et al., 1963) affected difference of results, because whole-body density was identical value. This study trended to be smaller upper arm (2.4±0.3 %M) and forearm (1.3±0.1 %M) than typical values (Dempster,1955 and Clauser et al.,1969). Females was bigger thigh and shank than males of same segmentation protocols, as sex difference affected %M (Zatsiorsky, 2002).

CONCLUSION: Estimation of whole-body mass by MRI method was equivalently evaluated with ADP method. In Japanese adult females, estimation of BSPs (%M) by MRI method showed to be smaller upper body and bigger lower body than previous studies.

INFLUENCE OF MEDIAL LONGITUDINAL ARCH HEIGHT AND REDUCED ANKLE DORSIFLEXION ON KNEE DYNAMIC ALIGNMENT DURING SINGLE LEG SQUAT

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INTRODUCTION: Single leg squat (SLS) test is recognized to identify core strength, and simpler to perform in sport or clinical site than drop jump test. Also, we reported hip abductor and hindfoot dysfunction during SLS were risk factors causing dynamic knee valgus (Kagaya et al., 2015). However, influence of medial longitudinal arch height or reduced ankle dorsiflexion (DF) on dynamic alignment in SLS remains unclear. This study aimed to determine how navicular height and DF angle contribute to SLS test.

METHODS: Eighteen female basketball players (36 legs) agreed to participate in this study. Their age was 21.0±1.9 years, height and weight were 166.5±5.9cm and 62.6±5.8 kg, respectively. Subjects clasped hands behind their back and performed SLS by bending the knee of the supporting leg to about 60°. This procedure was recorded simultaneously using a 2D video camera in the front on the subjects. Knee-in distance (KID) was measured as the distance from hallux to the point where the line connecting the center of the patella and the anterior superior iliac spine (ASIS) intersects the floor. Hip-out distance (HOD) was measured as the distance from hallux to the projection of ASIS on the floor. Additionally, we measured DF angle, and navicular drop (ND) as the subtraction of navicular height on sitting and standing position. The collected data from subjects were divided into either limited or flexible group by excluding the subjects among average ±1/2 SD of the DF and the ND, respectively. The limited DF or ND group was compared between flexible DF or ND group using Mann-Whitney tests, respectively.

RESULTS: Limited DF group (n=12, 32.0±3.1°) demonstrated greater KID (9.3±3.1cm vs 6.5±3.9cm) than flexible DF group (n=10, 49.7±4.2°) ($p<0.05$). However, the HOD (15.7±1.6cm vs 14.7±1.4cm) did not significantly differ between the limited and flexible DF group. Also, the KID (7.8±4.9cm vs 9.0±5.9cm) and HOD (14.1±1.4cm vs 15.4±1.4cm) did not significantly differ between the limited ND group (n=12, 2.8±0.9mm) and flexible ND group (n=10, 8.9±2.1mm).

CONCLUSION: Limited DF range has been reported as a possible contributor to excessive knee valgus and has been linked to harmful landing mechanics (Lima et al., 2018). Our study also revealed that female basketball player having limited DF augmented dynamic knee valgus during SLS. It was suggested that subjects having reduced DF try to compensate for this lack of range in the sagittal plane with movement in the frontal plane as they perform SLS. However, it was not considered that navicular height led to dynamic knee valgus. KID values for single leg squat had been greater for athletes with flexible hindfoot than for athletes with normal hindfoot function, whereas HOD values did not significantly differ between that groups (Kagaya et al., 2015). The hindfoot and medial longitudinal arch might not completely be linked throughout the kinetic chain and need to be evaluated individually.

TEMPORAL CHARACTERISTICS OF HOPPING MOVEMENT IN PRESCHOOL CHILDREN

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INTRODUCTION: Hopping, one of the fundamental locomotor skills, is a rhythmically cyclic movement that requires significant muscle strength, multi-limb coordination, and dynamic balance. Typically developing children begin hopping around the age of three and improve on it during early and middle childhood. Previously, we reported the developmental changes in motor coordination patterns of arms and legs during hopping in preschool children. In this study, we have expanded on the previous study by focusing on the temporal aspects of hopping movement patterns in preschool children.

METHODS: Participants were 157 typically developing children aged between 4 and 6 years. They were asked individually to perform the hopping movement on their preferred foot. Hopping movement has been demonstrated before the test, and a video recording of each individual was captured. The recording (30 fps) was analyzed in terms of temporal parameters: hopping cycle time, flight phase and stance phase duration. Based on these parameters and criteria from a previous study by Halverson and Williams, 1985, children were classified into 4 developmental levels of leg action.

RESULTS: The number of children categorized in each developmental level of leg action, from step 1 to 4, was: 0 (0.0%), 104 (66.2%), 42 (26.8%),and 11 (7.0%), respectively. The average age in each developmental level group (step 2, 3, 4) was 67.7, 71.0, and 71.7 months, respectively. As for the temporal parameters of hopping, the cycle and the flight phase duration both increased with advancing level of development. On the other hand, the stance phase duration decreased with the level of development.

CONCLUSION: Overall, the hopping performance improved with aging in 4 to 6 year-old children. However, the level of development was not uniformly distributed, with the majority of subjects being at levels 2 and 3. This means they were still improving in the movement (Halverson and Williams, 1985, Masci et al, 2012). The flight phase duration was longer in the advanced movement levels than in the lower ones. The duration of the stance phase has decreased with the advancing levels of development. These findings suggest qualitative changes in the neuromuscular function in these children during hopping.

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LONG-DISTANCE RUNNER'S VASTUS LATERALIS ARCHITECTURE PARAMETERS ARE LARGER THAN THE CONTROL GROUP, BUT KNEE EXTENSOR TORQUE IS NOT.

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INTRODUCTION: The scientific literature is sparse regarding adaptations in muscle architecture concerning long-distance runners. Chronically, no differences in vastus lateralis (VL) architecture were observed after 12 weeks of training for a marathon (1), and professional distance runners had a reduced VL fascicle length (FL) than the control group (2). However, both studies acquired ultrasound images at one site only; 50% of the VL. The muscle architecture from runners, using the ultrasound extended-field-of-view technique (EFOV) has not yet been evaluated, as well as the voluntary torque production capacity of the knee extensors of this sample. This study aimed to compare the muscle architecture of the VL and the knee extensor torque between long-distance runners and control participants.

METHODS: The runners group consisted of 21 amateur long-distance runners and the control group of 12 healthy young participants, with similar anthropometric characteristics between groups. All participants in the running group had at least two years of training and performed at least one long-distance race (≥ 10km) in the last year. An experienced evaluator acquired panoramic mode ultrasound scans of the VL at 50% of muscle length for anatomical cross-sectional area (CSA) normalized by the body mass (BM) (3) and at two VL lengths to assess distal and proximal muscle length (4) normalized for the muscle length (ML). To assess torque production capacity, the isometric peak torque, concentric and eccentric peak torque at 60°/s, and the concentric and eccentric angle of the peak torque were measured. The T-test for independent samples was used to compare the means for the FL/ML, CSA/BM, and torque parameters ($p \leq 0.05$).

RESULTS: No statistical differences were found between groups for the knee extensor torque parameters ($p > 0.05$). The EFOV ultrasound scans of the group of runners showed statistically higher values for the normalized fascicle length of the proximal (0.23 ± 0.02) and distal length (0.22 ± 0.02) compared to the group control (0.21 ± 0.02 and 0.20 ± 0.02 - proxi-

mal and distal, respectively) (p=0.034 and p=0.027, respectively). In the same way, the runners had larger normalized CSAs (0.38 ± 0.06) compared to the control group (0.34 ± 0.05) (p=0.028).

CONCLUSION: It appears that long-distance amateur runners have longer FL/ML (proximal and distal) of the VL, as well as CSA/BM. Although speculative, these results may be due to VL adaptation in response to the demand imposed by specific training performed. In addition, the results suggest that the EFOV method for acquiring ultrasound images is more suitable for such functionality compared to the one-site ultrasound images. The isometric and dynamic torque production capacity, as well as the dynamic torque peak angle, are not statistically different between groups.

DUAL-TASK INTERFERENCE ON TRUNK-PELVIS COORDINATION DURING GAIT IN INDIVIDUALS WITH PARKINSONS DISEASE

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INTRODUCTION: Parkinson's disease (PD) is a heterogeneous neurodegenerative disorder. Atypical posture and mobility of individuals with PD (IwPD) increase the risk of falls and limits the capabilities of daily activities. Reduced range of motion in IwPD is attributed to rigidity and may be hindering trunk coordination, and consequently contribute to gait dysfunction (i.e., decreased step and stride length), turning difficulties, and poor posture. In a neurotypical gait pattern, there is a progressive transition mainly from in-phase to anti-phase coordination, in the axial plane, as gait speed increases. An in-phase pattern is more evident in IwPD; resulting in the trunk and pelvis to display synchronous axial rotations in the same direction. Furthermore, IwPD have increased difficulty performing more than one task simultaneously, possibly due to restricted central processing. It's hypothesized that trunk-pelvis coordination (TPC) will be aggravated during dual-task (DT) activities, and greater DT inference (DTI) will occur during motor-motor DT (MMDT) than cognitive-motor DT (CMDT). The primary aim of this study was to establish if DT activities, in contrast to single-task (ST) conditions, affect TPC during walking in individuals with mild to moderate PD compared to apparently healthy age- and sex-matched individuals (Control group). The secondary aims were to compare two DT paradigms, and to determine which condition resulted in the most interference for TPC, gait variables and other coordination indices, during walking in IwPD compared to the control group.

METHODS: This was a cross-sectional within-group and between-group quasi-experimental study design. Participants were asked to randomly perform a ST (i.e., 2 Minute Walk) and DT activities (i.e., CMDT by serial three subtraction, and MMDT by carrying a tray with two glass

RESULTS: Twenty-two IwPD (age 72.50 ± 4.35 years; 1.82 ± 0.66 Hoehn & Yahr scale) and 22 healthy age- and sex-matched Control group (age 72.77 ± 4.30 years) were tested under ST, MMDT and CMDT conditions. Significant interaction effects were found for gait speed, gait variability, gait speed variability and TPC variation ($p < 0.01$), with post-hoc results indicating that CMDT cause a great deterioration in gait in both groups. Results of the DTI show significant interaction effects for gait speed ($p < 0.01$), stride time ($p = 0.02$),gait variability ($p = 0.02$), and gait speed variability ($p < 0.01$). Great DTI was observed in MMDT than CMDT for TPC in the PD group and Control group.

CONCLUSION: The findings suggest that DT gait performance is influenced by MMDT and CMDT in IwPD. Dual-task interference on gait parameters were significant in both DT conditions in the PD and Control group. The findings may contribute to the way healthcare professionals treat IwPD, by modifying expectations and monitoring the cognitive and/or motor demands placed on IwPD both in everyday life and during rehabilitation may improve quality of life and independence.

THE FMS PROFILE WITH TRAINING INTENSITY FOR TENNIS PLAYERS OF COLLEGE TEAM AND HIGH SCHOOL TEAM

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INTRODUCTION: Athletic tennis is a sport that requires a lot of training and practice to fit for high-intensity, low-intensity intermittent competitions. Not only does it require developing technical skills, but it also requires developing specialized fitness abilities.

Kekelekis (2020) shows that most tennis injuries are related to overuse and a chronic time process. For professional athletes and coaches, it is important to avoid overtraining or cumulative injuries that can lead to injuries during training. In Taiwan, training of tennis players with tennis major from in high school and college team have heavy intensive training. Therefore, this study aims to investigate the training time between high school and college and both related FMS profile and the relationship between training time and FMS and sub-FMS scores to provide a reference for coaches or players in their training plans to prevent injury.

METHODS: The study recruited 46 male tennis players with tennis major. Twenty-two were college athletes, and 24 were high school athletes. All participants were informed of potential risks of the study and provided written informed consent. The FMS scores were calculated according to the guidelines described in the Functional Movement Screen manual. The data collected included the weekly training time and frequency. The FMS scores were calculated according to the Functional Movement Screen manual. Participants also filled out a personal information form that included information about their physical fitness and training time. The FMS score is calculated by giving a score of 0-3 for each item, with a maximum score of 21. Independent sample T-test and Chi-square test of SPSS 25.0 were used to test a significant difference in training time and FMS scores. Spearmans correlation analysis was used to examine the relationship between the FMS and training time.

RESULTS: The results shows that high school players investing more both technique (HG 24.1±8.0, CG17.1±13.9 hrs) and physical training time (HG 24.1±8.0, CG17.1±13.9 hrs, $P<.05$) There is no significant difference on total FMS scores, but on sub-FMS score: HG > CG on shoulder mobility and active straight leg raise while CG> HG on In-line lunge and Trunk stability push-up. Besides, only HG showed mild negative relationship between physical training time on deep squat ($r=-.444$, $p<.05$) and Rotary stability scores ($r=-.507$, $p<.05$).

CONCLUSION: our study showed HG is better in shoulder and pelvis mobility, but CG better is related to pelvis and trunk stability and strength. It may be due to young age and long training time but less strength training. Also, young athlete demonstrates the negative effect on long time training which is about 30 hours weekly. It suggested that increasing training pelvis and trunk strength and stability are important to young athletes.

SCAPULAR MUSCLES ACTIVATION DURING TWO ADAPTATIONS OF THE SHRUG EXERCISE

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INEFC

INTRODUCTION: Shrugging exertion with barbell or dumbbell is commonly used to strengthen the upper fibers of the trapezius (UT) because this exercise has been traditionally recommended as the function of elevating the scapula. However, it has been suggested that the transverse orientation of the upper and middle fibers of the trapezius does not allow for the elevation of the scapula (1). This observation was evidenced by a higher UT activation when adopting an arm abduction of 90º and 150º during the shrug (2). On the other hand, when doing the dumbbell shrug with an arm abduction of 30º the UT and lower trapezius (LT) were more solicited (3). Nevertheless, other conditions with a lower deltoid solicitation have not been studied yet for conditioning purposes. We aimed to examine whether activity of scapular muscles varies when performing shoulder shrugs under three different conditions.

METHODS: Eight volunteers performed shoulder shrugs under three conditions: the traditional barbell shrug at a 0º (BS0) and at a 30º (BS30) of abduction with a barbell and using a pulley (PS30) aligning the resistance with the arm. EMG activity was collected from levator scapulae (LS), UT and LT, and serratus anterior (SA) during 5 repetitions at a load of 25% relative to the 1RM of each one of the three conditions. Root mean square was used to measure levels of muscle activity for the whole repetition and normalized (nRMS) with the isometric maximal voluntary contraction. The duration of each repetition was standardized with a metronome.

RESULTS: Significant exercise and muscle main effects were found ($p<0.006$). In addition, the interaction of exercise and muscle was significant ($p=0.041$). Post-hoc analysis revealed a higher activity in the UT and SA muscles during the BS30 than the BS0 ($p<0.026$). Additionally, BS30 solicited more the LS and SA muscles than the PS30 ($p<0.037$). On the other hand, LT muscle was activated in a similar way in the three conditions. When comparing muscles activity, no significant differences were observed between the UT and LS in the three conditions, while the UT was more solicited than the LT in the three conditions ($p<0.05$), and the SA with the BS0 and PS30 exercises ($p<0.037$). Finally, LS showed greater activity than the SA in all three conditions ($p<0.05$), and the LT during BS0 and BS30 situations ($p<0.013$).

CONCLUSION: Contrary to preconceived ideas, the UT is not the greater elevator of the scapula, like it is the case for the LS. Therefore, performing traditional shrugs (BS0) does not seem the best option to stimulate the UT. For practical purposes, we suggest adopting the BS30 to better activate the UT, thanks to the facilitation of the scapular upward rotation.

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FUNCTIONAL ANKLE INSTABILITY SCORES ARE NOT RELATED TO DYNAMIC POSTURAL STABILITY INDICES IN NETBALL PLAYERS.

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INTRODUCTION: It is well known that the ankle joint is the most frequently injured body part court-based sports. Research further indicates that postural stability deficits during landings following vertical and horizontal jumps are a precursor for future ankle injuries (1). A common practice to highlight deficits in postural stability associated with the incidence of ankle injury, has been the use of the forward facing vertical drop-landing task. Studies reveal that increasing the single leg lateral landing orientations of a drop jump showed significant alterations in postural stability values (2). The Functional Ankle Instability (FAI) questionnaire has been widely used to determine ankle instability (3). Additionally, assessments of postural control during landing tasks, like the Dynamic Postural Stability Index (DPSI) have provide quantitative metrics to evaluate landing stability (4, 5). The aim of this study was to investigate the relationships between FAI scores and metrics of landing stability and dynamic postural control.

METHODS: 25 female netball players (age: 20.7±2.01 years; stature: 174.4±4.72cm; mass: 67.2±9.52 kg) performed anterior and lateral drop landings from 40cm onto a force plate. FAI was evaluated using the idFAI questionnaire with a cut-off of >11 indicating instability. DPSI was calculated over three seconds from initial plate contact. Correlations were run between FAI scores and landing stability metrics for anterior and lateral landings.

RESULTS: 12 athletes presented with FAI and 13 did not surpass the threshold (FAI scores: 11±9). Landing indices for anterior landings were: ML: 0.07±0.01; AP: 0.05±0.03; Vertical: 1.21±0.22; DPSI: 1.21±0.22, peak BW force: 3.93±0.87. Lateral indices were: ML: 0.479±0.01; AP: 0.08±0.02; Vertical: 1.24±0.16; DPSI: 1.24±0.16, peak BW force: 4.06±0.87. No significant correlations were noted between FAI scores and landing metric for anterior and lateral landings ($p>0.05$) .

CONCLUSION: The lack of relationships between FAI scores and indices of landing postural stability would indicate that dynamic tasks, such as landing, are more complex than pure kinetics. Additionally, it is apparent that postural control during landing is mediated by the lower kinetic chain and ankle joint weaknesses can be mitigated by the knee and hip. Kinematically, postural control is highly variable, and the pure kinetic assessment may not be a prudent evaluation of DPSI or ankle stability.

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DONIMANT VERSUS NON-DOMINANT FOOT INITIATION OF THE SIT TO WALK MOVEMENT: DIFFERENCES OF THE VERTICAL GROUND REACTION FORCE TEMPORAL PROFILE

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INTRODUCTION: The Sit to Walk (STW) movement is performed about 60 times per day [1] and is a fundamental activity for daily living independence. The STW is often initiated from a staggered feet placement, that is one foot is slightly in front of the other. The foot dominance does not appear to affect the magnitude of the Ground Reaction Forces (GRFs) during a staggered STW initiation [2]; however little is known about the timing of the vertical (Fz) GRF profile. This study aimed to examine the foot dominance effect on the Fz temporal profile when the STW is initiated from a staggered foot placement.

METHODS: Fifteen healthy men and women (22.1+2.2 years) performed STW trials from two staggered foot placements, (a) the dominant foot (DF) slightly in front of the other, and (b) the non-dominant foot (NDF) slightly in front of the other (4 trials per condition, preferred distance between feet). A force plate was used to collect the GRF data (sampling at 1000 Hz, Kistler Type 9286AA). A low pass filter (cut-off frequency at 10Hz) was applied to all data. The extracted variables concerned the total STW and the feet unloading duration (feet backward preparatory action), as well as the duration of the intervals defined by the subsequent Fz dips and peaks (Interval A: Fz 1st dip to Fz first peak, Interval B: Fz 1st peak to Fz 2nd dip, Interval C: Fz 2nd dip to Fz 2nd peak, and Interval D: Fz 2nd peak to STW termination). The timing of the Fz variables was expressed as a percentage of the total STW duration, and the 4 trials' average was used in statistical analysis (SPSS 28.0, $p=0.05$).

RESULTS: The magnitude of all Fz peaks and dips did not differ significantly between the DF and the NDF condition ($p>0.05$). However, in the NDF, the STW duration and the feet-unloading phase were significantly prolonged (+35%, $p=0.035$, +10.5% $p=0.012$, respectively). Except for the significantly longer time to reach the 2nd Fz dip (+19.2%, $p=0.000$), the absolute timing of the Fz peaks and dips was not altered in the NDF condition. However, the temporal profile of the Fz Intervals was significantly altered (shorter Interval A and Interval B, -9.4% $p=0.038$ and -6.3%, $p=0.030$, respectively, and longer Interval C +42.1% $p=0.000$) with no significant alteration for Interval D (+2.3%, $p=0.363$).

CONCLUSION: The foot dominance does not appear to affect the magnitude of the Fz peaks and dips when STW is initiated from a staggered foot placement. However, the significant temporal alterations in the NDF placement most possibly indicate the necessity for more time to address the feet backward preparatory action (feet unloading phase) as well as for a longer propulsion time (Interval C) of the supporting foot at walk initiation [3].

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INERTIALLY SENSED BREATHING 3D LINEAR ACCELERATIONS OF THE ABDOMINAL WALL IN THE HEADSTAND AND THE UPRIGHT STANCE

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INTRODUCTION: In popular fitness modalities, the participants are often required to maintain inverted body stances such as the HeadStand [1]. Inverted body stances challenge breathing mechanics as the respiratory muscles are necessitated to reverse their normal activation pattern, and expiration is resisted rather than assisted by the gravitational force. This study aimed to compare the breathing-related 3D linear acceleration of the abdominal wall between the HeadStand (HS) and the Upright Stance (US).

METHODS: Twenty-five men and women (27.6 ± 7.3 years, all experienced in maintaining the HS for at least 40s) performed normal breathing trials while in the HS and the US (3 trials per body stance). A triaxial inertial sensor (LORD MicroStrain®, 3DM-GX3®-45, sampling at 100 Hz) was used to record the 3D linear acceleration of the abdominal wall [2]. With the participant in the US, the inertial sensor was securely positioned on the left side of the abdominal wall (at 2 cm from the umbilicus and at 2 cm above the umbilicus height). Acceleration signals presented clear peaks and dips that served to visualize the breathing cycles' initiation and termination, as well as to define the first time point of the 30s breathing duration that was extracted for further analysis. All signals were pre-processed (high pass filtering followed by low pass filtering, at 0.5Hz and 6Hz cut-off frequency, respectively, MatLab R2021b). In continuance, across the three trials, the mean and the RMS, as well as each participant's individual coefficient of variation (Acc-IndCV) were estimated for the anterioposterior (AP-Acc), the mediolateral (ML-Acc) and the vertical (V-Acc) linear acceleration of the abdominal wall. Paired t-test was applied for the differences between the HS and the US (SPSS 28.0, $p<0.05$).

RESULTS: In the HS, the ML-Acc, the AP-Acc, and the V-Acc were all significantly increased compared to the US (+15, +15, and +20%, respectively, p=0.00 for all). In both body stances, the values were greater for the V-Acc, with ML-Acc and AP-Acc rising to 75 and 54% of V-Acc and to 56 and 39% of V-Acc, in the HS and the US, respectively. The Acc-IndCV was 12.8, 10.1, and 9.7% in the US, with a significant increase in HS for the AP-Acc (+18%, p=0.013) but not for the ML-Acc (+12.6%, p=0.929) and the V-Acc (+13.4%, p=0.187).

CONCLUSION: Inertial sensing effectively recorded the breathing-related 3D linear acceleration of the abdominal wall, in both the US and the HS. Taken into account that HS may necessitate a greater activation of the abdominal muscles to ensure trunk stabilization, the significant HS differences appear to highlight the greater postural disturbances imposed due to the reversal of normal breathing mechanics [3], as the expiration muscles are counteracted rather than assisted by the gravitational force.

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EFFECT OF AN EXERCISE BOUT ON WALKING SYMMETRY AND REGULARITY FOR PEOPLE WITH TRANS-TIBIAL AMPUTATION

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INTRODUCTION: To be able to walk, people with trans-tibial amputation (PTTA) use a prosthetic limb which does not fully replicate the anatomical limb. The limitations of the prosthetic limb result in compensatory movements which may lead to gait asymmetry, and differences in the repeatability of the stride-to-stride walking pattern. Gait symmetry indicates healthy gait and is often stated as an aim of rehabilitation (1). Increased asymmetry has been associated with increased falls occurrence in PTTA and is considered a key contributor to lower back pain (2), osteoarthritis (3) and osteoporosis (4).

This study aimed to determine if step symmetry and stride regularity were changed after brisk walking (completing a six minute walk test).

METHODS: Data for fourteen active PTTA were analysed. An accelerometer (MSRelectronics, MSR145) was attached to the lower back using double sided tape and recording started prior to initiating the walking test. First, participants were asked to complete a ten-meter walk test at their self-selected walking speed. Second, they completed a six minute walk test (6MWT). Finally, they returned to the start line and performed another the ten-meter walk test.

Data were extracted from the accelerometer and assessed in Matlab 21.0 (R2020b, The Mathworks Inc). Autocorrelation was used to determine the step to step symmetry and the stride to stride repeatability. Vertical, anterior-posterior and mediolateral directions were assessed. Paired t-test was used to determine difference before and after exertion ($p \leq 0.05$).

RESULTS: No significant differences were found for symmetry or regularity in any dimension.

Symmetry pre-post: autocorrelation r=1 indicates perfect regularity and symmetry:

ML r=0.68 - 0.65; AP r= 0.81 - 0.88; Vert 0.73 - 0.70.

Regularity pre-post: autocorrelation mean (SD):

ML r=0.82 - 0.81; AP r= 0.92 - 0.90; Vert r= 0.92 - 0.91.

CONCLUSION: PTTA are encouraged and want to use walking as a health-related activity, as one of the most accessible forms of physical activity. There is little research to investigate if this is a safe activity which is resilient to fatigue. By assessing the risk factors for falling and asymmetrical loading, albeit for a short walking bout, we have found no evidence that walking increases risk for falls or bone health.

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POSTURAL CONTROL IN CHILDHOOD AND ADOLESCENCE

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INTRODUCTION: The development of systems influencing postural control occurs at different ages with the somatosensory system maturing first, followed by the visual and vestibular systems (Hirabayashi & Iwasaki 1995). As visual input predominates over somesthetic information in children, the afferent contributions of the somesthetic system are seriously limited when visual information is available (Foudriat et al. 1993). Our study explored the age-dependent modifications of postural control in healthy children and adolescents.

METHODS: Four sensory conditions were used: eyes open or closed (stresses proprioception) while standing on stable or unstable surface (foam mat; disrupts proprioceptive acuity). Moreover, to evaluate the contribution of proprioceptive inputs, bilateral Achilles tendon vibration (60 Hz) was applied with the eyes closed. Three 60-s trials were conducted in each condition. The following variables were calculated: the Center of Pressure position (CoP), the mean velocity and the standard deviation (SD) of the CoP excursion in antero-posterior and medio-lateral direction.

RESULTS: The CoP velocity was greater in children compared to adolescents in all sensory conditions ($p < 0.05$), while no differences were observed in CoP SD. However, the adolescents presented greater postural displacement due to vibration compared to children ($p < 0.05$).

CONCLUSION: The balance control and the processing of sensory integration are still developing in children, however, it seems that they did not rely primarily on leg muscle proprioception compared to adolescents during postural control.

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HOW TO AFFECT THE DIFFERENT SHOE-LACING ON IMPACT ACCELERATION AND PERCEIVED CONFORT RUNNING?

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INTRODUCTION: The regular practice of running has increased in popularity due to the benefits it brings (1). However, an increase in injuries is observed (2). Several studies present shoe-lacing pattern as a risk factor that it has effects on performance and comfort (3).

METHODS: The study sample consisted of 24 runners (12 men and 12 women). The participants performed a prolonged running test on treadmill (h/p/cosmos pulsar® 3p, h/p/cosmos, Nußdorf, Germany), formed by a warm-up of 5 min at 2,22 m/s and 20 min of running at 2,77 m/s with an incline of 1%. Two shoe-lacing patterns were tested: conventional crossover lacing and heel look lacing. The biomechanical accelerometry variables were collected using Xsens DOT sensors (Xsens Technologies B.V., Enschede, The Netherlands), heart rate by a pulsometer (Polar V800, Polar Electro, UK and perception of effort by a Borg' scale (6-20)(4); throughout the prolonged running test at minute 1, 5, 15 and 20. Finally,

comfort test was recorded after running using a visual analogue scale. The statistical analysis was carried out using the statistical package for social sciences software SPSS V26 (IBM Corp., Armonk, NY). The differences were tested using a repeated measures ANOVA, establishing the shoe-lacing pattern and instant as within-subject factors and the sex of the participants as an between-subject factor, the effect size was calculated using the partial eta squared and a significance level of $p<0.05$ was established.

RESULTS: In relation to the type of shoe-lazing pattern, they didn't influence the heart rate and effort perception variables.

On the other hand, we found that maximum impact peak was higher at right tibia ($p= 0.043$, ES=0.219) and head with the conventional crossover lacing ($p=0.003$, ES= 1.175). The impact magnitude on the head with both legs: right leg ($p= 0.22$, ES= 1.166) and left leg ($p= 0.01$, ES= 0.917) were higher in conventional crossover lacing also. The values to attenuation were higher with left leg ($p=0.038$, ES=1.014) at the heel lock lacing.

Finally, comfort results show a decrease comfort perception at plantar sensation in crossover lacing ($p=0.017$, ES=0.231) and the loop comfort perception was the best comfort at heel lock lacing.

In relation to the instant, the values of heart rate and perception effort increased during time running test, in this sense-head magnitude impact with both legs-right ($p= 0.22$, ES= 1.166) and left ($p= 0.01$, ES= 0.917) were higher at instant 5, and the attenuation values were higher with the impact of the left leg ($p=0.038$, ES=1.014) at all instants.

CONCLUSION: The conventional crossover lacing shows higher peaks impact head. The impact attenuation increases with the heel lock at the beginning and it is maintained during the rest of running test. Finally, these results show that the use of different lacing could modify running impact variables and perceived comfort.

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MEASURING CADENCE IN ROAD CYCLING BASED ON MACHINE LEARNING AND SEAT POST MOTION

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MCI INNSBRUCK

INTRODUCTION: Cadence is a parameter of major interest in cycling. The most common mode of measurement is based on a permanent magnet and a hall effect sensor. Alternative methods utilize the motion of the pedals [1] or measure the angle of the crank arm directly [2]. These given systems have drawbacks regarding costs, exposure or are providing limited information. Therefore, this work conducts a study to examine the possibility of cadence measurement based on the motion of the seat post [3].

METHODS: In a first step, an embedded system was developed to be able to record the motion data as well as the analog cadence signal from a hall effect sensor in a synchronized fashion. Secondly, an experiment was planned out and ethically approved. After all participants had signed a form of consent, the experiment conducted to gather corresponding data. Four road cyclists (males and females, aged from 23 to 57) carried out 13 rides in total and provided 642 minutes of data, comprised of three-dimensional accelerations, spin rates and magnetic flux densities combined with the analog cadence signal from the hall effect sensor. The recorded data was resampled to 50 Hz. The analog cadence signal was preprocessed to get wider impulses in the cadence signal, so the optimizer needs to focus more on the impulses during training. The preprocessed data was subsequently split into training, validation and test sets. The neural network, which was based on a convolutional neural network architecture, using dense and pooling layers in combination with a long short term memory, was trained using a mean squared error loss function and the Adam optimizer [4]. The final network requires merely the last 50 samples of the acceleration data as input and predicts the current analog cadence signal. Based on the predicted and measured cadence signal, the cadence is calculated by counting the number of peaks in both signals within a minute.

RESULTS: The accuracy of the network for the prediction of the cadence signal was 92.9%. The comparison of the predicted cadence to the ground truth above 50 rpm showed an overprediction of cadence by approximately 0.9 rpm on average with a standard deviation of approximately 2.05 rpm.

CONCLUSION: The original goal was to find out whether it is possible to measure cadence based on the motion of the seat post. The results show strong evidence that it is possible, but with limitations regarding the accuracy. Nevertheless, this supports the hypothesis that cadence measurement may be conducted by motion sensors in smart devices, without the need of external measurement systems.

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INERTIALLY SENSED INTER- AND INTRA-TRIAL RELIABILITY OF MOVEMENT PATTERN DURING REPETITIVE SQUATTING

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INTRODUCTION: Repetitive squatting is one of the most widely used exercises in strength, power, and mobility training worldwide, thus triggering the research interest concerning its spatiotemporal pattern [1]. Inertial sensing allows a valid detection of spatiotemporal patterns and may be applied in field settings [2]. This study aimed to estimate the inertially sensed intra-trial reliability of spatiotemporal variables during repetitive squatting to determine the number of trials and repetitions per trial that allows a reliable evaluation of the squat pattern.

METHODS: Thirty active men and women (26±6 yrs) performed 3 trials of 20 squats per trial (preferred tempo). An inertial sensor (Xsens MTw Awinda, sampling at 100Hz, attached to the trunk at L5 level) was used to record the angular displacement trajectories (sagittal plane). Angular displacement demonstrated clear periodic peaks (anterior direction) and dips (posterior direction) and served to define the squat cycle initiation and termination. For each squat cycle (1st and 20th were excluded to eliminate the effect of trial initiation and termination) and after signal pre-processing (2rd-order Butterworth lowpass filter; cut-off frequency at 2 Hz, Matlab R2021b) the following variables were defined: squat cycle duration (tcycle), squat tempo (cycles per minute), absolute (s) and relative (%tcycle) ascent and descent phase duration, and the trunk tilt (degrees). For all variables, the inter- and intra-trial reliability were estimated using the relative (ICC: intraclass correlation coefficient, ICC 2-way random effects absolute agreement method) and the absolute (SEM%: percentage standard error of measurement) reliability index. Both reliability indices were applied for repetition accumulation (2nd to 3rd, 2nd to 4th, ..., 2nd to 19th) for the average of 2 and 3 trials, respectively (SPSS 28.0, $p<0.05$). The ICC values were interpreted as poor (<0.40), fair to good (0.40-0.75), and excellent (>0.75) [3].

RESULTS: Overall, a total of just 2 trials with 3 repetitions per trial proved sufficient for excellent relative reliability (ICCs □ 0.93 across all variables). However, the SEM% indicated a total of 3 trials (3 repetitions per trial) for absolute reliability ranging well below 5% across all variables.

CONCLUSION: The reliability analysis applied for repetition accumulation revealed that 3 trials with 3 repetitions per trial (that is a data collection with 5 repetitions per trial to exclude the 1st and the last one) are sufficient to ensure an excellent - both relative and absolute-inter- and intra-trial reliability across all examined spatiotemporal variables of the squat pattern during repetitive squatting.

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Coaching

RELATIONSHIP BETWEEN ANTHROPOMETRIC CHARACTERISTICS AND BALL VELOCITY IN ELITE ADOLESCENT HANDBALL PLAYERS

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INTRODUCTION: The performance evolution of handball players needs to be studied in many areas such as anthropometric characteristics and ball velocity. The purpose of this study was to investigate the effects of anthropometric characteristics on ball velocity in handball.

METHODS: In this study, 60 handball players age= 17.61±1.53 years, body height =183.77±5.9 cm, body mass = 82.68±9.03 kg, with an average training experience of 6.86 ± 2.03 years and weekly training volume 8.21 ± 2.71 (hrs) participated and were evaluated. The measurements included body height(cm), body mass, body mass index (Kg/m2), arm span(cm), hand length(cm), hand width (cm), five skin folds thicknesses (mm) (biceps, triceps, subscapular, suprailiac and calf), three circumferences(cm) [calf and biceps girth (relaxed and tensed)] and two widths(cm) (femur, humerus). Fat Mass percentage (%), fat free mass (kg), Fat mass (Kg), and Sum of 5SKFS (mm) were all calculated. The precise anatomical sites of measurement by the respective somatometric instruments and the measurement procedures were all carried out according to Norton et al., 2000. Ball velocity was measured using a Radar Gun (Sports Radar 3300, Sports Electronics Inc) with ±0.1 Km/h accuracy within a field of 10o from the gun. The Pearson's correlation coefficients were calculated between all parameters. A stepwise multiple regression analysis with the anthropometric indices as the dependent variables and ball velocity as potential predictors was carried out.

RESULTS: A statistically significant simple positive correlation was found between age (r = 0. 423, p = 0.001), humerus breadth (r = 0. 280, p = 0.030), upper arm flexed and tensed girth (r = 0. 274, p = 0.034), upper arm relaxed girth (r = 0. 307, p = 0.017), fat free mass (r = 0. 483, p = 0.000), fat mass (r = 0. 275, p = 0.033), BMI (r = 0. 356, p = 0.005), hand width (r = 0. 347, p = 0.007), hand length (r = 0. 378, p = 0.003), and ball velocity at standing position, and a negative correlation between weekly training volume and ball velocity at standing position. The multiple linear regression identified that anthropometric characteristics provided good explanatory power for ball velocity at standing position 35% (p =

0.024). The anthropometric characteristic with the highest explanatory power in the regression model for ball velocity at standing position was fat free mass (p = 0.024) followed by age and hand length.

CONCLUSION: Variables related to fat free mass, age, hand length may contribute to handball throwing performance.

STRUCTURAL RELATIONSHIP BETWEEN SUBJECTIVE CONFIDENCE AND OBJECTIVE KNOWLEDGE IN DECISION-MAKING

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INTRODUCTION: During a basketball game, it is necessary to execute instantaneous decision-making to perform effective plays. However, since various situations change instantaneously in basketball games, it is not easy to examine the instantaneous decision-making process. However, subjective confidence and knowledge of decision-making, which are the basis for instantaneous decision-making, can be examined because they are not time-bound and can be taken up as research subjects. Furthermore, it is easy to analogize that the subjective confidence and objective knowledge of decision-making for basketball games differ among basketball players and others. Therefore, the purpose of this study is to clarify the knowledge that is structurally related to the confidence that is important in effective play selection, based on the relationship between both that confidence and knowledge. By doing so, it is possible to identify the objective knowledge that is necessary for PE classes in which students acquire a sense of self-efficacy in improving their own ability for decision-making.

METHODS: The subjects consisted of 346 university students taking PE basketball classes. The content of the 18 subjective confidence questionnaire items was based on a Japanese version of the questionnaire items created by Elferink-Gemser, et al. (2004), and they were revised in order to be specific to basketball skills, which were surveyed with a 5-point scale. The objective knowledge test consisted of 16 multiple-choice tests with 4 items on Offense, 4 items on Defense, 4 items on Transition, and 4 items on Rebounding. From the two sets of data, correlation ratios were computed and a cross table, consisting of 1s for the combinations of items that showed significant values and 0s for the combinations of items that did not, was created. The two-dimensional configuration was displayed, and groupings were made using Quantification Theory Type Three. In grouping, clusters were created using hierarchical cluster analysis to investigate structural associations between subjective confidence and objective knowledge groups.

RESULTS: As a result of cluster analysis, the following four clusters were extracted: "Cluster 1 (C1): General decision-making," "C2: Individual situational judgment," "C3: Instantaneous decision-making" and "C4 Decision-making in interpersonal play." The results suggest that improving subjective confidence, which was classified into four clusters, improves knowledge of each of the decision-making cases necessary for basketball games. In addition, with "C3 Instantaneous decision-making," many of the objective knowledge test items were related, suggesting that the students need to watch the opponents movements during the game and choose the best play to make.

CONCLUSION: Gaining knowledge of decision-making before a game, such as how to defend against opponents and understand transitions, is thought to lead to increased confidence and improved skills.

THE CLASSIFICATION AND PREDICTION OF FACTORS REGARDING AWARENESS OF COMPREHENSIVE COMMUNITY SPORT CLUBS USING A TREE STRUCTURE

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INTRODUCTION: The features of comprehensive community sport clubs (CCSCs) in Japan are that young and old people with an athletic level from poor to excellent can get familiar with sports in their community. CCSCs have been advocated as one measure to promote sports by the Ministry of Education, Culture, Sports, Science and Technology since 1995. They are independently managed by people who live in their communities. However, the degree of awareness of them is not necessarily sufficient and acknowledgement and recognition of them by people are needed prior to promoting them. It is important to discriminate to understand whether CCSCs are using these features. Thus, this study investigated the factors that make people come to recognize the existence of CCSCs using a decision tree. Although multivariate analysis that uses composite scores summing up all weighted variables is usually used, it was thought to be impractical in this case. Therefore, this study used a decision tree method using a few variables to assess it in a practical way.

METHODS: A questionnaire containing the following 10 items in addition to "whether or not CCSCs are known" was conducted: individual features such as "Gender," "Age," "Confidence in physical fitness/sports," "Like or dislike of PE classes in elementary school," "Lessons other than exercise/sports," "Family members who play sports," "Acquisition of information on sport clubs through the media" and "Desire to play sports alone, with two to four others, or with more than five others." The questionnaire was conducted on 1,361 people. Of these, the responses of the 560 people who answered that they do not exercise nor play sports were used for the analysis. While using as few items as possible, a tree structure classifying two groups of people who know about CCSCs and those who do not was derived. A rpart() function in R was used for the analysis and the cp (complexity parameter) was set to 0.001.

RESULTS: As a result, a tree-based model with four layers and four nodes that branch to the right and left in two ways depending on the options to the question was obtained. The correct discriminant rate was 87.3%. Although the specificity to correctly find out the group that did not know about CCSCs was 98.6%, indicating fairly high, the sensitivity to correctly

find out the group that did know of CCSCs was very low at 3.0%, indicating that this tree structure is effective in predicting those who do not know about CCSCs. Since the items included in this tree structure were "Acquisition of information on sport clubs through the media" and "Desire to play sports alone, with two to four others, or with more than five others," people who know about CCSCs often see advertisements for sport clubs, and want to exercise or play sports alone or with fewer people.

CONCLUSION: Contact with information about sport clubs and the desire to exercise or play sports alone or with a small number of people are involved in the awareness of CCSCs.

TRAINING DISTRIBUTION IN ROWERS: A CASE STUDY OF AN OLYMPIC GOLD MEDALIST

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INTRODUCTION: Against the backdrop of the postponement of the Tokyo Olympic Games, the Chinese National Rowing Federation made training measures and load adjustments for the competition year of the Tokyo Olympic cycle. As a result of the load design, Chinese elite rowers won a gold medal and two bronze medals at these Olympic Games. The purpose of this paper is to analyze the overall load differences between the two years of preparation for the Olympic Games using the two-year training cycle of the bronze medal-winning Chinese women rowers as an example

METHODS: METHODS: Subject

Table 1 : Elite rowers personal information

Number Year High body

weight（kg）

X1 24 179 74

X2 30 187 78.4

X3 27 188 80.6

X4 29 181 85

X5 28 181 85

X6 29 181 76

X7 27 180 81

X8 29 185 78.5

Eight female former and current China elite rowers (Table 1). All athletes had won a least one individual Olympic or World Championship senior gold medal during their career.

Design

The training schedule was adjusted to September 2019-August 2020 for the Olympic qualifiers and September 2020-August 2021 for the Olympic competition. During this cycle, the researchers have systematically and accurately recorded the rowers training routines. The training consisted of training time on the water, dynamometer （Concept2） training, strength training, cross training and other training.

RESULTS: For the womens eight-man single scull, the total load for the two competition years was 1243.26 hours and 988.37 hours, respectively. Water training was reduced by 20.18 hours, Concept2 training time was decreased by 98.32 hours, strength training was accelerated by 141.40 hours, cross training was reduced by 3.08 hours, another training was increased by 42.82 hours, stretch regeneration was decreased by 34 hours, and overall training time was reduced by 254.89 hours, according to a comparison of the two competition years.

CONCLUSION: This case study is the first study in Chinese rowing to adjust the load for the summer Olympic Games competition year, and the total load for the two competition years supports the previous conclusion that elite endurance athletes train up to 1000 hours per year and are not significantly altered by changes in Olympic competition time limits.

PERFORMANCE INDICATORS THAT PREDICT SUCCESS DURING COUNTER-ATTACKS IN WORLD CUP MATCHES

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INTRODUCTION: It has been reported that although counter-attacks occur less frequently during soccer matches than organized attacks, they are the most effective style of play for scoring goals, especially against an imbalanced defense. Moreover, as football is a low scoring sport, general measures of offensive effectiveness such as scoring opportunities, shots on goal, and final third pitch entries have been proposed as good indicators. The present study aimed to investigate the factors associated with final third entries during counterattacks during men's, women's and u20 men's World Cup (WC) matches.

METHODS: The sample consisted of 48 knockout World Cup matches (16 Men's WC 2018, 16 Women's WC 2019 and 16 u20 Men's WC 2019). The study design included the analysis of the following indicators: (a) situational indicators, (b) defensive performance indicators, (c) offensive performance indicators, (d) the possession result, "final third entry" or "no final

third entry", was used as a dependent variable. Intra- and inter-reliability of the observational instrument was tested, as described previously, with mean kappa statistics of k=0.95 and k=0.89 classified as "perfect" agreement respectively. Binary logistic regression models were constructed for each tournament included the above performance indicators as predictors and the dichotomous result as the predicted variable. The backward Wald method was used and all assumptions of binary logistic regression were met.

RESULTS: The following indicators increase the likelihood of entering into the final third during counter-attack for each World Cup tournament: (1) Men WC 2018 : low defenders' position, inside penetration zone, low pass number, high penetrative pass number, long duration and offensive half pitch recovery, (2) Women WC 2019 : low defenders' position, inside penetration zone, low pass number, high penetrative pass number, long duration and offensive half pitch recovery, (3) Men u20 2019 : low defenders' position, 4-5 defenders, 1-3 attackers, long duration and offensive half pitch recovery.

CONCLUSION: The regression models identified common indicators in order to increase the likelihood of entering the final third during counter-attack between the three tournaments. No previous study has used final third entry as predicted variable for success during women's and youth's tournaments. Consistent with previous studies, our results revealed agreement for recovering inside opponent's penetration zone and inside offensive half pitch, with high proportion of penetrative passes, participating 1-3 attackers. The present results provide practical implications for training counter-attacks both from offensive and defensive point of view, as well as for coach's decision making prior and during match-play.

A KINEMATIC ANALYSIS OF THE EFFECT OF THE DIFFERENT BALL MASS ON THE KICKING MOTION IN THE SOCCER PLAYER OF ELEMENTARY SCHOOL

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INTRODUCTION: This study was to establish guidelines for proper selection of soccer balls for elementary school students by conducting a kinematic analysis of the form displayed by students of a youth soccer team when kicking two types of balls with differences in mass—a size 4 ball and size 3 ball .

METHODS: Ten youth soccer team players aged 8-11 years, who all kicked using their right foot, were included in this study. On a youth soccer pitch, the participants were asked to perform an instep kick with full strength to hit a stationary soccer ball toward a target 8 m away. Two types of balls were used in the experiment—a size 4 ball weighing 360 g (hereafter, normal) and a size 3 ball weighing 300 g (hereafter, light). The kinematic parameters calculated were the angular velocities of the hip joints of the kicking and supporting legs.

RESULTS: The mean rebound ratio (the ball speed divided by the speed of the toes immediately before impact) was 1.126 ± 0.076 for normal and 1.214 ± 0.049 for light balls. The ratio of these rebound ratios (light/normal) was 1.077. The participants were divided into groups in reference to this ratio: SG group, rebound ratio < 1.077 and WG group, rebound ratio > 1.077. Three participants were selected: one in the SG group whose mean light/normal ratio was close to the mean light/normal ratio of the entire SG group (HS), another in the WG group with the lowest light/normal ratio (SO), and another in the WG group with the highest light/normal ratio (KS). These selected participants were compared as typical examples. With respect to the adduction/abduction angular velocity of the hip joint of the kicking leg on impact, there was no significant difference in the peak value between the normal and light balls for HS from the SG group, while it was apparently higher with the light ball than with the normal ball for SO and KS from the WG group. With respect to the extension/flexion angular velocity of the hip joint of the kicking leg on impact, after an initial large extension angular velocity, HS from the SG group exhibited a gradual decrease in velocity, whereas SO and KS from the WG group demonstrated a sudden decrease. All three selected participants exhibited a high extension/flexion angular velocity of the hip joint of the supporting leg on impact, with no significant difference.

CONCLUSION: For SO and KS from the WG group, the adduction angular velocity of the hip joint of the kicking leg was high on impact with the light ball. For HS from the SG group, the adduction angular velocity of the hip joint of the kicking leg was high with the normal ball. This suggest that the adduction angular velocity of the hip joint of the kicking leg might have been insufficient for the normal ball in the WG group. In particular, SO tended to exhibit a lower adduction angular velocity of the hip joint of the kicking leg with the normal ball, suggesting the effect of the difference in the ball mass.

CHARACTERISTICS AND DIFFERENCES IN THE VERBAL RESPONSES OF EXPERT AND NOVICE BASKETBALL COACHES ELICITED BY COGNITION OF FIXED VTR IMAGES AND VR IMAGES

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INTRODUCTION: In this study, in order to examine how coaches perceive phenomena during a basketball game, we reproduced fixed VTR images that captured the entire space where the phenomena occurred and VR images recorded with a 360-degree omnidirectional camera, and explored the differences in the coaches' verbal responses during viewing of each type of image.

METHODS: The persons to be analyzed are 2 novice coaches and 2 proficient coaches in the college basketball club. As for the image collection method, the practice games of the college basketball were recorded by installing a fixed video camera and a 360-degree omnidirectional camera on the side of the benches where the coaches sit. 4 subjects uttered

while watching the images recorded by a fixed video camera (hereinafter referred to as "fixed VTR images") and the images recorded by a 360-degree omnidirectional camera (hereinafter referred to as "VR images"). The subjects freely utter what they think while watching the recorded game images.

RESULTS: As a result of classifying utterances, there were 9 categories. The categories are situation description, expectations and proposals, prediction, retrospection, praise (general), praise (concrete), instruction, and criticism. The fixed VTR images were able to elicit a certain amount of verbal responses from the novice coaches in categories that objectively captured the phenomena taking place, such as situation description, prediction, and general praise or criticism. Among the proficient coaches, the same verbal responses were elicited during fixed VTR image viewing as during VR image viewing, regardless of category. While viewing the VR images, the novice coaches tended to make fewer verbal responses in all categories, whereas the proficient coaches made similar verbal responses in all categories as they did while viewing the fixed VTR images. In addition, more verbal responses of the expectations and suggestions, praise, and instructions categories were made by the proficient coaches during VR image viewing than during fixed VTR image viewing.

CONCLUSION: 1) From fixed VTR images, both novice and proficient coaches tended to observe phenomena objectively, in terms of being able to describe the situation and offer guidance and criticism.

2) From VR images, proficient coaches tended to offer praise or instructions on the basis of specific individual characteristics of player or team movements.

A STUDY ON PERFORMANCE COMPOSITION OF UNEVEN BARS

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INTRODUCTION: In recent years, there have been big changes in the composition of the uneven bars in womens gymnastics. In particular, the pattern of move between high and low bars (bar change) is clearly different from that of 10 years ago. It is important for gymnasts and coaches to select a training subject suitable for the times at the training field. For that purpose, it is necessary to grasp the trend of performance composition that changes day by day from the results of actual competitions.

This study examined all the performances of top Olympic games over the last 30 years. And we revealed what changes in performance composition have occurred throughout history. In addition to that, by showing the performance trends as of 2023, we aimed to give effective knowledge to the training field.

METHODS: In this study, the following methods were used.

1) Video clips were checked of the performance composition of all gymnasts who participated in the finals of each Olympic event from 1988 to 2021. The performance number was 72.

2) In the performance, we categorized the type of swing elements, support elements, bar change element and dismounts.

3) We clarified the changing trends in acting over the past 30 years and showed the acting trends as of 2023.

RESULTS: As a result of the analysis, it was found that the frequency of performing swing elements has been decreasing, and as of 2021, the percentage during performance was 50%. Among the bar change elements, there was an increasing tendency to "Inner front support on low bar, back circle through handstand with flight to hang on high bar". As of 2021, all finalists have performed the element more than once.

CONCLUSION: The guidelines for future training have been clarified from the trends in the composition of the uneven bars. In other words, rather than emphasizing the practice of swing elements on the high bar, it is better to incorporate many of the element of the "Inner front support - back circle", into the training target.

Through this research, we were able to obtain useful knowledge for training on uneven bars.

A STUDY ON IMPROVEMENT OF TEACHING SKILL OF BALL MOVEMENT IN UNIVERSITY STUDENT AIMED BECOME SPORTS INSTRUCTOR

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INTRODUCTION: The skill coaching ability greatly influences depth of sports experience of the sports instructor himself/herself. In the field of sports practice, immediate response is required for various movements that exhibit complex structures. If coaches and teachers do not have the depth of variations in movement and the diversity of teaching techniques, athletes/students will not improve their movement. Movement using a ball is the basis for developing various sports, so the instruction must be done carefully. It is especially important for young children and those new to movement. There are few studies that show the relationship between sports experience and skill coach ability of sports instructors and improve coaching ability. This study focused on specialized classes related to ball movement instruction in the training course of sports instructors (physical education teachers), and verified the effects based on specific instructional practices.

METHODS: The subjects were 20 university students aiming to become sports coaches or physical education teachers. We extracted the subjective sensory consciousness generated in the ball-throwing movement in teaching practice and analyzed it from a phenomenological standpoint. The observational analysis of movement was conducted by the first author.

Observers focused on the formation and execution of movement images and the results of movement. In addition, we recorded students behavior on repetition after instruction of the movement.

RESULTS: As a result of the analysis, it was found that the skill of ball movement and the build of the movement image were performed. In addition, the subjects showed an increase in variations in movement patterns and repetitive phenomena. From these results, it was found that it is possible to improve movement skill coach for college students who have little sports experience.

CONCLUSION: Through this study, we were able to deepen the sports experience of the sports instructors, and obtained new knowledge to improve their coaching ability of ball movement.

STUDY ON ATHLETIC ABILITY THAT DETERMINE INFANT'S ABILITY OF LONG THROW : EXAMINATION OF CONTRIBUTION BY MULTIPLE REGRESSION ANALYSIS

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INTRODUCTION: The purpose of this study was to examine the motor ability that contributes to infants long throwing ability based on multiple regression analysis.

METHODS: A total of 173 boys and girls aged 3 to 5 years were the participants. To measure long-distance throwing ability, participants were asked to throw a softball ball (hereafter referred to as ball throwing) twice. Out of the two times, good records were adopted. The motor ability test consists of items that can be performed by infants and are commonly used to measure motor ability, such as sprint (25m), standing long jump, long sitting forward flexion, standing on one leg on a pole, maintaining body support, jumping over both legs continuously, and grip strength. Then, multiple regression analysis was performed with the results of ball throwing as the objective variable and the results of each motor ability test as the dependent variable for each age and gender, and partial regression coefficients were obtained. Then, we calculated the standardized regression coefficient (β) and examined the contribution of motor ability to determine throwing ability.

RESULTS: As a result, the ball-throwing record improved with age for both boys and girls. This result is like previous studies such as Fujii (2006). This was particularly noticeable in boys, and the standard deviation tended to increase with age (3; 3.03±1.07m, 4; 5.40±2.18m, 5; 7.64±4.19m). A previous study reported that "because the throwing movement is an ontogenetic movement, its ability contributes to acquired factors". Based on this report, it is suggested that boys experience value for acquiring throwing ability is polarized between boys with high throwing ability and boys with low throwing ability. This was more pronounced with increasing age. The results of multiple regression analysis showed that men and women tended to have different motor abilities that determine throwing ability. Examination of the degree of contribution based on the standardized regression coefficient (β) revealed that grip strength had the highest value in boys ($\beta = 0.499$). Girls showed high values in standing long jump and long sitting forward bending (Standing long jump; $\beta = 0.631$, Long sitting forward bending; $\beta = 0.441$).

CONCLUSION: Grip strength is an index of whole-body muscle strength, and it is possible that boys throwing ability is determined by muscle output rather than kinematic dexterity and coordination. On the other, the standing long jump and long sitting forward bending require dexterity and coordination, suggesting that girls throwing ability is determined by the coordination of body manipulation. From these results, it is conceivable that there is a possibility that there is a gender difference in the performance of throwing ability from infants when there is no difference in physique and muscle mass. This is a finding that will be helpful in teaching for exercise for infants.

FEATURES OF VISUAL SEARCH BEHAVIOR DURING BALL TRACKING IN UNIVERSITY TABLE TENNIS PLAYERS

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INTRODUCTION: Table tennis is a game in which players must quickly and accurately return balls with a racket to scores points; in this context, accurate returns require instantaneous reading of the movement of the opponent, racket, and ball. As such, investigation of the visual search behavior of players to the batted ball is important to consider the ideal prediction method. Hence, the purpose of this study was to clarify the characteristics of the visual search behavior of university table tennis players using a wearable eye-tracking device.

METHODS: In total, 37 players, including 24 university table tennis players (16 men and 8 women) and 13 non-table tennis players (all men), hit 10 balls each under four conditions: forehand stroke (F), backhand stroke (B), F+B, and interpersonal rally (R). A wearable eye tracker (Tobii Pro Glasses3, Tobii Co.) was used to capture the front background image and visual search behavior at 50 frames/s to analyze the ball return duration, ball tracking duration, and tracking rate during play. In addition, the distance between the opponents was divided into five areas (opponent, Area I; opponent's end side, Area II; opponent's net side, Area III; own net side, Area IV; own end side, Area V), and the fixation duration and fixation-duration ratio of the gaze during play were analyzed for each area.

RESULTS: The eye tracking duration for the batted balls and tracking rate for return duration were shorter in elite players than in non-table tennis players (56–65% vs. 72–77%). In addition, regarding the fixation duration of the gaze, non-table tennis players concentrated on the Area I during ball play (F, B, and F+B) and on the Area II during R. However, the table tennis players concentrated on the Area II to the Area III, regardless of the trial.

CONCLUSION: University table tennis players have a shorter eye tracking duration and lower tracking rate than non-table tennis players, meaning that they can identify and predict the ball to return balls more quickly. In addition, non-table tennis players were tracking the ball while keeping their eyes on the opponent and elite table tennis players keeping their eyes near the opponents net. These results suggested that elite college table tennis players mainly focused on the area around the net, and acquired visual information of the opponent and the ball while playing by covering the whole area with peripheral vision.

DECISION-MAKING OF PLAYERS WITH SOCCER AND FUTSAL BACKGROUND

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INTRODUCTION: Acquisition of perceptual-motor skills in sports domains is a multidimensional process. In team sports such as soccer, the development of skills can be enhanced through practice under multi-interacting constraints during task performance (e.g. playing soccer with different formats, dimensions, number of players, and rules such as those of Small Sided Games or futsal). Based on the concept of affordances, futsal enriches the learning process and benefits skill acquisition which may be transferred to the "parent" sport [1]. Transferable elements are mainly motor, perceptual, and conceptual while tasks with similar elements are expected to allow greater transfer between domains. Futsal is an indoor 5-a-side variant of soccer many of its tactical, technical, and perceptual skills replicate the 11-a-side game. Playing with reduced personal space has the potential to improve skills because players are forced to make quicker technical and tactical decisions. Taking into account that decision-making skills part of which consist of recognition and recall skills transfer between sports, it is essential to assess their transferability. The aim of the study was to examine whether the decision-making of players is specific to futsal and/or soccer or whether it may be transferred between them.

METHODS: 26 male players (17.19±0.91yrs) with 7.81±2.32 years of experience, 11 of which had also played futsal (3.09±0.83yrs) participated in this study. The participants viewed 60 life-size (1.5mX1.5m with 0.50cm distance from floor) video sequences of soccer and futsal footage that a panel of UEFA-qualified coaches selected and rated. The videos are based on temporal occlusion decision-making procedures. Each footage started with a 3sec frozen frame with a circled player of which the participant played his role, followed by a 7sec video evolution and ended when a 3sec frozen frame appeared with 3 passing options. During the final 3sec frozen frame, the participants were required to select the option they would execute. ANOVA was used to analyze differences in decision-making tasks according to sports background ($p< 0.05$).

RESULTS: Significant differences were found between groups on decision-making in both futsal ($F= 5.03$, $p< 0.05$) and soccer ($F= 4.67$, $p< 0.05$) footage. Players with a futsal background showed higher decision-making performance in both futsal (115.50±5.24 vs 106.35±5.99) and soccer (234.50±5.93 vs 227.29±9.45) tasks.

CONCLUSION: It seems that although decision-making skills are transferable across sports, the transferability of players with a soccer background was lower. This is probably explained by the fact that futsal constraints are more relevant to soccer and players with a futsal background have developed recognition and pattern recall skills more than players with a soccer background. Additionally, it is possible that acquired visual search behaviors of futsal players may be transferred between sports [2].

1. Yiannaki et al. (2018)

2. Causer & Ford (2014)

EYE TRACKING ANALYSIS DURING VOLLEYBALL SPIKE USING WEARABLE DEVICE -COMPARISON OF BEGINNER, INTERMEDIATE AND ADVANCED PLAYERS-

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INTRODUCTION: In volleyball, visual information is crucial to ensure that the ball is not dropped in your own court and in order to ensure that the ball is dropped in the oppositions court. When receiving instructions on how to perform a spike in volleyball, how many of us remember receiving information on where to look? Therefore, the aim of the study was to determine the gaze characteristics of novice, intermediate and expert volleyball players using a wearable eye tracking device. It was thought that teaching based on new visual information and the analysis of this information may be able to find the key to improving volleyball spike techniques and performance.

METHODS: The experiment was conducted with 21 university students belonging to the Department of Health and Sports Science, divided into 3 groups: beginners (3 adult female kendo players and 4 table tennis players), intermediate (5 adult male baseball players, 1 male tennis player and 1 male handball player) and advanced players (7 male members of volleyball team). Participants were fitted with smart glasses (Tobii Pro Glass 3, Tobii Technology), to analyse their eye gaze dynamics from the first touch to the spike hit. The dwell time that the eye gaze was stationary in certain areas of interest at less than 100 deg/sec was measured. This wearable device in the form of glasses, which uses a stereo imaging method to detect the scotopic pupil using the corneal reflections of two pairs of cameras on the top and bottom of the glasses lenses, which detect eye movement. The participants performed the trials twice, with Phase 1 from the receiver's first touch to the setters touch and Phase 2 from the setters touch to the spike hit, and the eye dwell time and eye dwell locations for each phase were analysed. The spiker's eye dwell locations were: 1) the ball, 2) near the ball, 3) the setter, 4) near the setter, 5) the receiver, 6) others. The definitions of near ball and near setter were defined as two balls around the ball and

the setter, not including when the eyes were on the ball or setter. The eye dwell time was expressed as a % of total time, and a one-way analysis of variance was used to test for significant differences among the beginner, intermediate and advanced groups, with multiple comparisons using the tukeys HSD.

RESULTS: Statistical analysis revealed that in Phase 1, beginners and intermediate players had significantly shorter % eye dwell times of 1) the ball (10.8, 4.2 vs 20.4%) and 4) near the setter (21.5, 10.5 vs 42.7%) than advanced players. In Phase 2, there were no significant differences.

CONCLUSION: This result suggested that the key to a successful spiking action exists in the early spike preparation phase (Phase 1). In addition, while the eye dwell locations of 5) receiver and 6) others for advanced players were 0% and 4.9% respectively, for the beginner and intermediate players they were 15%-20%. It is therefore evident that advanced players limit the number of gaze locations to the relevant information.

CHANGES IN PLAYERS' PERCEIVED RECOVERY AND MUSCLE SORENESS DURING AND AFTER A CONGESTED WEEK IN A U-19 SOCCER TEAM FROM THE CZECH REPUBLIC

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INTRODUCTION: An increase in training load with reduced recovery periods characterizes congested weeks, and it could result in residual fatigue, increasing the risk of match-play injury [1] and non-contact injury [2]. Monitoring the perceived recovery and muscle soreness during this period is essential to understand how players tolerate the stress imposed. Therefore, the study aimed to determine changes in perceived recovery and muscle soreness during and after a congested week.

METHODS: Sixteen Czech male soccer players (age 18.3± 4.1 yr; height 183 ± 5.5 cm; weight 73.5 ± 8.1 kg) from a professional U-19 team were monitored during a 5-days training camp, pre-season. The training included technical/tactical (n=7) and strength and conditioning (n=2) sessions, as well as friendly matches (n=2). A Self-reported Likert Scale from 0 to 10 was used to assess players' perceived recovery (0= poor recovery to 10= maximum recovery) and muscle soreness (0= absence of soreness to 10= very intense soreness). Total distance (m) and sprint (m) derived from a global positioning system (GPS) was used as load indicator from technical/tactical sessions and matches. Repeated measures ANOVA was used to compare the days, with Bonferroni post-hoc to detect significant differences. Significance was set at $p<0.05$.

RESULTS: During the 5-day, load indicators were progressively reduced (total distance, day 1= 5.444 ± 680 m and day 5 = 3.470 ± 876 m; sprint, day 1= 420 ± 154m and day 5= 72 ± 138m). Recovery was significantly impaired ($F=21.2$; $p<0.001$) after day 1 (7.73 ± 1.91) and continued during the days (day 2= 4± 0.9; day 3= 4.2± 0.9; day 4= 4.4 ± 1.3; day 5= 3.7 ±1.0 u.a) returning to normal values after one-day resting (7.7 ± 1.0). Similarly, the soreness increased significantly ($F=22.2$; $p<0.001$) after day 1 (2.2 ± 1.7) and continued during the days (day 2= 6.5 ± 1.4; day 3= 6.4± 1.3; day 4= 6.3 ± 1.0; day 5= 7.0 ±0.9 u.a) returning to normal values after one-day resting (2.4 ± 0.8).

CONCLUSION: A congested week demonstrated impairment in players' perceived recovery and muscle soreness after day 1 and remained across 5 days. Even though the load decreased progressively, it can suggest that players presented cumulative fatigue according to the perceptual measures. However, besides the significant reduction in players' recovery and increased muscle soreness, a subsequent return to initial conditions occurred by taking one day of rest after the congested week.

Disabilities

KNOWLEDGE ABOUT SLEEP HYGIENE AND SLEEP BEHAVIORS OF PARALYMPIC ATHLETES: TOKYO 2020 PARALYMPIC GAMES

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INTRODUCTION: Paralympic athletes have a high rate of sleep complaints, poor sleep quality, excessive daytime sleepiness, and acute or chronic sleep restriction (1). Sleep disorders in this population have been associated with the occurrence and severity of health problems (2). Sleep hygiene strategies (SHS), such as counseling on behaviors, lifestyle, and environmental factors that can positively influence sleep (3), and improving sleep quality is associated with better sports performance. Therefore, our objective was to evaluate the knowledge about sleep hygiene and the sleep behaviors practiced by medalist and non-medalist para-athletes at the Tokyo 2020 Paralympic Games.

METHODS: This is a cross-sectional study with 98 Paralympic athletes, who represent 52% of the paralympic athletes summoned by the Brazilian Paralympic Committee. Among them, 30 won a medal at the Paralympic Games. All had physical-motor disabilities, and competed in athletics (n = 34), sitting volleyball (n = 26), swimming (n = 14), wheelchair tennis (n = 6), table tennis (n = 8), and bocce (n = 8). =7), fencing (n = 2), and parataekwondo (n = 1). Through an online form, they answered the Sleep Beliefs Scale, the Athletes Sleep Behavior Questionnaire, and a structured questionnaire to investigate the frequency of SHS one month before the trip to the Tokyo 2020 Paralympic Games.

RESULTS: Paralympic athletes had low global knowledge about SHS (57% correct answers), as well as low knowledge about behaviors incompatible with sleep (68%), sleep-wake cycle behaviors (54%), thoughts and attitudes related to sleep

(50%), and high frequency of maladaptive sleep behaviors (48.7 ± 5.9). 26% of Paralympic athletes consider SHS necessary, and the frequency of the technical committee encouraging SHS was significantly higher among medalist Paralympic athletes compared to non-medalists (29% vs. 13%, p = 0.04).

CONCLUSION: Paralympic athletes had low knowledge about SH, a high frequency of behaviors negatively influencing sleep, and few considered SH important. In addition, medalist para-athletes had more significant SHS incentives when compared to non-medalists. This way, technical committee members can combat behaviors negatively influencing sleep through SHS.

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EFFECTS ON BODY TEMPERATURE OF PROTECTING THE SKIN OF PERSONS WITH SPINAL CORD INJURY TO PROMOTE PHYSICAL ACTIVITY IN A HOT ENVIRONMENT

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INTRODUCTION: Spinal cord injured persons have a marked increase in deep body temperature due to reduced sweating and dysfunctional vasomotor activity in the paralyzed area, which is greatly influenced by exercise and ambient temperature. To eliminate the limitation of physical activity in a hot environment, it is necessary to develop a strategy for body cooling in persons with spinal cord injury. This study examined the effect of skin protection to reduce the increase in core temperature in persons with high spinal cord injury in a hot environment.

METHODS: The subjects were three persons with cervical cord injury. Subjects spent 30 minutes in an environment with an outside temperature of 35.0±0.2 °C in a control condition with no measures, a condition with long sleeves and long pants covering the skin, and a condition with clothing covering the skin and wearing an ice vest. Measurements included core temperature, tympanic temperature, mean skin temperature, heart rate, and 9-point thermal sensation. Mean skin temperatures were calculated from the skin temperatures of the chest, upper arms, thighs, and calves.

RESULTS: Compared to the 27.0°Cindoor baseline (32.06 ± 0.40°C), skin temperatures in the control condition were significantly higher (38.03 ± 1.48°C). In particular, skin temperatures on the chest and thighs were above 40°C. The skin temperature in the clothing-covered condition increased to 36.28±0.15°C, but was 2°C lower than in the control condition. When an ice vest was used in combination with the clothing, skin temperatures remained at levels similar to those of abled-bodied persons. On the other hand, inspiratory temperature increased significantly (38.02±0.44°C) from baseline (36.10±0.34°C) in all conditions, influenced by radiant heat, although there was some sweating from the head.

CONCLUSION: In a hot environment, SCI with impaired thermoregulatory function has a significant increase in skin temperature, due to the large influence of radiant heat. Core temperature also increases significantly as skin temperature. However, the skin temperature increase was suppressed by simply covering the skin with clothing, and remained at the same level as that of able-bodied subjects. The same effect can be obtained with a breathable towel instead of clothing. Measures to control the increase in tympanic temperature by shielding the head from insolation exposure may also be necessary. Furthermore, the combination of an ice vest suppressed the increase in core temperature. These results not only contribute to outdoor activities in SCI, but also to the improvement of quality of life.

SPRINT-INTERVAL TRAINING AFFECTS CARDIORESPIRATORY COORDINATION IN OLDER ADULTS WITH INTELLECTUAL DISABILITIES

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INTRODUCTION: Older adults with intellectual disabilities (ID) have lower fitness levels and a greater likelihood of suffering from cardiovascular disease than older adults without disabilities (1). Implementing continuous aerobic training (CAT) or sprint interval training (SIT) could benefit the cardiac and respiratory systems. Currently, there is no research studying the effects of exercise on the coordination between the cardiac and respiratory systems in older adults with ID. Cardiorespiratory coordination (CRC), evaluated through principal components analysis (PCA), measures the co-variation of cardiorespiratory variables during exercise.

Objective: to investigate and compare the effects of two different exercise programs on CRC in older adults with ID during a maximal cardiorespiratory exercise test.

METHODS: This is a tree-arm randomized controlled trial. Seventy-one older adults with ID were randomly divided into three groups (CAT=24, 47.88±6.36 y.o.; SIT=23, 51.87±7.36 y.o.; Control=24, 49.92±6.58 y.o.). Participants completed a progressive maximal cycling test before and after the training period (72 sessions; 3 times/week; 90 min). The SIT performed bouts of 5 to 10-min of exercise consisting of 5 to 20-s all-out sprints followed by 15 to 60-s of low cadence recovery. The CAT performed aerobic bouts of 5 to 10-min at intensities of 55-85% of the HR reserve. PCA was performed on the time series of selected cardiorespiratory variables: ventilation per minute, the expired fraction of O2, the expired fraction of CO2, and heart rate. The number of PCs and the first PC Eigenvalues (PC1) were computed for each group before and after the training intervention.

RESULTS: The SIT (18.6 vs 23.8 ml/kg/min, $p<0.001$) and the CAT (18.5 vs 21.3 ml/kg/min, $p<0.001$) improved their cardiorespiratory fitness. SIT reduced the number of PCs from two to one, and increased PC1 Eigenvalues (2.64 ± 0.31 Vs 2.84 ± 0.25; Z=146, p=0.009; d=0.7). Notably, CAT and Control did not decrease the number of PCs or improved PC1 Eigenvalues after the training period.

CONCLUSION: These results show that 72 sessions of SIT or CAT are able to improve the cardiorespiratory fitness of older adults with ID. Nevertheless, the SIT was the only group improving the CRC during the cycle ergometer tests. As reported previously (2), the coordination and network interactions between subsystems are important indicators of physiological state and function. Since alterations in cardiorespiratory coordination may differ based on the type of training intervention, analyzing cardiorespiratory coordination along with other performance metrics can provide a more accurate assessment of physiological adaptations following CAT or SIT interventions.

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Health and Fitness

EFFECT OF A SIX-WEEK CROSSFIT TRAINING ON THE BLOOD LIPID PROFILE AND ATHEROGENIC INDEX OF PLASMA (AIP) IN PHYSICALLY ACTIVE MEN

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INTRODUCTION: Research shows that regular low or moderate-intensity exercises improve blood lipid profiles while regular high-intensity intermittent exercises reduce atherogenic indexes [1]. A popular multimodal form of high intensity training is CrossFit, which consists of various physical exercises performed in a circuit format with or without short rest periods [2]. Our study sought to determine the effect of a 6-week CrossFit workout programme on the blood lipid profile and atherogenic index of plasma (AIP) in healthy young men.

METHODS: Ten young men (aged 24.1 ± 1.7 years, body height 183 0 ± 7.8 cm, BMI 24.7 ± 2.0 kg/m2) participated in a workout programme based on the CrossFit training guide that recommends a five-day-on and two-day-off pattern. Training units of about 50 minutes started with a warm-up and ended with intense full-body stretching. Each training unit involved one, two, or three of the following, distinct modalities: monostructural metabolic conditioning, gymnastics, and weightlifting. Venous blood samples were collected from the participants at baseline and week 6 and were analysed for the concentrations of total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL), and triglycerides (TG). To determine participants' risk of developing vascular disease, the lipid ratios (TC/HDL-C), LDL-C/HDL-C, TG/-HDL-C), and the atherogenic index of plasma [AIP=log10(TG/HDL) with TG and HDL-C expressed in molar concentrations] were calculated.

RESULTS: The baseline levels of the lipid profile components were within reference ranges (TC ≥ 190 mg/dl, TG ≥ 150 mg/dl, LDL-C ≥ 100 mg/dl) in all participants. The concentrations of TC, TG, and LDL-C, all lipid ratios (TC/HDL-C), LDL-C/HDL-C, TG/HDL-C), and AIPs obtained post-intervention were lower than at baseline, but the changes were not signficant. A 4.1% increase in the concentration of HDL-C was observed.

CONCLUSION: A combination of aerobic and strength exercises during CrossFit workouts is reported to improve aerobic and anaerobic endurance, the activity of mitochondrial enzymes, and insulin sensitivity in overweight men [3]. Therefore, it can also be expected to improve lipid ratios that, together with the AIP, are the best risk predictors of coronary artery disease (CVD). An improvement in blood lipid profiles and reduction in participants' AIPs by an average of 57% showed that CrossFit training can moderate decrease the risk of developing CVD.

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THE INFLUENCE OF A SERIES OF TEN SAUNA BATHS ON HEMATOLOGICAL BIOMARKERS AND CHANGES OF PLASMA VOLUME FOLLOWING A SUBMAXIMAL EXERCISE TEST IN ELITE ATHLETES

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INTRODUCTION: It is known that numerous conditions, including environment, exercise and training, can affect changes in plasma volume. These modulations pose a particular problem when trying to determine the consequences of incorporating regular sauna bathing into the training process of elite athletes. Elite athletes often have developed certain thermal adaptations as a result of their long-term training history, which may limit the effectiveness of thermal interventions (HA), such as plasma volume increases, or greatly hinder the ability to identify the beneficial effects of HA on the body. The purpose of this study was to examine the effects of a series of ten sauna baths on selected hematological biomarkers and changes of plasma volume following a submaximal exercise test in elite athletes.

METHODS: The study included 14 male professional cross-country skiers (VO2max 64.5 ± 6.33 ml/kg/min). Selected hematological (Hb, RBC, HCT, MCV, RBCSD) and biochemical (TPP, ALB) biomarkers were studied twice: before [C] and after completed ten Finnish sauna baths [MT] with two days of rest between 5-6 heat exposures. In each phase participants performed a running exercise in thermoneutral conditions at the predetermined intensity, below HR-AT for ~60 min. The average heat stress (HS) session lasted ~35 min (internal temperature >38.5 oC). Sauna baths took place in the afternoon after part of the days training session in the transition (TP) and preparatory (PP) phase of the training program. Blood samples were taken: at rest (t0), post-exercise (t1), 1 hr (t2) and 24 hr (t3) of recovery, in each series of experiments, respectively. Relative changes in plasma volume (del PV%) were calculated according to the formula of Dill and Costil (1974).

RESULTS: The results of this study indicated that there were significant differences in resting hematological biomarkers between the TP and PP phases for RBC [$p<0.05$], MCV [$p<0.05$] and RCBSD [$p<0.05$]. The PV had increased after MT by 2.38%, <+1.5 +3.72> in both TP and PP phases. The regular MT had impact on resting Hb [$p=0.06$] and TPP [$p= 0.04$] in the TP phase. No significant difference was found between the TP and PP phase in del PV% either in control or after MT, immediately after exercise (t0-t1), and after 1 h recovery (t0-t2). The plasma volume increased after 24h recovery [+0.69% vs +3.92%; $p<0.05$] mainly in TP.

CONCLUSION: The results of the present study indicate that ten sauna baths included in the annual training program induced in a small expansion of PV in elite cross-country skiers. However, MT had an effect on post-exercise plasma volume recovery after a submaximal exercise test. This effect was noted mainly during the transition phase of the training program.

EFFECTS ON EXERCISE ON AD7C-NTP LEVELS AND COGNITIVE FUNCTION AMONG ACTIVE ELDERLY KOREAN ADULTS

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INTRODUCTION: Alzheimer-associated neuronal thread protein (AD7c-NTP) has been demonstrated to have high diagnostic accuracy in patients with Alzheimer's disease (AD). This protein has been found to be elevated in the urine from AD and Mild Cognitive Impairment (MCI) patients. Furthermore, this protein has been demonstrated to increase with age in a healthy population. However, it is unclear whether exercise has an effect on the level of AD7c-NTP among active elderly adults. Objective of study was to assess the effect of exercise on cognitive function and AD7c-NTP levels in urine among active elderly Korean adults, and to examine the correlation between Korean Mini-Mental State Exam (K-MMSE) scores and AD7c-NTP levels in urine in active elderly Korean adults.

METHODS: In total, 40 elderly adults whose activity levels were above ≥ 600 MET-minutes/week were selected and divided into three groups: Control group (CG, n=10), Resistance + Aerobic exercise group (RAG, n=12), aerobic exercise group (AG, n=18). CG performed dynamic stretching 2 times/week. RAG visited the center and performed Thera-band resistance exercise 2 times/week, as well as walking exercise according to the walking guidelines. AG performed walking exercise according to walking guidelines. A total of 12 weeks of exercise intervention were implemented. At week 0 and 12, body composition (weight, muscle mass, body fat percentage), Korean Mini-Mental State Exam (K-MMSE) and Stroop test were measured and a morning urine sample was obtained from each subject. The level of AD7c-NTP was measured using competitive ELISA. SPSS version 29 was used as a statistical tool. Two-way repeated measures ANOVA was used to see the group interaction by time. One-way ANOVA was used to see the group interaction before and after exercise. Bonferroni post-hoc test was used to see the group difference.

RESULTS: After 12 weeks of exercise intervention, there was a significant difference on the level of AD7c-NTP between RAG (1.04 ± 0.73 ng/ml) and CG (2.16 ± 1.23 ng/ml) ($p=.026$), AG (1.16 ± 0.90 ng/ml) and CG (2.16 ± 1.23 ng/ml) ($p=.032$) respectively. The AD7c-NTP levels in urine showed negative correlation with K-MMSE scores ($r=-.390$, $p=.013$) in all participants after exercise intervention. Furthermore, the activity levels showed positive correlation with muscle mass ($r=.316$, $p=.047$) and negative correlation with body fat percentage ($r=-.362$, $p=.022$) in all participants after exercise intervention. However, there was no significant difference of body composition and cognitive function tests (K-MMSE, Stroop test) between groups after exercise interventon

CONCLUSION: This is the first study looking at exercise effect on AD7c-NTP levels in urine among active elderly adults. This study demonstrates that exercise has an effect on the level of AD7c-NTP between groups and there is a negative correlation between AD7c-NTP levels and K-MMSE scores. However, further research is required with larger number of sample size and long-term intervention.

THE COVID-19 EFFECT ON HEALTH- AND RISK BEHAVIOUR AND LIFE SITUATION OF UNIVERSITY STUDENTS IN HUNGARY

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INTRODUCTION: Covid-19 increased the Hungarian mortality rate in 2021 and induced significant changes in our lifestyle during and following the prescribed countrywide shutdown (HCSO 2022). In collaboration with international researchers, we wanted to know how university students' health and risk behaviours and their life situations changed due to the pandemic.

METHODS: The Brigham Young University researchers created the questionnaire; the Hungarian version was approved by the Hungarian University of Sports Science ethical committee (TE-KEB/04/2022). Full time university students completed the online questionnaire in April 2022 (n = 245; 54% women; mean age 21,90±3,13 yr). We analyzed the data with SPSS v25 using descriptive statistics and independent t tests.

RESULTS: According to our results, 75% of males and 84% of females belonged to the normal nutritional status category. Of the students, 8.2% smoked and 60% consumed alcohol regularly. We found that access and opportunity to study and work were not affected by Covid-19, however, according to 51% of respondents, the number of their in-person meetings decreased. About 65% indicated their free time activity did not change, they spent the same time outside and inside as before Covid-19. Responses from 58% of the students indicated their physical activity did not change and 62% said their recreational time remained the same. The prevalence of smoking increased by 1.6% and the prevalence of alcohol consumption increased by 11.6% during and following the pandemic.

CONCLUSION: Based on this study, we conclude there were no significant changes in health and risk behaviours and in life situations among this population.

HCSO 2022: Hungarian Central Statistical Office https://www.ksh.hu/stadat_files/nep/en/nep0009.html

COMPARISON OF MOTIVATION AND GENDER DIFFERENCES AMONG UNIVERSITY STUDENTS ATTENDING PHYSICAL ACTIVITIES COMPULSORILY AND VOLUNTARILY

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INTRODUCTION: This study aimed to examine the effects of gender on university students motives for participating in organised mandatory and voluntary physical activities (PAs).

METHODS: A total of 434 respondents were participating in compulsory PAs (73 men, mean age: 21.6±2.2 years old; BMI=18.3±1.0 kg/m2; 150 women; mean age: 19.0±1.8 years old; BMI=20.2±2.8 kg/m2) and voluntary PAs (38 men, mean age: 19.4±1.6 years old; BMI=21.7±2.3 kg/m2; 42 women; mean age: 19.2±1.6 years old; BMI=20.3±1.7 kg/m2). They completed the Exercise Motivation Inventory-2 (EMI-2; Markland & Ingledew, 1997) and some demographic data during the first meeting. The type of PAs consisted of various racket games and physical fitness.

RESULTS: The results of the MANOVAs test showed a significant main gender effect on the combined dependent variables, Wilks Lambda = .88, $F(15, 416) = 3.74$, $p = .000$, $\eta 2 = .012$; a significant main effect for two types of activities, Wilks Lambda = .91, $F(15, 416) = 2.70$, $p = .001$, $\eta 2 = .089$; and non-significant interaction of gender and two-type of activities, Wilks Lambda = .96, $F(15, 217) = 1.11$, $p = .343$, $\eta 2 = .039$. These results indicated that exercise motivations varied by both gender and two-type of activities.

Univariate tests showed significant activity effects for 4 of the 14 motives. Respondents reported greater motivation to join voluntary PAs than mandatory PAs for revitalization, enjoyment, strength and endurance, with the most significant effect size difference for health pressure. In contrast, respondents rated health pressure higher as motivation to participate in mandatory PAs.

Analyses revealed significant gender effects for four motivational subscales. Male respondents rated higher levels of motivation than female respondents for the subscale of challenge, competition, social recognition and affiliation, with the most significant effect size difference for competition subscale.

In addition to these main effects, we found a significant two-type of activities by gender interaction for seven variables. Follow-up comparison scores indicated that female respondents participating in compulsory PAs rated the lowest motivation levels than other respondents for enjoyment, challenge, social recognition, affiliation and competition subscales. In contrast, male respondents attending mandatory PAs indicated higher motivation levels than other respondents for health pressure and nimbleness. Among all the respondents, the highest and lowest motives were positive health and health pressure, respectively.

CONCLUSION: All respondents were motivated to participate in the PAs compulsorily or voluntarily by an intrinsic factor such as health benefits. Still, they reported low levels of perceived pressure to be healthy.

THE EFFECTS OF A GUIDED EXERCISE PROGRAM ON FITNESS LEVEL AND ON SELF-ESTEEM IN MENOPAUSE: A LONGITUDINAL STUDY

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INTRODUCTION: A mix of physical, emotional and psychological changes take place during menopause. The reduction in oestrogen results these changes and may have effect on overall quality of life. Hormone replacement therapy, could be effective against the negative symptoms, however, the earlier publised side effects has resulted alternative treatment methods, such as regular exercise. The purpose of this study was to see whether is any changes in fitness level and physical self-esteem after a 1.5 year long exercise program.

METHODS: During the intervention, participants attended 2x1 hours of resistance training and 1x1.5 hours endurance training (i.e. cycling, walking) per week. Resistance training was executed with various strength-training tools, as well as, with participants' own bodyweight. Fitness test contained a sit and reach test (flexibility), a 2-minute step test (endurance), and handgrip measurement (strength). Body composition was measured with a TANITA BC-545N bio-impedance scale. Physical Self –Description (PSD) was measured with the short version of PSDQ by Marsh et al. (2010). Data were collected in June 2021 (N=20), in June 2022 (N=13) and in December 2022 (N=11). Descriptive statistics (means ± SEM) calculated for each variable and Wilcoxon test was used to analyze the data of fitness level and to see differences in PSDQ data through the intervention period.

RESULTS: Significant improvement was detected in all fitness tests: in flexibility, in strength and in endurance (cm: 12.4±2.5 vs. 21.1±4.8; N: 28.8±4.5 vs. 30.7±10.6; times: 82.9±3.6 vs. 124.26.5, respectively). Although the mean body weight decreased, it did not reach the significant level (kg:70.8±2.9; 67.9± 3.2; 67.6± 4.3). Significant difference were seen in muscle mass (kg:7.8±2.9 vs. 47.0±5.5) and in body fat percentage (33.63± 3.8 vs. 36.0± 6.5). BMI (29.6± 3.8; 29.6± 5.5; 30.8± 7.0), and bone mass (kg:2.4; 2.4; 2.2) slightly changed but none of them reached the significant level. Self-description of the women changed significantly over the intervention period and in 14 cases showed significantly better values at the end of the first year and additional 4 cases at the end of the 1.5 year period. These cases clustered in „Action, Global Esteem and Physical Esteem" which fit to the objectively measured data, however, participants underestimated their development in flexibility.

CONCLUSION: The high drop-out rate indicates that women in menopause with less experience in sport and a lower fitness level might need more attention to support their progression in lifestyle changing. Furthermore we concluded that both fitness level and self-esteem of postmenopausal women could be improved with a regular and guided exercise program.

EFFECT OF TIME-EFFICIENT OCCUPATIONAL EXERCISE ON CARDIORESPIRATORY FITNESS IN FIREFIGHTERS

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INTRODUCTION: Firefighters require a good level of cardiorespiratory fitness (VO2peak) for safe occupational performance and to pass annual fitness examinations. High intensity interval training (HIIT) is a time-efficient and potent exercise stimulus to increase fitness in healthy adults. The aim of this study was to investigate the effects of a novel workplace based HIIT intervention on cardiorespiratory fitness with a population of operational firefighters during their tour of duty. We also aimed to determine affective (pleasure and displeasure) responses to HIIT because a high degree of discomfort might lead to poor exercise adherence.

METHODS: Fifteen active firefighters were randomly allocated to either HIIT or moderate intensity continuous training (MICT) performed eight times over 4-weeks. HIIT involved 10 × 20 s intervals at maximal intensity interspersed with 40 s of recovery at low intensity, whereas MICT involved continuous exercise at 65% maximal heart rate. This training frequency was chosen to accommodate the on-duty shift pattern for the firefighters involved in the study. Exercise was completed on shift with two sessions performed on each tour of duty (i.e., one day and one night shift each week, leaving one day of rest in between). VO2peak and time trial performance were the primary outcome measures. Affective (pleasure/displeasure) responses to exercise were a secondary outcome.

RESULTS: A two-way mixed (condition x time) ANOVA showed a moderate increase in VO2peak for HIIT (6%) and MICT (8%) although this did not reach statistical significance ($P = 0.06$, $\eta 2 = 0.26$). A significant main effect for time trial performance ($P < 0.01$, $\eta 2 = 0.51$) was observed for HIIT and MICT (2% for both groups). Affective responses were more favourable for HIIT, but both exercise conditions avoided excessive sensations of displeasure. Differences between groups were not significant.

CONCLUSION: Despite a significantly reduced time commitment, 4-weeks of workplace based HIIT improved VO2peak and time-trial performance to a similar magnitude as MICT. This study highlights a novel exercise strategy that is time-efficient whilst avoiding overly negative affective responses with potential to improve occupational health of firefighters. Furthermore, implementation of this exercise strategy was feasible within the working firefighter environment with high adherence and no adverse effects reported.

COULD A SINGLE SESSION OF BALANCE AND COORDINATION EXERCISES IMPROVE ATTENTION IN OLDER ADULTS?

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INTRODUCTION: The cognitive decline that is characteristic of older adults has led researchers to seek methods for improving cognitive functions in this population in the short and long term. One broadly studied aspect relates to physical activity interventions and their impact on cognitive functions in older adults. This study examines the effect of a single session of balance and coordination exercises on cognitive functions in older adults, compared to that of a single session of aerobic exercises or a single control session of reading.

METHODS: The study included 30 physically active participants (23 females), with an average age of 73 (±5) years. The participants completed computerized cognitive tests to assess attention and executive functions in five separate sessions: two without interventions and three with interventions (aerobic exercise; balance and coordination; and reading while sitting). The interval between each session was at least two weeks. The order of interventions between participants was random.

RESULTS: While no differences were seen between the three types of intervention in executive function scores, our findings indicate that a single session of aerobic exercises and a single session of balance and coordination exercises led to higher scores on the attention test than in the control condition.

CONCLUSION: The present findings support and enhance the literature on improved attention in healthy older adults following a single aerobic exercise session, indicating the positive effect of a single balance and coordination exercise on attention among healthy older adults. As such, in addition to the importance of balance and coordination training in older adults, these findings could be used to encourage the developing of balance and coordination exercise programs for adults in general. Future research should be designed to assess the effect of chronic balance and coordination on cognitive function among older adults.

OBESITY AND NUTRITIONAL STATUS OF HUNGARIAN TEACHERS

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ELTE SEK PPK

INTRODUCTION: The epidemic of obesity is one of the most serious health problems worldwide and the World Health Organization predicts that it will continue to increase in the coming decades. Hungary has the highest proportion of obese people among the adult population in Europe.

Several causes contribute to the development of overweight, such as genetic, hormonal, psychological, sociocultural economic or environmental factors, which cannot be influenced by the individual. Today, almost 40 percent of young adults in Hungary and more than 70 percent of those over the age of 65 struggle with excess weight.

The aim of our research is to present the nutritional status of Hungarian teachers. The research was primarily conducted following the health promotion guidelines outlined in the Ottawa Charter, with a special focus on the workplace, one of the most important aspects that affect quality of life in many ways.

METHODS: Our research was conducted in 2020-2021 among Hungarian teachers. Participants were selected by random sampling. The sample included teachers from both lower and upper primary school, and secondary school as well. Participants body composition was determined using the Inbody 720 Body Composition Analyzer. After measuring the body height, the subject was put on the body composition measuring machine, where the measurement was started after entering the personal data. In the study we recorded participants height (BH/cm), fat-free weight (FFM/kg), fat mass (BFM/kg), body weight (BW/kg), muscle mass (SMM/kg), body mass index (BMI), body fat percentage (PBF%), waist-to-hip ratio (WHR), visceral fat (VFA/cm2), and obesity degree (%). Based on the data, we obtained a complex picture of the nutritional status of the individuals, through which, among other things, the degree of early obesity can be diagnosed.

RESULTS: The sample's average age was 43.9 years (female: 43.07 years; male: 44.8 years). The average weight was 56.6 kg (female: 46.4 kg; male: 66.6 kg) and had an average height of 172.5 cm (female: 167.3 cm; male: 177.8 cm). The average body fat percentage (PBF%) was 25.65% (female: 30.6%; male: 20.7%).

Based on the results it can be stated that there is a significant relationship between body fat mass and age in the examined sample ($p<0.0027$), and between waist-to-hip ratio (WHR) and visceral fat (VFA/cm2) ($p <0.001$) as well as body fat mass (BFM/kg) ($p<0.003$). With regards to gender, it can be stated that there is a significant correlation between womens lean fat mass and age ($p<0.002$). For men, we found no relationship between the two data.

CONCLUSION: Based on our results it can be stated that age is a key risk factor in the development of overweight and obesity. The data shows that the accumulated fat mass concentrates in the abdominal area, which poses an increased risk factor regarding the development of metabolic diseases. To stop or reverse this trend, targeted interventions are needed among the Hungarian population of working age

BROWN ADIPOSE TISSUE ACTIVATION DETECTED BY THERMAL IMAGING IN TACTICAL ATHLETES

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INTRODUCTION: Military personnel are recognized as tactical athletes because they have high physical and performance demands daily, like sprint run, bypass obstacles and movements under load. Though, this group had a high prevalence of obesity. Brown adipose tissue (BAT) is the new target in the quest to increase caloric expenditure and reduce body fat. It is inversely correlated with body mass index, but it is still not clear what correlation with Fat Mass Index (FMI). Infrared thermography (IRT) can detect BAT activation using cold stimulation. The purpose of this study was to compare BAT activation by cold stimulation evaluated by IRT in military men.

METHODS: Seventy-two military men from Brazilian Army were classified by FMI rages, Normal (35.9 ± 5.9 years, FMI: 4.84 ± 0.8 kg/m2), Fat Excess (35.8 ± 7.6 years, FMI: 7.68 ± 0.7 kg/m2) and Obesity (36.2 ± 10.1 years, FMI: 11.8 ± 2.8 kg/m2). Mean skin temperature in the supraclavicular right region (SCVTR), left region (SCVTL) and Sternum (STRT), determined as the control region, was measured by infrared camera E75 FLIR®, immediately after volunteers remained 30min in a thermoneutral environment (22.6 ± 0.2ºC) for acclimation. Then, after five minutes both hands submerged in a container with ice water at 13.0 ± 0.4ºC the temperatures were revaluated. The blood biomarkers were assessed and body composition using double X-ray absorptiometry was evaluated. Shapiro-Wilk normality test was applied and confirmed parametric approach. Two-way repeated measures ANOVA with Tukey post-hoc comparisons were conducted. The level of significance was $p< 0.05$.

RESULTS: The obesity group had lower mean skin temperatures and worse metabolic indicators than compared to the other two groups. There was a significant interaction between group factor (FMI) vs group moment (BAT activation) in the region SCVTR ($F(2,69) = 4.21$, $p < 0.001$, $\eta2 =0.010$) and SCVTL ($F(2,69) = 4.81$, $p=0.011$, $\eta2=0.013$). No interaction was found between groups STRT ($F(2,69) = 0.01$, $p= 0.986$, $\eta2 =0.00$). Only Normal and Excess of Fat groups presented a significant increase in SCVTR and SCVTL regions. Obesity group did not show a significant increase in SCVT (right side: $p = 0.368$; left side: $p = 0.096$). No significant increase in STRT was observed in all groups.

CONCLUSION: Tactical athletes classified with obesity by FMI did not activate BAT after exposure to cold. All others classifications of FMI showed significant BAT activation.

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HYBRID-TYPE, MULTICOMPONENT INTERVAL TRAINING IMPROVES CARDIAC MORPHOLOGY IN MIDDLE-AGED OVERWEIGHT AND OBESE ADULTS: A 1-YEAR DOSE-RESPONSE PRAGMATIC RANDOMISED CONTROLLED TRIAL

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INTRODUCTION: The increasing prevalence of overweight/obesity is a serious public health challenge negatively affecting more than one in two adults globally. Physical exercise is an essential component of an all-inclusive strategy for preventing, managing and treating obesity. In particular, a hybrid-type, multicomponent interval training programme (DoIT) has been reported as an effective exercise solution for lowering various cardiovascular risk factors. This study examined the dose-response effects of a 1-year DoIT on cardiac morphology parameters in previously inactive overweight and obese adults in a real-world gym setting

METHODS: Ninety-seven middle-aged (44.8 ± 5.2 years) overweight and obese individuals (31.2 ± 5.7 kg/m2) (66% female) were randomly assigned to the following groups: (i) no-intervention control (CON, n=29), (ii) DoIT performed once weekly (DoIT-1, n=24), (iii) DoIT performed twice weekly (DoIT-2, n=23) and (iv) DoIT performed thrice weekly (DoIT-3, n=21). DoIT was a time-efficient, intermittent-based, multicomponent exercise protocol using progressive loaded fundamental movement patterns with prescribed work-to-rest intervals (1:3 to 2:1) in a circuit format (2–3 rounds). Left ventricular mass (LVM), left ventricular internal diameter end systole (LVIDs), left ventricular posterior wall end diastole (LVPWd), interventricular septum end diastole (IVSd), right ventricular end diastole (RVD), body surface area (BSA), left ventricular mass index (LVMI), and relative wall thickness (RWT) were assessed by an electrocardiogram at baseline and 12 months following intervention.

RESULTS: No baseline differences were detected among groups in all outcome variables, including habitual physical activity levels and caloric intake. The overall training-related injury rate was 3.3% (3/90; 1 participant in each DoIT group). Attendance rates for DoIT-1, DoIT-2 and DoIT-3 were 87.8%, 86.3% and 85.0%, respectively with an overall dropout rate of 19%. CON exhibited no changes in any measures, besides LVM (-1.3%, $p<0.001$) and LVMI (-1.7%, $p<0.001$). All DoIT groups showed beneficial changes in LVM (+1.9%–8.7%, $p<0.001$), LVPWd (+1%–4.9%, $p<0.001$), LVIDs (+1.2%–4.9%, $p<0.001$), RVD (+1.1%–3%), and LVMI (+2.2%–9.1%, $p<0.001$) in time. In LVPWd and IVSd, DoIT-2 and DoIT-3 demonstrated greater in-

creases compared to baseline (+3%–4.8%, p<0.001), while DoIT-3 induced more beneficial changes than DoIT-1 (+6.9%, p<0.001). No significant differences were found in BSA and RWT within and between groups.

CONCLUSION: These results indicate that a multicomponent exercise approach incorporating bodyweight drills and resistance-based alternative modes performed under real-world conditions may improve cardiac morphology markers, but not widely in a dose-dependent manner in previously inactive, middle-aged overweight and obese adults. The present findings will enable physicians and exercise professionals to follow more efficient exercise prescription guidelines for this popular and effective exercise modality.

FITNESS CONDITION OF HUNGARIAN SECONDARY SCHOOL STUDENTS BEFORE AND AFTER THE COVID-19 PANDEMIC

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Introduction

The topic of our research is the effect of the COVID-19 pandemic situation on the fitness condition of secondary school students. The NETFIT is the National Unified Student Fitness Test, which has been a unified, criterion-oriented test system since 2014 to assess the fitness status of students from upper elementary school to the end of secondary school. The main mission of NETFIT is to develop the demand for lifelong physical activity in children and to promote health-conscious lifestyles among students, their families and public education stakeholders (Kaj, 2020). The tests assessed in NETFIT are divided into four main groups: body composition and nutrition profile, aerobic fitness profile, skeletal muscle fitness profile, and flexibility profile.

Materials and methods

The investigated class was the 12th D class of the Jurisich Miklós High School in Kőszeg, Hungary, English-Hungarian bilingual section, N=30. We compared the students by gender based on the NETFIT results of the 2018/19 school year and the 2021/22 school year, and the differences between the pre- and post-epidemic fitness indicators were compared to the national averages at the same years. The students were given tasks to complete at home during the online education. The physical education teachers gave the students exercises known from functional training, different self-bodyweight exercises and circuit training tasks.

Results

Like the national results, the aerobic capacity of the pupils studied decreased significantly after the epidemic (p=0.031* boys, p=0.006** girls), but was still strongly significantly (p<0.001) better than the national average in 2021/22. Boys performed significantly better in the handgrip strength (p=0.008**) and flexibility (p=0.003**) tests, while girls performed significantly better in the paced curl-up (p=0.042*) and paced push-up (p<0.001***) tests after the pandemic.

Conclusion

According to the aerobic fitness index of the studied class, the aerobic capacity of the students deteriorated less compared to the national average. Significant performance improvements were observed in several tests of skeletal muscle fitness profile. Students showed statistically significant improvements in many areas, however seeing the data, we should also emphasize the importance of daily physical education and attendance education as well, to encourage pupils for lifelong physical activity, so they become physically, mentally healthy young people.

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EXAMINING THE EFFECTS OF POSTURE IMPROVING EXERCISES DURING PE CLASSES

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INTRODUCTION: Inactivity due to much sitting also causes damage to the motor organs of an increasing number of children. The 2018 Health Behaviour in School-aged Children (HBSC) study is one of the studies on the physical activity of young people and the frequency of physical activity. It turns out that only one-sixth of children aged 11 to 17 years are likely to exercise enough daily. This rate is lower compared to the results recorded four years earlier, at that time one-fifth of children were characterized by a sufficient amount of daily movement. (Kun, Nemeth, Demetrovics, 2019).

The aim of our research is to perform a physiological examination of the spine of students and their spine's functional condition and assess the interventional effect of exercises applied over 12 weeks.

METHODS: The sample included 10th grade students (n=40) of the Jurisich Miklós Secondary Grammar School in Kőszeg, Hungary. Participants were divided into intervention (n=22) and control (n=18) groups. The intervention group performed 12 different posture-improving exercises in all PE classes over a period of 12 weeks.

The Spinal Mouse device was used to examine the spinal column. The device can examine the morphological characteristics and mobility of all vertebrae between C7 - S1 of the spine. Body weight and body height data were taken from the NETFIT test system. As an additional measuring tool, the Maligen test was applied, as well as an examination of the ef-

fects of some of the exercises aimed at posture correction,for example, the forward bending of the lumbar spine and the twisting of the lower back and lumbar spine.

In addition to the basic statistical calculations, an independent two-sample T-test approach was also used. Comparing the results revealed the relationship and differences between the two samples. Statistical tests were conducted with the CogStat 2.2 and the IBM SPSS v.25 tools.

RESULTS: The average height of the group is 171.6 cm, that of boys is 178.18 cm, while that of girls is 166.74 cm. Average body weight is 61.83 kg, boys weighing an average 66.29 kg and girls 58.52 kg. The second measurement among girls showed a significant relationship between the intervention and control groups regarding the position of the sacrum and the pelvic bone relative to each other. The result of Welchs D-test: t(23)=2.167; p=0.045.

The most evident deviations appeared only in the boy group after the Matthias test. There was a significant relationship between the data on the lumbar section and the position of the hips. It was on the second measurement of the lumbar section that the correlation was revealed. The standard deviation of the groups is the same (the Leven test was not significant (p=0.87)).

CONCLUSION: Our innovative training protocol included several combined exercises to preserve and develop torso and spine mobility. The research has proven that if students regularly perform general posture-improving gymnastic exercises, the physiological state of the spine can be improved (Gordos, 2022).

CHANGES IN LIFESTYLE BEHAVIORS AND PHYSICAL FITNESS OF JAPANESE CHILDREN DURING THE COVID-19 PANDEMIC: RESULTS FROM A 7-YEAR REPEATED CROSS-SECTIONAL STUDY

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INTRODUCTION: The COVID-19 pandemic appears to have had a great adverse impact on the healthy behaviors of preschoolers, in particular outdoor play. However, details are still unclear. Thus, this study aimed to investigate changes in lifestyle behavior and physical fitness of Japanese children during the pandemic.

METHODS: This study collected longitudinal data before and during the pandemic and objectively assessed changes in the physical fitness and lifestyle (outdoor playtime, screen time, and sleep) of Japanese preschoolers. Participants were 4,882 preschoolers in Hiroshima Prefecture who evaluation objective health and fitness assessments (25-m sprint, standing long jump, tennis ball throw); their parents answered questions on their demographics, physical activity, screen time, and sleep duration. Chi-squared test, ANOVA, and t-test were applied.

RESULTS: Among lifestyle behaviors, outdoor playtime decreased significantly in both boys and girls ($p<0.01$ and $p<0.05$, respectively), while sleep duration decreased significantly in boys alone ($p<0.05$). Among physical fitness items, significant differences were observed for the 25-m sprint ($p<0.001$ and $p<0.01$, respectively) and long jump in both boys and girls ($p<0.001$ and $p<0.01$, respectively).

CONCLUSION: The results showed negative effects of the pandemic on children's health and lifestyle behaviors, and fitness, thus endorsing various interventions to promote physical activity under pandemic conditions. preschools must increase organizational physical activity time, and local communities must seek effective policies for outdoor play of preschool children.

ANALYSIS OF FALL RISK AND GAIT PATTERNS DURING WALKING ACCORDING TO FALL EXPERIENCE IN OLDER KOREAN WOMEN

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INTRODUCTION: The purpose of this study was to compare the gait patterns and the relative risk of falling between Older Korean women that fall and do not fall based on the walking speed during flat walking and in the presence of obstacles.

METHODS: The study included 148 women, aged 65 years or older (22 fallers, aged 75.05±5.38 years; 126 non-fallers, aged 71.80±5.14 years). The gait variables were measured in a space of 9 m×1 m, and obstacle walking was measured while crossing obstacles measuring, 5 cm and 30 cm. A t-test, correlation analysis, and logistic regression analysis were performed to compare the gait patterns to determine if there was a fall and to analyze the relationship and the risk ratio of a fall at a walking speed.

RESULTS: Out of 148 participants, 22 participants (14.9%), fell while walking. During flat ground walking, right step length ($p<.01$) left step length ($p<.05$), and stride lengths ($p<.01$) were smaller in the faller group, while the stance phase ($p<.01$) and double-support time ratio ($p<.05$) were smaller in the non-faller group. In obstacle walking, slower walking speeds were observed for the 5-cm obstacles ($p<.01$) and 30-cm obstacles ($p<.05$) in the faller group. For the low-speed and medium-high speed groups, the odds ratio of the fall experience was 2.844 (1.125-7.191) ($p<.05$) for flat gait, 3.585 (1.354-9.491) ($p<.05$) for the 5 cm obstacle, and 4.877 (1.731-13.742) ($p<.01$) for the 30 cm obstacle. As the height of the obstacle increased, the fall odds ratio increased.

CONCLUSION: In the faller group, the step and stride lengths were smaller during flat walking, and the walking speed of the obstacles was low. The low-speed group had a high falling experience odds ratio, and as the height of the obstacle increased, the falling experience odds ratio increased.

DOES PINCH STRENGTH HAVE A RELATIONSHIP WITH SHOE TYING SPEED IN COLLEGE WOMEN ATHLETES?

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INTRODUCTION: Activities of daily living (ADLs) are essential for independent living in all ages and allow individuals to physically care for themselves, along with carrying out daily routine tasks. ADLs are an indication of functionality and may also show when preventative measures need to be implemented1. Research has shown low ADL functionality in tasks such as these, bathing, shoe-tying, and eating, has been linked to an increase in the risk of mortality and hospitalization in the elderly. Goetzinger et al., (2022) recently demonstrated there was a moderate negative correlation between pinch strength and buttoning speed, however, no studies have affirmed or denied a relationship between shoe-tying speed with pinch strength.

METHODS: 20 college female athletes (20.5 ±1.5 years) from a Midwest institution were recruited for this study. All participants were healthy and had no injuries to the wrist within the last 6 months. All subjects were shown a short instructional video, demonstrating how to tie the shoe for the study before the data collection took place. All subjects began by holding the laces at the center of the string, away from the shoe, where they were then instructed to begin tying the shoe as fast as possible upon command. When they were done tying the shoe, they held their hands up in signaling they were done, and the timer was stopped. The best time of two attempts was taken. The participants then used a Baseline LITE hydraulic pinch dynamometer to measure pinch strength in kgs., using their thumb superior to their index finger at a maximal effort one time. Pinch strength was assessed on dominant and non-dominant hands.

RESULTS: A Pearson correlation between the dominant hand pinch strength and shoe-tying speed was low to moderate ($r = -0.35$; $p = 0.126$). The correlation between the non-dominant hand pinch strength and shoe-tying speed was similar ($r = -0.32$; p-value = 0.163). Both pinch strength and shoe tying speed were not significant ($p < 0.05$).

CONCLUSION: This study was the first study to determine if there was a significant relationship between shoe-tying speed versus pinch strength in female college athletes. Although there was a moderate negative correlation between buttoning speed and pinch strength, the relationship between shoe-tying speed and pinch strength was weak compared to alternative ADL activities. The variety of shoe-tying methods used by the participants from experience could have played a role with the overall outcome of this study.

INTERVAL AEROBIC/RESISTANCE EXERCISE TRAINING DEPRESSES ADRENERGIC-INDUCED APOPTOSIS OF CD4+ LYMPHOCYTE IN SEDENTARY MALES

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INTRODUCTION: Exercise paradoxically influences adaptive immune function, depending on the type, intensity, and amount of exercise. Sympathetic stimulation affects lymphocyte autophagy and apoptosis by modulating β1-adrenergic receptor (β1-AR) and G protein-coupled receptor kinase 2 (GRK-2) downstream signaling. This study investigated how combined aerobic and resistance exercise training on the interval or continuous pattern influences β1-AR/GRK-2 signaling and corresponding apoptosis/autophagy of CD4+ lymphocytes in sedentary males.

METHODS: Thirty-four sedentary males were randomized and divided into interval training (IT, n=17) and continuous training (CT, and=17) groups. These subjects performed IT (bicycle exercise at alternating 40% and 80%VO2max and isokinetic exercise at alternating 60°/s and 180°/s) or CT (bicycle exercise at continuously 60%VO2max and isokinetic exercise at continuously 120°/s) for 30 min/day, 5 days/week for 6 weeks. CD4+ lymphocyte autophagy/apoptosis and β1-AR/GRK-2 signaling were analyzed using flow cytometry.

RESULTS: Both IT and CT groups increased isokinetic strengths at various angular velocities, whereas only IT significantly enhanced muscle endurance, indicated by lowering fatigue index. Moreover, the IT group revealed a higher improvement in VO2 max than the CT group. The graded exercise to VO2max (GXT) augmented (i) GRK2 and protein kinase A expressions, (ii) LAMP2 upregulation and acridine orange staining, (iii) mitochondrial transmembrane potential decreasing, caspase 3 activation and PS exposure caused by the epinephrine in CD4+ lymphocytes. However, the epinephrine-induced CD4+ lymphocyte apoptosis potentiated by GXT was suppressed by 6 weeks of IT.

CONCLUSION: The IT is superior for the CT to effectively enhance aerobic/muscular fitness and simultaneously ameliorate apoptosis of CD4+ lymphocytes evoked by intense exercise or adrenergic stimulation. These experimental findings can help to determine an effective combined aerobic and resistance exercise regimen to increase aerobic/muscular fitness and minimize the risk of infections and immune disorders at performing intense exercise.

AEROBIC EXERCISE IMPROVES PHYSICAL FITNESS IN OLDER ADULTS BY MEDIATING MIR-21 AND BODY COMPOSITION: A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Emerging evidence suggests that aerobic excise is associated with changes of body composition and circulating microRNA (c-miRNA) expressions in older adults. This study highlighted mediating roles of body composition and c-miRNA for the physical fitness progress after aerobic exercise trainings in older adults.

METHODS: We included 58 community inhabitants with age>= 60 years and instructed them to walk >= 8000 steps per day during a 24-week follow-up (F/U) period. Among them, 28 were randomly allocated to the supervised exercise training (SET) and 30 were assigned to the home exercise training (HET) groups. Only SET participants underwent an additional 24 sessions of 8-week SET at 70% of maximal predicted heart rate for 30 min per session. Estimated maximal oxygen consumption (eVO2max), calf circumference (calf_circ), handgrip strength (HGS), 5-time sit-to-stand duration (StoS), normalized body fat mass (nBFM), normalized skeletal muscle mass (nSKM), circulating miR-21 (c-miR-21), c-miR-126, c-miR-146a, and c-miR-222, were measured at baseline, and week 8 and 24 after recruitment.

RESULTS: A greater percentage of SET participants (81.6%) adhered to the instruction than HET participants (46.4%) during F/U. The HET participants developed a trend towards decreased calf_circ and HGS during F/U. In the SET participants, eVO2max, nSKM, and all tested c-miRNA levels significantly increased, but nBFM significantly decreased during F/U. The HGS, StoS, nSKM, all c-miRNA levels in SET participants were significantly greater than the HET participants at week 8 and/or week 24. The c-miR-21 was involved in the mediation of SET-associated improvement of StoS and eVO2max. SET affected muscle performance by mediating body composition.

CONCLUSION: A short-term in-hospital supervised exercise training program is beneficial for increasing exercise adherence, which help aging population maintain muscular fitness and improve cardiorespiratory fitness. A significant decline of muscular fitness has been observed in older adults without SET. The current study has also disclosed that the aerobic exercise can affect tissue component and induce post-transcriptional modification to improve physical fitness. The c-miRNA levels, especially c-miR-21, as well as body composition could be used as a clinical indicator for monitoring aerobic exercise effects on both muscular and cardiorespiratory fitness in older adults.

EFFECT OF TWO WEEKS AROMATHERAPY ON PAIN, FUNCTION OF LIFE, AND NECK FLEXION ENDURANCE AMONG PATIENTS WITH CERVICOGENIC HEADACHE

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INTRODUCTION: Headache is one of the common symptoms nowadays. In the past, studies have shown that the activation of the trapezius muscle of the cervical muscle group increased by the observation of electromyography (EMG) in the present of cervical migraine (Jensen, Bendtsen & Olesen, 1998), showing that patients with cervical headache may have a certain correlation between the trapezius muscle and the posterior neck muscle during headache (Lo Martire et al., 2017). In the treatment of migraine, aromatherapy (Aromatherapy) is one of the common alternative treatments. It has been often used in clinical care over the years. However, there are many comorbid symptoms caused by pain, which may cause anxiety and sleep disturbance. Therefore, the purpose of this study was to investigate the effect of 14-day of aromatherapy massage on pain improvement, daily life and quality of patients with cervicogenic headache.

METHODS: Study with single-blind, matching method. Twenty-four cervicogenic migraine patients were recruited in this study, who had to be diagnosed by a doctor first, and in accordance with the criteria of HIS: migraine lasted for more than one year with more than 2 attacks per month and no psychiatric disorder. Before intervening in, research objects need to fill in the brief pain inventory-short from (BPI-SF) and perform the neck flexion endurance test (NFE test) and then be divided into aromatherapy group (T group) and placebo group (P group) according to the pain scores. Conduct a 14-day experiment (once a day, 20 minutes of aromatherapy each time), the aromatherapy contains 15 minutes of inhalation and 5 minutes of essential oil roller application for the splenius cervicis muscle and upper trapezius muscle (Organic compound essential oils for T group; Carrier oil for P group). After intervening in, Acute and post-14 day group filled in BPI-SF and performed NFE test. The experimental data were analysed with two-way mixed design ANOVA.

RESULTS: 1. The percentage of pain improvement showed that the post-14 day of A group was significantly better than acute ($p < 0.5$), but not in P group ($p > 0.5$). 2. In terms of daily life impact score, acute and post-14 day of two groups were significantly lower than pre ($p < 0.5$), and the 14-day of A group was significantly lower than that of acute ($p < 0.5$), but not in P group ($p > 0.5$). 3. There was no difference in the NFE test, but it was significantly positively correlated with the pain score and the daily life impact score ($p < 0.5$).

CONCLUSION: Aromatherapy can reduce nociception and the impact on quality of life in patients with cervicogenic migraine. Cervical muscle endurance might be associated with nociception and the influence on daily life.

CIRCUIT AEROBIC TRAINING IMPROVES BIOENERGETICS AND DEPRESSES SENESCENCE OF LYMPHOCYTES IN SEDENTARY MALES

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INTRODUCTION: Appropriate aerobic exercise can improve the regulation of acquired immunity. The immune function of lymphocytes is related to their mitochondrial bioenergetics that depends on the operating efficiency of their electron transport chain. Circuit Aerobic Training (CAT) is a novel exercise strategy that utilizes multi-sports equipment for improving systemic aerobic fitness. However, the CAT effect on lymphocyte immunity has not yet been established. The study was to investigate the effects of CAT and traditional aerobic training (TAT) on phenotype characteristics and mitochondrial bioenergetics of lymphocytes in sedentary males.

METHODS: Thirty healthy sedentary males were randomized and divided into CAT (n=10), TAT (n=10), and control (n=10) groups. These subjects progressively performed CAT on multi-sports equipment or TAT on a bicycle ergometer from 60%

to 80% maximal workload for 30 min/day, 5 days/week for 6 weeks. A graded exercise testing (GXT) and an isokinetic strength test were conducted to evaluate cardiopulmonary fitness and muscle strength, respectively. The phenotype characteristics and mitochondrial respiratory capacity in lymphocytes were analyzed using flow cytometry and high-resolution respirometry, respectively.

RESULTS: After the intervention for 6 weeks, either CAT or TAT significantly increased the VO2 values at the anaerobic threshold and maximal performance as well as the isokinetic strength of the quadriceps. The two exercise regimens also heightened degree of behavioral changes related to physical activity.

Both CAT and TAT reduced blood senescent T lymphocyte count at rest and diminished the mobilization of senescent helper T lymphocytes into the peripheral blood following the GXT. However, CAT rather than TAT lowered the proportion of senescent cytotoxic T lymphocytes in the blood. Either CAT or ICT effectively depressed lymphocyte mitochondrial oxidant burden caused by the GXT. Furthermore, the two exercise regimens improved mitochondrial bioenergetic efficiency in lymphocytes by stabilizing the mitochondrial membrane potential and improving the capacity of the electron transport chain following the GXT.

CONCLUSION: Both CAT and TAT enhance cardiorespiratory/muscular fitness as well as improve lymphocytic bioenergetic efficiency. However, CAT is superior to TAT for slowing the senescence of cytotoxic T lymphocytes in blood.

MOVE WELL, BE STRONG: GRASSROOT COACHES' AND PHYSICAL EDUCATION TEACHERS' KNOWLEDGE, ATTITUDE AND CONFIDENCE TOWARDS DEVELOPING THE MOVEMENT COMPETENCY OF CHILDREN IN SAUDI ARABIA

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INTRODUCTION: There are significant knowledge gaps amongst grass-root coaches and PE teachers regarding movement competency and injury prevention programmes [1]. As children are a high-risk group for non-contact sporting injuries, they are an important target group fpr improving movement competency. It is unclear if coaches and PE teachers have the knowledge, attitude towards and confidence to deliver such and if differences exist between sexes.

METHODS: 95 grass-root coaches and PE teachers (25 females, 70 males) from across the Kingdom of Saudi Arabia completed a validated questionnaire exploring use, knowledge, attitude towards and confidence to deliver youth movement competency training. A Bayesian factor was used to quantify the evidence for and against the hypothesis of independence (H0) in each of the survey questions and with regards to sex differences using an assumed Poisson sampling scheme (as there was no a priori restriction on any cell count, nor on the grand total) (BF10 Poisson). Bayes factors were categorised into discrete categories ranging from extreme evidence to anecdotical evidence.

RESULTS: 93% of participants thought injury risk management in children was possible, with 61% considering children to be at high risk of injury. Participants ranked helping children to develop movement skills as their most important role (47%) with developing technical skills as their least important role (15%). No sex differences were observed in terms of the importance of developing movement skills (BF10 Poisson = 0.16). Only 35% of participants had heard of any injury prevention programmes and 47% included movement competency training in their coaching/PE. In both cases significantly more males had knowledge of and were using injury prevention in their coaching and PE lessons than females (BF10 Poisson = 2.67 and 1.4 respectively). Nearly all participants (93%) felt that incorporating an injury prevention programme would be good for children. Most coaches indicated they needed more knowledge around injury prevention programmes (90%), understanding of growth and maturation and injury (87%) and specific exercise to improve movement competency (87%). Two thirds of participants had a positive attitude towards (68%) and were confident to deliver (67%) movement competency training.

CONCLUSION: Despite two thirds of coaches/PE teachers rating their knowledge, attitude towards and confidence to deliver movement competency training as good, less than half of participants were using such training. Training and upskilling is required to provide coaches/PE teachers with the skills and confidence to deliver movement competency training. Appropriate resources need to be developed that are culturally suitable and delivered in an accessible way to PE teachers and grassroot coaches. Sex differences in the knowledge around movement competency training indicates that females should be provided with training to increase knowledge and confidence.

SYSTEMATIC REVIEW ON THE EFFECTS OF EXERCISE WITH AND WITHOUT BREAKFAST CONSUMPTION ON COGNITIVE PERFORMANCE

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INTRODUCTION: Both acute bouts of exercise and breakfast consumption have been shown to improve cognition. Further, research has also shed light on the potential interactive effects of exercise and breakfast consumption (consumed before exercise) on cognition. Hence, the aim of this systematic review was to review the current evidence on the effects of acute exercise with and without preceding breakfast consumption on cognitive performance.

METHODS: This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines and is registered in the International Prospective Register of Systematic Reviews (CRD42023396125). Studies were included if they investigated the acute effects of exercise without and without preceding breakfast intake on performance of cognition measured during and following exercise in adults without any cardiovascular disease, history of brain injury, or psychiatric or neurological disorder. Eligible studies from 4 electronic databases, PubMed, Scopus, MEDLINE, and

Web of Science, were searched and screened from 6 November 2022 to 29 January 2023. Study quality was assessed using the Physiotherapy Evidence Database (PEDro) scale.

RESULTS: A total of 609 studies were screened. Five studies, involving 70 participants (42 women, aged between 18 and 50 years) in total (sample size per study: 10-24), were eligible for inclusion in this review. The included studies had a mean PEDro score of 4.0 (scored between 3 and 5), suggesting 'fair' methodological quality. The synthesized results showed that 2 of the 5 studies found a positive effect of acute exercise, either delivered as moderate-intensity continuous aerobic exercise or high-intensity intermittent exercise, on processing speed measured during exercise in young healthy men [1] and inhibitory control and cognitive flexibility measured post-exercise in overweight perimenopausal women [2]. However, such exercise induced changes in cognition were not differed by breakfast consumption before exercise, regardless of the composition of macronutrients provided during breakfast [1,2].

CONCLUSION: Preliminary evidence did not support that exercise induced changes in cognition would be differed by prior breakfast consumption. However, the actual interactive effects of breakfast consumption and exercise on cognition warrant further verification given a) the small sample size of studies included, b) the heterogeneity across studies in exercise protocols, participants' characteristics, and selection of cognitive tasks, and c) the lack of good methodological quality in studies included.

References:

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COMPARISON BETWEEN AUGMENTED REALITY AND TRADITIONAL LOWER EXTREMITY STRENTHENING TRAINING ON RANGE OF MOTION, BALANCE AND PROPRIOCEPTION IN HEALTHY ADULT

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INTRODUCTION: Augmented Reality(AR) is a computer technology providing users with additional information about the observed situations. AR is considered the future of rehabilitation because it allows patients to easily access and participate in rehabilitation training regardless of time and place. The purpose of this study was to compare the effect between augmented reality and traditional lower extremity muscle strength exercise on range of motion(ROM), balance, proprioception.

METHODS: 52 healthy male and female university students were participated in this study. The subjects were divided into randomized augmented reality training group (ARG) and traditional exercise group (TG). All the subjects have conducted AR or traditional lower extremity strengthening training according to groups in three times a week for a total of four weeks. ROM, balance and proprioception variables were measured before and after 4 weeks intervention. For data analysis, we used matching sample t-test for comparison between groups and the independent-sample t-test for comparison of changes in groups.

RESULTS: In the comparison within group, ARG showed statistically significant differences in balance and proprioception($p<0.05$). TG showed statistically significant differences in ROM of knee flexion during walking and balance($p<0.05$). In the comparison between group, there was no significant differences between the groups in knee ROM while walking, balance and proprioception($p>0.05$).

CONCLUSION: As a result of this study, compared to TG, it was found that AR can show the same effect as there is no difference in each variable after 4 weeks of strength training. Also the group with ARG showed changes in balance and proprioception after lower body strengthening. Therefore, AR training can be a good training method for the elderly who are at high risk of falling due to deficits in balance and position sense, regardless of time and place.

APPLYING A FIREFIGHTER FITNESS PROGRAM USING A KINECT-BASED MIXED REALITY DEVICE

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INTRODUCTION: Recently, a Korean firefighter fitness program (KFFP) combined with a Kinect-based mixed reality device was developed. Since the Kinect sensor can identify movements and provide visual feedback to correct incorrect movements, it helps to increase the Korean firefighters' exercise participation rate, which is low due to the lack of exercise instructors. A previous study validated the KFFP moderate-intensity program for male participants in general. However, in the previous study, the participants' VO2max was lower than that of Korean firefighters, and the high-intensity program has not yet been verified. Therefore, the aim of this study was to investigate the effects of medium- and high-intensity KFFP combined with a Kinect-based mixed reality device on the aerobic abilities and muscular functions of Korean firefighters.

METHODS: Korean male firefighters were divided into a Kinect-based mixed reality device exercise group (EG, n = 10) and a control group (CG, n = 10). The EG group participated in an intervention consisting of medium- to high-intensity KFFP for 3 days/week, while the CG group was asked to maintain their lifestyle without any extra exercise for 8 weeks. Aerobic ca-

pacity was assessed by a graded exercise test with a respiratory gas analyzer, and muscular function was measured by an isokinetic dynamometer.

RESULTS: There was no significant interaction between group type and time in VO2peak and HRpeak. However, The VO2peak of the EG group was significantly increased by about 1 MET (from 42.2 ± 6.2 mL/kg/min to 45.9 ± 4.3 mL/kg/min, p = .04) and HRpeak was decreased by about 3 beats/min (191.3 ± 6.8 beats/min to 188.8 ± 8.3 beats/min, p = .04) after the intervention. There was no significant change in VO2peak and HRpeak in the CG group. There were significant interactions between the groups and increases in peak torque of the knee extensors (p = .04), knee flexors (p = .002), shoulder extensors (p = .03), shoulder flexors (p = .04), and trunk extensors (p = .02). There were also significant interactions between the groups and increases in total work of knee extensors (p = .02), shoulder extensors (p = .02), and shoulder flexors (p = .047).

CONCLUSION: These results suggest that KFFP combined with a Kinect-based mixed reality device can help firefighters perform firefighting tasks by improving the cardiorespiratory capacity, muscular strength, and muscular endurance of Korean firefighters.

EFFECT OF P. GINGIVALIS INDUCED BACTEREMIA ON SKELETAL MUSCLE INJURY HEALING IN VIVO

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INTRODUCTION: P.gingivalis, one of the most causative bacteria of periodontitis, has been reported that it aggravates various diseases by invading the body from oral cavity. There is a possibility that P.gingivalis has adverse effect to skeletal muscle healing, however, there is lack of research investigating the direct relationship between P. gingivalis-induced bacteremia and skeletal muscle healing. Therefore, in this study, we investigate the effect of P. gingivalis to skeletal muscle healing in vivo. It has been reported that young people, who have bad oral hygiene, even though they didn't be diagnosed as periodontitis, P. gingivalis was also found in their oral cavity. Thus, to clarify the relationship among P.gingivalis-induced bacteremia and skeletal muscle wound healing is important for not only elderly people but also athletes.

METHODS: In this study, a total of fifty-six 8-week-old male Wistar rats were utilized. The animals were randomly divided into two groups. One group intraperitoneal administered with sonicated P. gingivalis (ATCC33277) once per week for three weeks(PG group), and another group administered with an equal amount of saline (CO group). Skeletal muscle injury was induced in gastrocnemius by injection with cardiotoxin to both groups in three weeks after from the first intraperitoneal administration. During days 1, 3, 5, 7, 11, and 14 after injury, animals were euthanized, and gastrocnemius was extracted. The cross-sectional area of regenerating skeletal muscle cell was evaluated by HE-staining, and the degree of muscle fibrosis was evaluated by Massons-Trichrome staining. The expression of Pax7 and MyoD were analyzed to identify the stage of muscle cell regeneration by immunohistochemical staining. In addition, a lower minimum calcaneus height between walking was measured by motion analysis using treadmill walking for evaluating functional ability at days 1, 3, 5, 7, 11, and 14 after injury.

RESULTS: The cross-sectional area of regenerating muscle cells were significantly smaller in the PG group at day 7 after injury, but no significant difference observed in the cross-sectional area at day 14 after injury. Area of fibrosis is significantly larger in the PG group. Pax7+/MyoD- ratio was significantly lower in the PG group compared to the CO group at day 1 after injury. Motion analysis of treadmill walking showed that the PG group had a lower minimum calcaneus height than the CO group at days 3, 5, 7, and 11 days after injury.

CONCLUSION: The results of this study suggest that rats administered with sonicated P. gingivalis may delay the healing process of muscle injury, particularly apparent in the early stages, compared to control group. Delayed healing resulted in increasing muscle fibrosis, and it may increase the risk of recurrent injury. From the results of this study which shows that to maintain clean oral hygiene may help athletes to recover quickly from skeletal muscle injury.

CONCURRENT INFLUENCE OF FAMILIAR BACKROUND' DIFFERENT FACTORS ON CHILDREN ACTIVITY LEVEL AND NUTRITIONAL STATUS

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INTRODUCTION: The lifestyle of the young generations is determined by the socio-economic background of the family, and parental role modeling is also important. Our aim was to define the "familiar" variables that most influence the level of habitual physical activity (PA) and nutritional status.

METHODS: A total of 2 825 children and adolescents between the ages of 7 and 19 years (n=1 413 males, n=1 412 females) were enrolled in this analyses from the cross-sectional cohort study. They provided anthropometric and physical activity data. Data about their parents and socio-economic background were measured with the use of self-reported questionnaires. Gender differences were tested with Student's t-test, and chi-squared test, differences in the respective subgroup's means were tested by one-way ANOVA. We conducted binary logistic regression models to examine the associations of settlement' type, parents BMI and education level with children' physical activity (sporting or not sporting) and BMI (normal or overweight and obese).

RESULTS: The BMI and the percentage of body fat were the lowest among boys and girls in the capital, The muscle percentage was the highest in children of towns in both genders, and BMI was the significantly highest among boys in

towns. The children in the capital had the most sport activity hours per week (boys: 4.81±4.44, girls: 3.65±4.10 hrs/week, average: 3.91±3.74 and 3.07±3.39 hrs/week).

BMI, fat percentages and sport activities differed by parents education categories. Education level of mother may effect on BMI and hours per week of sport activities in both girls and boys. There were significant differences in BMI and sport activities in children by father's education. Boys and girls sport activity differed by parents sport: 3.3±3.6/2.43±3.11 (parents no sport) vs 4.9±3.7/3.8±3.4 hrs/week (both parents play sport).

More than three hours PA was associated with the residence in the capital (OR=1.25 95% CI 1.06-1.47), normal maternal BMI (OR=1.41 95% CI 1.15-1.71), and higher maternal education (OR=3.16; 95% CI 2.38-4.2).

Normal children' BMI was associated with the normal maternal BMI (OR=2.63 95% CI 2.08-3.32), and higher maternal education (OR=1.67; 95% CI 1.22-2.29).

CONCLUSION: The main findings were that children with less „risk familiar factors" had better BMI and physical activity level.

MODERATE INTENSITY AEROBIC EXERCISE AFTER PARTIAL SLEEP DEPRIVATION DOES NOT AFFECT AORTIC PULSE WAVE VELOCITY AND AUGMENTATION INDEX RESPONSES IN HEALTHY YOUNG ADULTS

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INTRODUCTION: Chronic sleep deprivation increases morbidity and mortality of cardiovascular disease (CVD). Arterial stiffening is an independent risk factor for CVD. Aortic pulse wave velocity (PWV) and augmentation index (AIx) are representative clinical indicators to assess arterial stiffness. Aerobic exercise is known to be beneficial for dampening arterial stiffness. To date, it is difficult to find studies investigating the combined effects of sleep deprivation and aerobic exercise on aortic PWV and AIx. Thus, the purpose of this study was to evaluate the effect of moderate intensity aerobic exercise after partial sleep deprivation on aortic PWV and AIx, compared to recommended sleep condition, in healthy young adults.

METHODS: Six healthy young adults (22.2±0.3 yrs) participated in this study. Participants performed moderate intensity aerobic exercise at 70% of peak heart rate for 30 minutes each under the partial sleep deprivation (SD; 2.5-3 hrs) and the recommended sleep (RS; 7-9 hrs) conditions by a randomized crossover design. The wash-out period between two sleep conditions was set to one week. Carotid-femoral PWV as aortic PWV and AIx as pulse wave reflection were measured using SphygmoCor Xcel system.

RESULTS: There was no significant difference in carotid-femoral PWV, AIx, and AIx adjusted at 75 beats/min of heart rate (AIx@75) responses to moderate intensity aerobic exercise between SD and RS condition (P □ 0.16).

CONCLUSION: In conclusion, one-time partial sleep deprivation does not influence aortic pulse wave velocity and pulse wave reflection responses to moderate intensity aerobic exercise in healthy young adults.

RESPONSE OF PERIOSTIN ON THE INTAKE OF N-3 POLYUNSATURATED FATTY ACIDS

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INTRODUCTION: Athletes are exposed to air pollution, allergens,cold and dry air during high-intensity training with an increase in the ventilation volume (1). These environmental and exercise stress stimulations cause airway epithelial injury repeatedly and may result in chronic airway inflammation. Therefore, athletes are at a high risk of exercise-induced asthma.

Recently, periostin, a matricellular protein, has been reported to play an essential role in the mechanisms of type 2 allergy. IL-4 and IL-13 induce periostin, showing a high level with multiple allergic diseases, such as allergic rhinitis and bronchial asthma. Therefore, periostin is focused on the type 2 biomarker (2). Although fractional nitric oxide (FeNO) has also been a known type 2 biomarker, periostin may be a chronic type 2 biomarker.

n-3 polyunsaturated fatty acids (PUFAs) are observed to inhibit the arachidonic acid cascade and have anti-allergy effects. However, it has not been known whether PUFAs are effective on periostin. Therefore, we investigated whether the intake of n-3 PUFA supplements affected periostin production. Purpose: To investigate the effect of intake of n-3 PUFAs supplements on periostin in athletes.

METHODS: University athletes who participated in this study were divided into two groups: PUFAs group (FeNO≥25 ppb, n=6) and control group (FeNO<25 ppb, n=7). The PUFAs group took supplements containing 260 mg of docosapentaenoic acid and 600 mg of eicosapentaenoic acid (EPA) daily for 3 weeks. Baseline measurements of FeNO, respiratory function, dietary intake (food frequency questionnaires), and blood tests were taken. FeNO levels were measured weekly, and the rest were measured after three weeks. The plasma periostin value was determined by ELISA.

RESULTS: Serum periostin values were not significantly different between the PUFA and control groups at baseline and 3 weeks (baseline: PUFAs; 78.0±7.2 ng/mL vs. control; 75.4 ± 9.8 ng/mL; 3 weeks: PUFAs; 71.7±10.2 ng/mL vs. control; 73.7±14.9 ng/mL). However, the FeNO levels of the PUFA group significantly decreased after 3 weeks compared with baseline (baseline: PUFAs; 59.3±32.3 ppb vs. 3 weeks:45.8±27.6 ppb). The FeNO level of the control group was not

change between baseline and at 3 weeks (PUFAs group; baseline, 15.1±2.7 ppb vs. 3 weeks; 15.4±4.7 ppb). The pulmonary function was not significantly different between the PUFAs and control groups at baseline and at 3 weeks.

CONCLUSION: Periostin production was not changed by the intake of n-3 PUFA supplements in the short term.

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DAILY PHYSICAL ACTIVITY ENHANCES EFFICACY OF TREATMENT WITH SGLT2 INHIBITORS IN PATIENTS WITH TYPE 2 DIABETES

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INTRODUCTION: Sodium-glucose cotransporter 2 (SGLT2) inhibitors are newer hypoglycemic agents for patients with diabetes mellitus. Although daily physical activity is promoted as an essential component in the management of type 2 diabetes, combined health benefits of daily physical activity and SGLT2 inhibitor treatment are poorly understood. Thus, we investigated the combined effects of daily physical activity and SGLT2 inhibitor treatment on glycemic control in patients with type 2 diabetes using a large health insurance claims data and health check-up data in Japan.

METHODS: A retrospective cohort study was conducted using JMDC, Inc. (JMDC) database (2013-2019). JMDC has created a database, using data collected from health insurance societies in Japan, consisting of ledgers of insureds, claims (for hospitalization, outpatient treatment, drug preparation), and health checkup results. Our primary analysis included glycemic uncontrolled 1,403 patients (HbA1c >= 7.0%; mean age 51.4 years, SD 7.3 years) who were administrated SGLT2 inhibitors for more than 3 months and had neither regular exercise nor daily physical activity before SGLT2 inhibitor treatment. Controlled blood glucose level was defined as HbA1c lower than 7%. Daily physical activity was defined as walking or physical activity equivalent to walking in a daily life for at least one hour per day. The patients were assigned to one of two categories based on their daily physical activity status during treatment: no physical activity or physical activity. We used logistic regression models to estimate odds ratios and 95% confidence intervals (CI) for glycemic control after SGLT2 inhibitor treatment. The analysis was adjusted for age, sex, regular exercise, hypertension, dyslipidemia, number of co-administration antidiabetic drugs, body mass index, and baseline HbA1c in a multivariable model.

RESULTS: The blood glucose levels were controlled by 36.7% (515/1403) in total patients after SGLT2 inhibitor treatment (median: 7 months; interquartile range: 5-10 months). The glycemic control rate was significantly greater in daily active individuals (45.5%, 90/198) as compared to individuals with no daily activity (35.3%, 425/1205; P=0.006). Compared with reference group (i.e., no daily physical activity), the adjusted odds ratio in daily active individuals was 1.61 (95% CI 1.17-2.22; P=0.004).

CONCLUSION: The combination of daily physical activity and SGLT2 inhibitor treatment resulted in a higher glycemic control rate than SGLT2 inhibitor treatment without daily physical activity. This result reinforces the importance of daily physical activity to better control of blood glucose in patients with type 2 diabetes.

SKIN ADVANCED GLYCATION END-PRODUCT LEVELS AND LIFESTYLE-RELATED HABITS OF WOMEN COLLEGE ATHLETES DURING AND AFTER SELF-RESTRAINT PERIOD

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INTRODUCTION: Advanced glycation end-products (AGEs) are harmful compounds formed through an excess of protein and sugar in the human body. Excessive accumulation of AGEs has been reported to accelerate the aging process and contribute to diseases such as arteriosclerosis and diabetes. The first the self-restraint period due to the coronavirus disease 2019 pandemic was announced in Japan for about a month in April 2020. For university athletes who exercised regularly before the self-restraint period, there was a concern that their amount of physical activity will significantly reduce. This study investigated lifestyle-related habits, including eating habits, during and after the self-restraint period and determined whether these habits affected skin advanced glycation end-product (AGE) levels.

METHODS: The subjects were female university students belonging to a physical education university in Tokyo. A questionnaire was administered, and answers on (1) lifestyle-related items, (2) exercise habits, (3) eating habits, and (4) luxury grocery items (e.g., alcohol and tobacco) were obtained. A regarding the measurement time, it was set on a schedule 3 months or more, after the end of the self-restraint period since the skin AGE value is not a short-term index but an index showing the condition 2–3 months ago. First, the AGE value was measured in September 2020. Furthermore, these surveys were conducted in October 2021 for comparison with 2020 AGEs values.

RESULTS: The average skin AGEs value for female students in 2020 was 143.7±24.0 AU.

After the self-restraint period, we could not possible to measure the same subjects. So we measured the skin AGEs values of student athletes from the same university in 2021 for comparison with the 2020 results. The average skin AGEs value for female students in 2021 was 173.9 ± 26.2 AU.

CONCLUSION: In this survey, there were concerns that student athletes lacked knowledge about nutrition, or even if they had knowledge, they could not make full use of it. This study determined the issues faced by students, such as the lack of knowledge about nutritional requirements of college athletes and practical methods to implement that knowledge.

EFFECTS OF 24-WEEKS OF RESISTANCE EXERCISE WITH INSTABILITY ON FUNCTIONAL MOBILITY, BALANCE, AND MUSCLE STRENGTH OF OLDER PEOPLE WITH PROBABLE MILD COGNITIVE IMPAIRMENT: A RANDOMIZED CLINICAL TRIAL

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INTRODUCTION: Mild Cognitive Impairment (MCI) individuals have higher risk of functional deterioration compared to their peers without MCI, which may substantially increase falls risk, hospitalizations, and disability. Resistance exercise (RE) is a well-established strategy to mitigate functional decline trajectories. Resistance exercise with instability (REI) –RE performed under metastability states of equilibrium (e.g., balance pad)– is a promising modality to improve physical functioning. Despite previous findings showed the efficacy of 12-weeks of REI to improve physical components of healthy older adults, their long-term effects in people with signs of cognitive deterioration is not well established. Here, we analyzed the effects of 24-weeks of a REI on functional mobility, balance, and lower limb strength of older individuals with probable MCI.

METHODS: This was a randomized controlled trial (RBR-9bv3dc9) delivered in a single-center in Petrolina-PE, Brazil. Ninety-one participants (mean age=71 years) with probable MCI (MoCA=20±4.5 points) were eligible to the study. Out of 91, 45 were randomly assigned to REI (free-weights-based exercises combined with unstable surfaces/devices including balance discs, foam pads, Bosu®, and Swiss ball) and 46 to a SHAM, attention-matched, control group (unstructured light activities without load progression). Both groups received 24-week intervention (2-times/week) and assessments took place at 0, 12 and 24 weeks. Outcomes included the Short Physical Performance Battery (SPPB), 6-minute walk test (6MWT), Timed Up and Go (TUG), MiniBESTest and isokinetic test. Treatment effects were examined using ANCOVA adjusting by age and baseline of each outcome.

RESULTS: We did not observe significant changes in physical function over 12-weeks in both groups. During 24-week period, REI group improved performance on the SPPB (Δ=0.6 points; 95%CI=0.2;1.0); Usual gait speed (Δ=0.09m/s; 95%CI=-0.03;0.15); 6MWT (Δ=26.7 meters; 95%CI=7.5;45.8) and MiniBESTest (Δ=1.5 points; CI95%=-0.5; 2.6). Similar chances occur in SHAM group for SPPB (Δ= 0.5 points; CI95%=0.1; 0.85) and MiniBESTest (Δ= 1.3 points; CI95%=0.3; 2.3). At completion of 12- and 24-weeks, no difference between-group differences were found (p>0.05). Exploratory per-protocol analysis revealed similar results, with exception for the 6MWT, where REI significantly improved functional capacity (Δ=22.1 meters; 95%CI=1.7; 42.6) at completion of 12-week.

CONCLUSION: Opposing to our initial hypothesis, compared to a SHAM control, 24-weeks of REI did not promote physical function of older people with probable MCI. Despite findings, participants of REI experienced a maintenance of functional mobility, dynamic balance and lower limb strength over study period.

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MECHANICAL PROPERTIES OF QUADRICEPS AFTER FATIGUE AND VIBRATIONAL RECOVERY IN LONG DISTANCE RUNNERS

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INTRODUCTION: Long-distance running has become a popular sport in the world due to its great health benefits. However, regular training or intense competition of the long-distance running usually puts strong demand on both cardiopulmonary and musculoskeletal systems, and thus results in sport injuries especially in the lower extremity. Recovery or relaxation for the major lower extremity muscles after fatigue are important for long-distance runners to prevent injuries. A number of previous studies had demonstrated the effects of using a foam roller on muscle strength, flexibility, range of motions and athletic performance. However, studies investigating the effects of using vibrational gun as relaxation intervention are rare despite the vibrational gun has been commonly used. The purpose of this study was to investigate the effects of fatigue and using the vibrational gun for recovery on muscle mechanical properties and athletic performance in long-distance runners.

METHODS: A total of 12 long-distance runners who has been trained at least 30 km/week for at least 6 months were recruited in this preliminary study. They all received standardized procedures for the aerobic and muscular fatigue, followed by standardized recovery intervention using the Hypervolt vibrational gun on the right rectus femoris. The mechanical properties of right rectus femoris was assessed using a myotonomer. The athletic performance including maximal knee extensor strength, knee flexion range of motion, flexibility of rectus femoris, maximal jumping height, and triple hopping distance were also assessed. All measurements were performed before and after fatigue, and after recovery intervention of vibrational gun.

RESULTS: The results demonstrated that only the maximal strength of quadriceps was changed after fatigue and intervention. The maximal strength of quadriceps significantly decreased after fatigue (P=0.001). The strength improved after vibra-

tional recovery (P=0.020); however, it was still lower than the strength at the baseline (P=0.008). No other changes were observed after fatigue and recovery.

CONCLUSION: The current findings of the pilot study did not support our hypothesis. Several explanations were provided including small sample size, not enough exhaustion and recovery too soon. Further research is still required.

STEPS PER DAY ARE ASSOCIATED WITH BETTER PHYSICAL FUNCTIONING BUT NOT GLOBAL COGNITION IN OLDER PEOPLE WITH PROBABLE MILD COGNITIVE IMPAIRMENT

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INTRODUCTION: The aging process is directly associated with a decline in physical and cognitive capabilities. Physical Activity (PA) play a significant role in terms of boost physical and cognitive functioning, which may alleviate the risk of disability, loss of autonomy, hospitalizations and premature death. Previous studies showed the PA volume (e.g., steps/day), instead intensity, could be a target priority to promote healthy benefits, particularly in older adults–a subgroup of population that have experience higher barriers to engage and maintain healthy behaviors. With this in mind, we explored the association between steps/day with physical and cognitive variables in older adults with probable mild cognitive impairment (MCI)–a population at risk of faster decline in such outcomes.

METHODS: We performed a cross-sectional analysis using baseline data from a clinical trial (RBR-9bv3dc9) that looked at the effects of Resistance Training with Instability on falls incidence in older people with probable MCI [Montreal Cognitive Assessment (MoCA)=20.0; SD=4.7]. The final sample of this sub-study involved 81 community-dwelling older adults (mean age=71 years; SD=0.24; 76% women). The independent variable was the number of steps/day, which was obtained using accelerometry (ActiGraph GT3x) for 7 consecutive days. Physical function was assessed using the Timed Up and Go (TUG), TUG with cognitive demand (animal naming), 6-minute walk test (6MWT) and Short Physical Performance Battery (SPPB) tests. The assessment of global cognitive function was determined through MoCA. The association between PA volume with each physical and cognitive outcomes was tested using multiple linear regression analysis adjusted for age, sex, education level and time spent in moderate-vigorous physical activity. The significance level was set at $p<0.05$.

RESULTS: The adjusted analysis showed a significant and negative association between the number of steps/day and TUG performance (β= -0.44; b= -0.0003; 95% CI: [-0.0005, -0 .0000]; $p<0.01$). No significant associations were observed between the PA volume with TUG (animal naming), 6MWT, SPPB as well as MoCA ($p>0.05$ for all).

CONCLUSION: Our findings revealed that a higher number of steps/day is related to better functional mobility in cognitively impaired older adults. The clinical relevance of these findings are that, for each increment of 2,000 steps/day may potentially to promote a reduction of roughly 0.6 seconds in TUG performance. Therefore, behavioral interventions that encourage an increase in the daily volume of PA (e.g., establishing reasonable steps/day targets) may be promising to improve functionality in this population.

ARE FUNCTIONAL MOBILITY AND BALANCE VARIABLES ASSOCIATED WITH EXECUTIVE FUNCTIONING IN OLDER ADULTS WITH PROBABLE MILD COGNITIVE IMPAIRMENT? A CROSS-SECTIONAL ANALYSIS

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INTRODUCTION: Individuals with Mild Cognitive Impairment (MCI), a risk factor for Alzheimer's Disease, have higher probability to progress for states of functional and executive function declines, which may lead to further adverse outcomes including physical and cognitive frailty, falls, hospitalization, and death. Despite physical and cognitive functioning declines often co-exist in normal aging trajectories, it is not well established whether some domains of functionality and cognition are correlated in impaired cognitive states. Herein, we analyzed the association between functional mobility and balance components with executive functioning in older adults with probable MCI.

METHODS: We performed a secondary analysis using baseline data from a clinical trial who looked at the effects of metastability resistance training on fall prevention. Eighty-two participants (mean age=71 years; SD=0.24; 76% female) met the criteria of probable MCI (MoCA=20.0; SD=4.7) and were included in the study. Variables related to functional mobility and balance involved single- (TUG) and dual-task- Timed Up and Go (TUGcog), Short Physical Performance Battery (SPPB), Six-minute walking test (6MWT) and MiniBESTest. Executive functions were assessed using the Stroop Color-Word Test, Trail Making Test Part A (TMT-A), Digit Symbol Substitution Test (DSST), Digit Span Forward and Backward, Semantic and Phonological Verbal Fluency (VF). The associations between physical domains and executive functioning were determined from crude and multiple linear regression analyzes controlling for factors such as age, sex, body mass index, global cognition (Montreal Cognitive Assessment – MoCA) and total physical activity (GT3X accelerometer).

RESULTS: In the adjusted analysis, we identified that the SPPB was positively associated with DSST (b= 1.99; SE= 0.70; 95%CI= 0.60; 3.39) and phonological VF (b= 1.93; SE= 0.86; 95%CI= 0.22; 3.64), and negatively associated with Stroop part II (b= -2.03; SE= 0.97; 95%CI= -3.95; -0.10), Stroop part III (b= -8.82; SE= 3.52; 95%CI= -15.83; -1.81). We also observed a significant association between MiniBEST with TMT-A (b= -3.87; SE= 1.69; 95%CI= -7.24; -0.49). Nonsignificant associations were found between other domains of physical and cognitive functioning ($p>0,05$).

CONCLUSION: In summary, we demonstrated that, in older people with probable MCI, better functional mobility and dynamic balance performance were independently associated with better executive functioning. The clinical relevance of

these results is that tailored interventions aiming to promote functional benefits can potentially boosting cognitive functioning such as inhibitory control and working memory in people at risk of cognitive decline.

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AGE-RELATED DETERIORATION OF MUSCLE QUALITY OCCURS EVEN IN YOUNG ADULTS DURING A 2-YEAR FOLLOW-UP PERIOD

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INTRODUCTION: Muscle strength has been influenced not only by muscle mass but also by muscle quality, that is, the proportion of non-contractile tissue such as intramuscular fibrous and adipose tissue. Therefore, it is important to understand the age-related changes in muscle characteristics such as muscle mass and quality to develop an evidence-based approach for improving muscle performance. Several cross-sectional studies have shown that age-related changes in muscle quality may occur at an earlier age than the loss of muscle mass. Furthermore, our longitudinal study demonstrated that the degree of age-related decrease in lower-limb muscle mass depends on the muscle. However, no longitudinal study has focused on age-related changes in individual muscle quality, including various lower-limb muscles. Moreover, no longitudinal studies have examined the characteristics of age-related changes in each age group.

This longitudinal study aimed to investigate the age-related changes in muscle mass and quality using the proportion of non-contractile tissue of lower-limb muscles.

METHODS: The participants comprised 37 healthy women aged 20-69 years (mean age, 43.1 ± 13.6 years). The thicknesses of the rectus femoris, vastus lateralis, vastus intermedius, biceps femoris, gastrocnemius, soleus, and tibialis anterior muscles were measured as an index of muscle mass using a B-mode ultrasound device. We also evaluated echo intensity on ultrasonography images as a muscle quality index. Enhanced echo intensity indicates changes in muscle quality due to increased intramuscular fibrous and adipose tissue. Muscle thicknesses and echo intensities were assessed before and after the 2-year follow-up period.

To examine differences in the characteristics of age-related changes by age, participants were classified into two subgroups (aged ≤ 39 years vs. ≥ 40 years), and paired t-tests were conducted to determine changes in muscle thickness and echo intensity between baseline and 2 years later.

RESULTS: Regarding changes in muscle thickness during the 2-year follow-up period, a significant decrease was observed in the tibialis anterior muscle in the middle-aged and older group aged ≥ 40 years, whereas no significant difference was observed in the young group aged ≤ 39 years. With regard to the changes in echo intensity during the 2-year follow-up, significant increases were observed in all muscles in the young group aged ≤ 39 years and the middle-aged and older group aged ≥ 40 years.

CONCLUSION: This longitudinal study showed that age-related muscle atrophy was the greatest in the tibialis anterior muscle among the lower-limb muscles. Additionally, our findings suggest that muscle quality, which is determined by the proportion of non-contractile tissues, such as intramuscular fat, may be more susceptible to aging than to muscle atrophy and that age-related deterioration of muscle quality occurs even in young adults aged ≤ 39 years.

EFFECTS OF SPORTS AND RECREATIONAL ACTIVITIES ON FUNCTIONAL FITNESS AND PSYCHOLOGICAL FUNCTIONING IN THE ELDERLY

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INTRODUCTION: Having the capacity to live independently as people age is important. Being able to socialize and actively participate in social interactions is therefore the goal of health in old age. In order to achieve this goal, health promotion should begin at an early age.

In this study, we investigated the effects of sports and recreational activities on functional fitness and psychological functioning in elderly people.

METHODS: Thirty-seven subjects aged 65 to 89 years old were enrolled in the present survey. Twenty-five subjects performed sports and recreational activities (Ex group). The control group consists of 12 individuals not engaged in either sport activities or recreational activities (Co-group). The subjects in the Ex-group were asked to participate in 90-minute sports and recreational activities. The intervention was set every two weeks for one year (total participation = 24 times). In addition, we implemented a non-supervised exercise regimen. For this reason, we advised the participants to do stretching and resistance training at least three days a week at home. Before and after the one-year-long intervention, each group was assessed by functional fitness tests, including grip strength, standing on one leg with open eyes (SLE), the time up and go test (TG), the 5-meter normal walking test (5-mNW), and the 5-meter maximum fast walking test (5-mMFW). In psychological functioning, subjective well-being, smile scores, and the positive and negative affect schedule (PANAS) scores were investigated.

RESULTS: The results demonstrated that the SLE score, TG score, 5mNW score and 5mMFW score in the post-intervention of the Ex-group was higher than those in their pre-intervention (P <0.05- P < 0.0001), but not in the Co group. The SLE score, TG score, 5mNW score, and 5mMFW score of post-interventions in the Ex-group were significantly higher (P <0.05–P <0.01) than those in the Co-group. The psychological functions in the Ex-group were significantly higher than that in the Co group (P <0.05).

CONCLUSION: These finding suggest that the intervention regimen adopted in this investigation, which included unmonitored exercise therapy, is a successful strategy for enhancing functional fitness and some of the psychological functions in elderly people. Furthermore, we propose that an intervention program that incorporates sports and leisure activities may be able to partially prevent the decrease of functional fitness in the elderly.

THE IMPACT OF HIGH-INTENSITY INTERVAL TRAINING ON REPRODUCTIVE HEALTH

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INTRODUCTION: Exercise is well established to improve human health, but also as a therapy for preventing and managing many diseases.

The aim of this study is to investigate the impact of high-intensity interval training (HIIT) on reproductive health.

METHODS: We reviewed the studies available in full text in the past 15 years, English language articles that focused on the effects of high-intensity interval training on reproductive health, using a MEDLINE/PubMed database

RESULTS: Analysis of the literature has shown that HIIT has the greatest impact on insulin resistance, positive changes in reproduction-related hormones, improve testosterone levels, improved menstrual cycles, increase mitochondrial respiration, increased level of adiponectin, decreased fat percentage, improve semen parameters, sperm DNA integrity, and pregnancy rate, improve body composition and cardiorespiratory fitness

CONCLUSION: HIIT is time-efficient training that affects metabolic, hormonal, and anthropometric parameters, and also increased cardiorespiratory fitness.

EFFECTS OF A MULTIMODAL CARE INTERVENTION ON SUBMAXIMAL EXERCISE PERFORMANCE AFTER KIDNEY TRANSPLANTATION – RESULTS OF THE KTX360° STUDY.

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INTRODUCTION: Kidney transplantation (KTx) is the therapy of choice for patients with end stage renal disease. However, mental and physical impairments are common in patients undergoing KTx. Patients typically report low energy levels and fatigue, low physical activity, poor exercise capacity, and a sedentary lifestyle, factors all of which have been associated with increased risk of cardiovascular events and mortality.

METHODS: As part of KTx 360°, an interdisciplinary, multimodal aftercare program, we included adult KTx recipients after signing informed consent and a general medical examination by a physician. To estimate exercise capacity (peak workload in watt [W]) for subsequent physical activity prescriptions, patients performed an incremental bicycle exercise test until volitional exhaustion. At baseline (BSL), month 6 and 12 a submaximal constant workload test (CWT) of 25 min at 50% of peak exercise capacity was performed. Heart rate, arterialized blood lactate concentration and arterial blood pressure (BP) was recorded at min 0, 15, 20 and 25 of the CWT. Patients received personal training recommendations based on their current activity and physical performance level. The guided training included increasing of daily steps, targeted endurance units and suitable strength exercises. Between the personal appointments at the study center every six months, the training was controlled via telemonitoring (video/telephone). For motivation and training control, patients were equipped with a training diary illustrating suitable exercises and a wearable activity tracker with heart rate measurements.

RESULTS: Out of 814 patients, 715 performed the incremental exercise test at BSL (35% women, age: 57±14 ys, BMI: 26.1±4.7 kg/m2, time from Tx: 4.7±5.7 ys). Patients achieved a peak power output of 112±41 W (women: 89±26 W, men: 127±43 W, p <0.01). This corresponds to 70±20 % of the calculated target power from a healthy norm population. After the 12-month guided program, 206 patients completed the CWT at BSL, month 6 and month 12. The mean heart rate during the constant workload phase of the CWT (from minute 15 to minute 25) was 108.4±18.0 bpm at BSL, 106.2±17.6 at month 6 and 105.6±17.3 bpm at month 12 (p<0.01 for overall time effect). Lactate concentrations did not change significantly when comparing the CWTs at the three visits. The mean systolic BP during the constant workload phase was 150±21 mmHg at BSL, 143±20 mmHG at month 6, and 142±19 mmHG at month 12 (p<0.01 for overall time effect).

CONCLUSION: As previously described in smaller cohorts, performance of kidney transplant patients is significantly reduced as compared to normative values. A 12-month telemonitoring-supported multimodal treatment including psychological, social and physical activity-promoting content shows significant but small effects on submaximal exercise performance in KTx patients.

COMMON RISK FACTORS FOR SPORTS INJURIES IN AMATEUR RUNNERS

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INTRODUCTION: The risk ratio was used to identify runners injuries and protective factors to provide runners with suggestions and guidance for preventing sports injuries. To collect and extract the relevant risk factors of sports injury, a questionnaire was designed for runners to investigate sports injury risk factors.

METHODS: The target population was set as adults who exercise regularly, regardless of gender. The questionnaire was put through Netease positioning and questionnaire star platform in the form of electronic files, utilizing trap questions and manual screening to review the quality. The reliability of the questionnaire was tested by three rounds of the Delphi method and repeated distribution of the questionnaire, which resulted in the final version of the questionnaire. Factor analysis and Binary logistic regression models were developed to identify risk factors for injury. All statistical analyses were conducted utilizing IBM SPSS Statistics Editor for MAC Version 26. A p-value of 0.05 or less was considered significant.

RESULTS: A total of 18316 valid questionnaires were collected and included in the statistical analysis. Among them, 6365 people chose running as their main exercise mode (male: 3305, age = 36.82±7.11years; height = 174.50±4.93 cm; and body mass = 69.99±7.75 kg; female: 3060, age = 32.2±7.38years; height = 163.53±4.95 cm; and body mass = 56.01±6.97kg). The results of the questionnaires showed that the risk ratio of injury for runners was 71.9% (4579/6365) [38.4% (2444/6365) for men and 33.5% (2135/6365) for women]. The results of Bartletts spherical test showed that the KMO values for male and female data were 0.665 and 0.695 ($p < 0.001$). Four common factors were extracted by the principal component method of factor analysis for both male and female runners and named strength quality, exercise habit, fatigue recovery, and physical factors according to risk factor characteristics. The total variance contribution rates of the common factor rotation were 71.021% for males and 69.467% for females, which could generally explain the risk factors of sports injuries for runners.

CONCLUSION: In this study, the injury risk questionnaire has been proven to have good reliability and can effectively collect information on the risk factors of sports injury for runners. To evaluate the sports injury risk for runners, four aspects (strength quality, exercise habits, fatigue recovery and physical factors) could be considered. In addition, fatigue recovery has the greatest impact on the risks of running injuries, while strength training has the least impact on them. Therefore, in the prevention of sports injuries, runners should focus on fatigue problems.

LONG-TERM EFFECTS OF METASTABILITY RESISTANCE TRAINING FOR PREVENT FALLS IN COMMUNITY-DWELLING OLDER ADULTS WITH PROBABLE MILD COGNITIVE IMPAIRMENT: STUDY PROTOCOL WITH PRELIMINARY FINDINGS

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INTRODUCTION: Falls is the most common accident among older adults and is associated with poor functional independence, hospitalizations, and greater economic burden. Older adults with Mild Cognitive Impairment (MCI) have higher rates of falls annually (~70%). Falls prevention guidelines suggests a targeted approach to multicomponent programs that focus on strength and balance, appear to be particularly effective. Previous studies showed that Metastability Resistance Training (MRT)–a strategy of high motor complexity that promotes proprioceptive stimulation through resistance exercises performed under metastable states of equilibrium– is effective to improve functional mobility, balance, muscle strength, and cognition health of older people. However, evidence about its efficacy on falls prevention is unknown. Herein, we will present a study protocol designed to verify the effects MRT as a strategy to prevent falls in older adults with probable MCI.

METHODS: This is an ongoing single-site, randomized controlled trial (RBR-9bv3dc9) which is recruiting (target sample size=286) non-disabled, sedentary, community-dwelling older adults with probable MCI (Montreal Cognitive Assessment=20.0 points, SD=4.5), aged 65 years and older. They will be randomly allocated into two experimental groups: MRT group or SHAM match-attention control group, twice-weekly for 6-months. The MRT protocol will consist of seven weight-bearing and dumbbell exercises (3 sets, 10-15 repetition maximum target zone), simultaneously (and progressively) performed under metastable states of equilibrium (e.g., BOSU, balance disc, Swiss ball, foam pads and suspension traps) throughout the intervention. The SHAM group will perform group-based classes of low-intensity (no progression load) strength/balance, stretching and relaxation exercises. Our primary outcome will be falls rate over 6-months. Secondary outcomes will include concerns about falling, functional mobility/balance, gait biomechanics and cognitive function. These assessments will take place after baseline, 3-, and 6-months. At completion of 6-months, the incidence of falls and the concerns about falling will continue to be monitored for 6-months (follow-up).

RESULTS: Between February and April 2022 (first wave), a total of 196 older adults were screened. Ninety-one participants were eligible, and they were randomly allocated into MTI(n=45) or SHAM(n=46). Most of participants were female (78%) and had a mean age of 71 years (SD=4.8). The dropout rate during 6-months intervention was 15% and 11% for MRT and SHAM, respectively. Participants are currently being monitored for falls incidence and concerns about falling. In February 2023, we started a second wave of recruitment with almost 300 older adults are being screened for eligibility criteria.

CONCLUSION: This innovative trial may to provide insights on the efficacy of a novel exercise modality that could lead a significant reduction of falls rate and improve falls related variables among older adults with MCI.

DO COLLEGE MALE CYCLISTS HAVE LOW BONE MASS? —COMPARING OSTEOGENIC RESPONSES WITH THOSE OF VOLLEYBALLERS

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INTRODUCTION: The immobilization and reduction of physical activities lead to decreases in muscle and bone mass, i.e., sarcopenia or osteoporosis in old age. Therefore, physical activities, especially during young, are very important as a countermeasure for these disorders. Cycling and swimming are popular sports and have positive effects on muscle mass and health. Conversely, many studies reported that the bone mass of cyclists and swimmer were lower compared with aged-matched counterparts or weight-bearing sports players, such as runners or volleyballers. However, cyclists also currently carry out various weight-bearing trainings; thus, whether their bone mass is low is uncertain, although the effects are site specific. Thus, this study aimed to investigate osteogenic responses in cyclists by comparing with those of volleyballers.

METHODS: The participants were male college cyclists (n=13, age = 20.7 ± 0.5 years, height =171.5 ± 6.2 cm, weight = 71.2 ± 6.5 kg) and volleyballers (n=13, age = 19.6 ± 0.8 years, height = 177.7 ± 7.2 cm, weight = 71.5 ± 10.2 kg). Serum bone markers, osteocalcin, bone-specific alkali-phosphatase, and tartrate-resistant acid phosphatase 5b, and 1,25-(OH)2 vitamin D (VD), were measured. Bone stiffness, broadband ultrasound attenuation (BUA), speed of sound (SOS), and Z-score at the calcaneus were measured by defining the dominant and nondominant hand side using quantitative ultrasound (QUS).

RESULTS: The athletic career of cyclists (6.0 ± 0.4 years) was significantly shorter than that of volleyballers (8.8 ± 3.1 years). All bone parameters of the cyclists, except BUA, were significantly lower compared with those of the volleyballers. No significant differences were noted between the dominant and nondominant sides in both groups. The range of Z-score in cyclists were −1.0 to 2.7 at the dominant side and −0.7 to 3.5 at the nondominant side, and in volleyballers, 0.3 to 4.2, and 0.2 to 4.9, respectively. Many cyclists maintained above basal level in terms of Z-score, although only a few cyclists showed a low level (less than 0). Additionally, the bone markers, except VD, had no significant change in both groups. The VD of cyclists was significantly higher than that of volleyballers, which was probably due to the difference in time spent outside.

CONCLUSION: The bone parameters of the calcaneus using QUS were reported to be strongly correlated with bone mineral density at the lumbar spine and femoral neck. Our data showed that osteogenic responses of cyclists were certainly low compared with those of volleyballers; however, college cyclists do not necessarily have less bone mass. It was suggested that various weight-bearing trainings, such as weight training, contributed to bone maintenance in cyclists.

EFFECTS OF EXERCISE BY TYPE AND DURATION ON MILD TO MODERATE IDIOPATHIC SCOLIOSIS IN ADOLESCENTS: A SYSTEMATIC REVIEW AND META-ANALYSIS.

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INTRODUCTION: Adolescent idiopathic scoliosis is a common spinal disease that occurs in a specific age group and poses a serious threat to the physical and mental development of adolescents. Appropriate exercise interventions can produce good corrective effects, but the therapeutic effects of different exercise methods and the optimal exercise time are currently unclear. We conducted a meta-analysis to compare the effects of different types and duration of exercise on mild to moderate idiopathic scoliosis adolescents (AIS).

METHODS: Two researchers searched the electronic databases (PubMed、Web of science、Embase、The Cochrane library、CBM、CNKI et al.). The Cochrane bias risk assessment tool evaluated the methodological quality and publication bias. The data analysis were implemented by Revman 5.4 and Stata 17.0. A total of 18 out of 778 articles were involved into analysis. The Cobb angles was used as the outcome indicator.

RESULTS: The meta-analysis results showed that the Schroth exercise group (MD = -3.48, 95% CI -4.73 to -2.23, $p < 0.00001$), the strength exercise group (MD = -3.43, 95% CI -4.06 to -2.80, $p < 0.00001$), the combined exercise group (MD = -2.76, 95% CI -3.18 to -2.34, $p < 0.00001$), and the suspension exercise group (MD = -2.54, 95% CI -4.13 to -0.95, $p = 0.002$) effectively improved the Cobb angle.

The included studies were divided into two subgroups in regard to exercise duration, less than 60 minutes and more than 60 minutes, to examine the effects of exercise duration on the outcome. The meta-analysis included ten articles with a total sample size of 437. The results of the meta-analysis showed that the group with exercise duration of fewer than 60 minutes (MD = -3.02, 95% CI -3.53 to -2.51, $p < 0.00001$) performed better than the group with more than 60 minutes (MD = -2.49, 95% CI -3.18 to -1.80, $p < 0.00001$) in terms of the effect of Cobb angle.

CONCLUSION: This study confirms that Schroth exercises and strength exercises better affect Cobb angle among the many common exercise modalities for AIS patients. In clinical practice, the appropriate exercise method is selected according to the patients condition to achieve optimal efficacy. Second, this study confirms that the effect on the Cobb angle is better in the group with less than 60 minutes than in the group with more than 60 minutes. Patients with AIS can achieve a better effect with exercises within 60 minutes at a time, but it is essential to ensure the quality of the training.

EXAMINING THE EFFECT OF SUPERVISION ON INDIVIDUAL RESPONSES TO EXERCISE TRAINING IN TERTIARY EMPLOYEES

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INTRODUCTION: Inter-individual variance of responses to exercise have been reported, however the effect of supervision type on individual responsiveness is less understood. Our primary aim was to examine the effect of supervision type on the incidence and distribution of individual responses to exercise training in tertiary employees. The secondary aim was to determine if adaptations at week 8 predicted changes at week 16.

METHODS: Seventy-eight tertiary employees (females n = 55, males n = 23, mean age = 42±9.9) were randomly assigned to three groups: direct supervision in gym (1:1, n = 28), indirect supervision in gym (1:25, n = 24), and non-supervised control (home-based exercise, n = 26) which each completed resistance and aerobic exercise. Cardio-respiratory fitness (VO2peak), muscle strength (sum of bench and leg press (kg), fat loss (mass), mean arterial pressure, and total cholesterol were measured at baseline, 8 and 16 weeks of the intervention. A mixed-methods approach including mixed-effects linear models, technical error of measurement, bivariate profile analysis, and random-intercept random-slope mixed models were employed to determine low, average, and high responders.

RESULTS: A wide range of inter-individual variance of responses were observed, with no consistent responses between outcomes within individuals. Direct and indirect supervision had significant effects on VO2peak (both $p < 0.001$) and muscle strength (both $p < 0.001$) compared to control at week 16. Direct supervision had a significant effect on fat loss at week 8 ($p < 0.05$) and week 16 ($p < 0.001$), but indirect supervision did not have a significant effect ($p > 0.05$) compared to control. Direct supervision appeared to attenuate the incidence of low responses in muscle strength (n = 0/28) and fat loss (n = 3/28) but there was no statistically significant difference compared to other groups ($p = 0.06$ and $p = 0.23$, respectively). Training adaptations at week 8 predicted the magnitude of adaptations at week 16 for all outcomes very highly ($p < 0.001$).

CONCLUSION: Responsiveness to exercise training vary between tertiary employees and do not aggregate consistently across outcomes, highlighting the need for a personalised approach. Direct supervision of exercise may attenuate low responses in strength and fat loss, which may have implications for workplaces and organisations aiming to improve the health of sedentary employees. In addition, training adaptations observed after 8 weeks of training commencement can be used to predict training response 8 weeks later. Early identification of individual responsiveness may alert practitioners to the need for personalised exercise prescription to attenuate the incidence of low responses in healthy, untrained people.

EXERCISE AMELIORATES MITOCHONDRIAL OXIDATIVE CAPACITY IN CARDIOVASCULAR DISEASES: A META-ANALYSIS

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INTRODUCTION: A strong correlation between reduced mitochondrial oxidative capacity and cardiovascular diseases (CVD) has been shown. Our previous studies demonstrated that moderate-intensity continuous and high-intensity interval exercise regimens improved mitochondrial functions of platelets in patients with heart failure [1], stroke [2], and peripheral artery disease [3]. Exercise is potentially a strategy to restore mitochondrial health and fight against CVD. This systematic review aimed to clarify the effect of exercise on mitochondrial oxidative capacity in individuals with CVD and to assemble the exercise protocols.

METHODS: We searched using the PubMed, Web of Science, and Scopus databases using terms including "mitochondria", "exercise", "oxidative capacity", and "cardiovascular disease" in varied combinations. We excluded animal studies, studies involving subjects with hereditary disease, studies with only one bout of exercise, and articles written in languages other than English or have no available full text.

RESULTS: The search yielded 643 records for abstract screening, of which 11 articles met the inclusion criteria. Eight studies examined skeletal muscle while three studies examined peripheral blood cells. The studies measured mitochondrial oxidative capacity (oxidative phosphorylation, mitochondrial ATP rate, phosphocreatine measures, and citrate synthase activity) in patients with heart failure, stroke, or peripheral artery disease after at least four weeks of aerobic or resistance training. Five of the recruited articles were eligible for a meta-analysis, which although with high heterogeneity among the studies ($I2=75\%$, $p=.003$), demonstrated a significant effect size of exercise in improving mitochondrial oxidative capacity (SMD=4.78, CI=2.99 to 6.57, $p<.01$). The findings indicated that aerobic exercise enhanced succinate-involved oxidative phosphorylation. In summary, the exercise regimens proposed low-to-high-intensity aerobic or resistance training, ranging from 10 to 60 minutes per session, low to high weekly volume, and a training period ranging from six to 24 weeks.

CONCLUSION: Exercise training improves the mitochondrial oxidative capacity in skeletal muscles and platelets in patients with CVD. However, exercise protocols employed in the studies were diverse and inconclusive. Further studies are necessary to explain how exercise modifies the pathway of mitochondrial oxidative capacity.

SLEEP AND PHYSICAL FUNCTION ON MENTAL HEALTH IN COMMUNITY-DWELLING OLDER ADULTS: A CROSS SECTIONAL STUDY

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INTRODUCTION: Depression is a common problem among older adults, and it is associated with physical pain, poor medical health and cognitive impairment. Previous research has found a link between poor physical function (handgrips strength, HGS; gait speed, GS; etc), sleep quality and psychological distress. However, the underlying synergistic mechanisms of this connection have still not been well explored. The aim of this study was to examine the roles of HGS, GS, sleep quality and in the link between these risk factors and psychological depression among community-dwelling older adults.

METHODS: In this study we included a total of 117 men and women aged 70.1±4.2 years. We defined depression using Korean version of the short form Geriatric Compression Scale (SGDS-K) developed by Sheik & Yesavage (1986). HGS was measured with hand-held dynamometer with an adjustable grip (TKK-5101, Takei Scientific Instruments Co., Japan). We measured GS was participants walked around a 7 m walkway at comfortable paces. Sleep duration was measured using a modified Munich Chronotype Questionnaire. Older individuals were assessed using the International Physical Activity Questionnaire, body impendence analysis, mobility and aerobic endurance were also measured as a confounding factor.

RESULTS: Thirty-four participants were identified as having depression. In older adults, physical function and sleep quality had a substantial direct influence on depression. Linear and non-linear regression models showed that after controlling data for age and/or sex, depressive score was associated with sleep and physical function. Stronger and significant ($p < 0.05$) associations were also observed for the 70 or more years old age group than <70 years. Results from the multivariate-adjusted logistic regressions showed that individuals who have lowest HGS, GS, short sleep duration (<5 h), and those in combination group (lowest tertile of HGS and GS and short sleep duration) were 2.1 (1.01-3.42), 3.0 (1.09-5.01), 3.7 (1.13-4.89), and 5.8 (1.93-9.37) times more likely to have depression, respectively, compared to those in the highest tertile groups of HGS, GS, sleep and those in the combination group (highest tertile of HGS and GS and adequate sleep time).

CONCLUSION: Each of the physical functional measures and sleep duration was associated with the risk of depression in the older adults. Moreover, participants with poor physical performance in combination of short sleep duration had the highest risk of depression. Given the significant health benefits of exercise and daily physical activity and its favorable effects on physical function and sleep pattern, strategies including exercise focused program should be considered in the prevention of depression in older adults.

THE RELATIONSHIP OF MOTOR COORDINATION WITH HEALTH AND FUNCTIONAL OUTCOMES AMONG CHILDREN IN HONG KONG DURING PANDEMIC-RELATED SOCIAL RESTRICTIONS

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INTRODUCTION: Children with Developmental Coordination Disorder (DCD) display impaired motor proficiency that interferes with age-expected daily activities. In addition to motor proficiency issues, they also have difficulties in other domains of health and function, all of which may be exacerbated by social restrictions such as those imposed during the COVID-19 pandemic. This study aimed to estimate the prevalence of probable DCD among children in Hong Kong and examined the relationship of motor coordination with health and functional outcomes.

METHODS: The participants consist of a population-representative sample of parents of children aged 5-12 years from across Hong Kong (N=632). The parents responded to an online survey that consisted of the Developmental Coordination Disorder Questionnaire-Chinese version, DCDQ-C (1) and components of the Patient Reported Outcome Measurement Information System (PROMIS) Parent Proxy Scale - Global Health, Physical Activity, Positive Affect, and Cognitive Function (2).

RESULTS: Based on the total DCDQ-C score, 19.1% (n=121) of the participants were categorized as "suspect DCD". Children suspected of DCD had significantly lower global health ($U=14888.00$, $Z=-8.89$, $p<0.001$), positive affect ($U=18184.00$, $Z=-7.11$, $p<0.001$), and cognitive function ($U=20844.50$, $Z=-5.56$, $p<0.001$) scores than those who were "probably not DCD". There was no difference in the physical activity score between groups.

For children who are probably not DCD, their DCDQ-C score is significantly correlated with their Global Health ($r=0.45$, $p<0.001$), Positive Affect ($r=0.27$, $p<0.001$) and Cognitive Function ($r=0.31$, $p<0.001$). For children suspected of DCD, their DCDQ-C score was significantly correlated with their physical activity ($r=0.17$, $p=0.05$) and positive affect ($r=0.19$, $p=0.03$). The general coordination subscale of DCDQ-C was particularly associated with Global Health ($r=0.22$, $p=0.014$), Physical Activity ($r=0.28$, $p=0.002$) and Positive Affect ($p=0.24$, $p=0.009$) among children suspected of DCD.

CONCLUSION: The findings revealed a high prevalence of children displaying indications of probable DCD in Hong Kong during the period of pandemic-related restrictions. The relationship between motor difficulties and health and functional outcomes differed between children who were suspected of having DCD and those who were not. However, positive affect was consistently related to motor difficulties among all children. Motor coordination, in particular, was associated with health-related outcomes among those suspected of DCD. As we move towards returning to regular school and social activities, activities that promote motor coordination are crucial to mitigate the extensive negative effects of the pandemic on childrens well-being.

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EFFECTS OF A 13 -WEEK PHYSICAL EDUCATION CLASS ON UNIVERSITY STUDENTS EXERCISE MOTIVATION, MOOD AND BODY IMAGE

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INTRODUCTION: Exercise motivation has been a topic well researched in the past, however, not many researches have been conducted on the relationship among the exercise motivation, mood and body image. The present study examined whether a 13-week physical education class will improve exercise motivation, mood and body image of university students.

METHODS: The participants in this study were enrolled in undergraduate physical education classes at a university in Hong Kong. A total of two hundred female respondents were recruited in this study. Measurement on Exercise Motivation Inventory 2 (EMI-2) and Body Appreciation Scale-2 (BAS -2) and Mood Questionnaire (The Positive and Negative Affect Scale) were used in the study. Participants filled in the three instruments at the first class and the last class. Data were analyzed at the significance level of $p<.05$ for one group pre-test and post-test of the data set.

RESULTS: The Mann-Whitney showed significance at the $p<.05$ for the Body Appreciation Scale-2 and the Mood Questionnaire. One hundred and twenty students (17 ± 2.1 years; 1.55 ± 0.15 m; 50 ± 6.4 kg;) reported increased body appreciation (mean value from 3.6 to 4.0) and one hundred and forty students reported positive mood (mean value from 3.9 to 4.3) after the 13-week class. The students reported to achieve health as the most important exercise motivation. The majority students desired to continue to do exercises in the future.

CONCLUSION: This study suggests that a 13-week physical education class showed increasing positive body image and enhancing mood after participating in physical education classes. Health was a very important concern of students when choosing to exercise. Since the participants in this study were all girls and future study can examine the gender difference on the topic.

LONG-TERM FOOTBALL TRAINING AND C-MIR-1303 EXPRESSION: EFFECTS ON PROLIFERATION, MIGRATION AND INVASION OF HUMAN BREAST CANCER CELL LINES MCF-7

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INTRODUCTION: We analyzed the effects of long-term football training on circulating miR-1303 expression and on the proliferation, migration and invasion pathways in the human breast cancer cell line (MCF-7).

METHODS: 15 veteran football players (VPG; trained at least 40y) and 15 active untrained (CG) healthy males matched for age (66–72 y) were recruited by prof. Krustrup in Denmark. Blood samples at rest (VPG and CG) and immediately after a football match for VPG were collected. MCF-7 cells were cultured to confluence in DMEM with 10% FBS1.

MCF-7 proliferation and migration were assessed by wound healing assay. In brief, cells were starved in 0.5% FBS for 18h, scratched and cultured in 5% sera pool from VPG or CG or FBS (as control) or transiently transfected with 25□M of miR-1303 or miR-1303-Inhibitor (miR-1303-I; mirVana®miRNA mimic, Thermo Fisher, Italy) for 24h and 48h, respectively. The wound closure percentage was calculated in each group and among the groups. The expression of cmiR-1303 in sera from VPG and CG pools and in transfected MCF-7 cells was determined by RTqPCR. For the invasion assay, cells were treated as described above and then layered at a confluence of 5000 cells/well over GrowDex in the 24-transwell chamber. After 24 hours, the cells were fixed and stained with crystal violet and then counted. Phospho-AKT (Ser473) and mTOR protein expression levels were determined by western blot in MCF-7 cells after 48h of treatment.

RESULTS: miR-1303 expression was downregulated in the serum pool from VPG compared to CG ($p<0.05$), and parallel the expression found in the vastus lateralis muscle biopsy from VPG compared to CG2. A 18% increase in wound closure was observed in miR-1303 MCF-7 cells treated compared to FBS or miR-1303-I ($p<0.05$), respectively at 24h. Moreover, MCF-7 cells treated with VPG pool sera shows a 15% compared to CG ($p<0.05$) and 21% compared to miR-1303 transfected cells ($p<0.01$) reduced wound closure, respectively at 24h. miR-1303 over-expression increase the MCF-7 invasion compared to miR-1303-I ($p<0.01$) treated cells; VPG pool sera treatment induces a shut-down of invasion process in MCF-7 cells compared to CG ($p<0.05$). Significant Phospho-AKT (Ser473) and mTOR protein expression increase were found in miR-1303 compared to FBS or miR-1303-I treated MCF-7 cells ($p<0.05$) after 48h.

CONCLUSION: Our preliminary results indicates that the expression of cmiR-1303 was lower in VPG compared to CG; cmiR-1303 expression affect proliferation, migration and invasion process in MCF-7 cells by targeting PI3K-AKT-mTOR pathways. Ongoing experiments are in progress in order to further elucidate the pathways.

Acknowledgments

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SHORT-TERM EFFECTS OF COVID-19 ON PHYSICAL PERFORMANCE, TRAINING LOAD AND MENTAL HEALTH — A STUDY OF CHINESE YOUNG WELL-TRAINED SPRINT KAYAKERS

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INTRODUCTION: COVID-19 has a complex impact on multiple body systems affecting both physical performance and mental health [1]. Evidence-based information on the effects of COVID-19 on athletes' performance can help towards safe return-to-play protocols and clinical management strategies [2]. This study aims to examine the short-term effects of COVID-19 on physical performance, training load, and mental health in young well-trained sprint kayakers during the 2022-2023 season.

METHODS: 17 kayakers (8 male,9 female, age 17.5 ± 1.6 yrs, height 176.03 ± 7.02 cm, body mass 68.8 ± 10.0 kg; mean±SD) underwent two upper-body strength tests and anthropometric measurements before (2 weeks) and after a mild COVID-19 infection (up to 2 weeks after retraining). Mild COVID-19 infection was defined as being without hospitalization and without any health complications lasting longer than 14 days [3]. Peak and mean power output (PP and MP), peak and mean propulsion velocity (PV and MV), and 40-s maximal repetitions of bench pull and bench press were measured with a linear transducer (Gymaware) before and after COVID-19. CR-10 session rating of perceived exertion (sRPE) for training load and Hooper questionnaire for mental status were measured daily and averaged weekly. Nose swab PCR/antigen tests for COVID-19. Statistical analysis included the use of Wilcoxon signed rank test, Student t-test, Pearsons and Spearmans r correlation coefficients.

RESULTS: Duration of main symptoms, detraining, and retraining was 2.9 ± 1.1, 10.4 ± 1.8, and 12.1 ± 1.1 days. There was a significant improvement in body mass, fat-free mass, muscle mass, flexed biceps circumference, absolute and relative PP, and MP of bench pull before and after COVID-19 ($p < 0.05$). There was a significant reduction in training hours per week, sRPE, sRPE-TL, fatigue levels, muscle soreness levels, and Hooper index before and after COVID-19 ($p < 0.05$). However, the duration of main symptoms and detraining were negatively correlated with PP, MP, and PV of bench press after COVID-19 [range $r = -0.51$ ($p < 0.05$) to $r = -0.67$ ($p < 0.01$)]. Duration and training hours per week of retraining were positively correlated with body mass, fat-free mass, muscle mass, flexed biceps circumference, PP, MP, PV, and MV of bench pull and bench press [range $r = 0.50$ ($p < 0.05$) to $r = 0.73$ ($p < 0.001$)]. Sleep quality, stress, fatigue, muscle soreness levels, and Hooper index during the retraining period were negatively correlated with PP and MP of bench pull and bench press [range $r = -0.48$ ($p < 0.05$) to $r = -0.85$ ($p < 0.001$)].

CONCLUSION: A mild COVID-19 infection resulted in changes of anthropometric, training, mental health, and performance variables, but did not result in a reduction of physical performance in well-trained young athletes after short-term retraining. The results of this study will provide valuable information to inform clinical management and improve return-to-play protocols.

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A NOVEL ANTHROPOMETRIC METHOD FOR CENTRAL OBESITY: A PILOT STUDY

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INTRODUCTION: We developed a novel anthropometric method for estimating central obesity. A novel index was also produced to test its correlation with percentage body fat measured using with bioelectrical impedance analysis.

METHODS: 72 university male students participated in the study (Age, mean ±SD, 22.49 ± 1.17 year). Waist circumference (WC) and hip circumference (HC) were also measured. The waist-hip ratio (WHR) and the waist-height ratio (WHtR) were calculated. Measuring central obesity included the following: 1) the length of the vertical abdominal line was measured with an anthropometric tape from the tip of the xiphoid process to the upper margin of the symphysis pubis. An equation was produced to determine a central obesity index (COI) as a measure of central obesity. Percentage body fat was measured using bioelectrical impedance analysis.

RESULTS: Percentage body fat was significantly correlated with both vertical abdominal line and COI ($r = 0.27$, $P = 0.05$; $r = 0.72$, $P = 0.001$) respectively. There was also a significant positive correlation between COI and BMI, WC, WHtR, and WHR. However, vertical abdominal line was correlated significantly only with BMI and WC.

CONCLUSION: Our method is simple, requires minimal training and could an accurate alternative to measure central adiposity in practice especially with large populations.

EXPLORING THE PARADOX OF NORMAL LUNG FUNCTION AND IMPAIRED MUSCLE OXYGENATION DURING MAXIMAL EXERCISE IN UNCOMPLICATED TYPE 2 DIABETES

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INTRODUCTION: Type 2 diabetes (T2D) has been linked to micro and macro-vascular complications due to long-term hyperglycemia, which may affect pulmonary function and muscle oxygenation. The aim of this study was to evaluate all stages of the oxygen pathway in obese individuals with uncomplicated T2D and matched obese individuals without T2D.

METHODS: The study included obese adults with T2D free from clinically detectable microangiopathy (glycated hemoglobin 'HbA1c':8.3±1.2%), and 15 obese adults without T2D, matched for gender, age, and physical activity level. Lung function was assessed at rest and 15 minutes after exercise using spirometry. Participants performed a maximal incremental exercise test during which muscle oxygenation was monitored by near infrared spectroscopy "NIRS". Arterial blood gas samples were collected from the radial artery at rest and during maximal exercise.

RESULTS: Dynamic lung volumes (forced vital capacity: 102.2 ± 11.74 vs. 106.8 ± 16.15 %; forced expiratory volume in 1 second: 100.6 ±10.5 vs. 105.13 ± 16.5 %) were normal in both T2D and controls groups at baseline. There were no significant difference in spirometric lung function between pre- and post-exercise. During maximal exercise, the accumulation and increment in [THb] were significantly lower in the T2D group compared to the control group. [HHb] accumulation from rest to maximal exercise was significantly lower in type 2 diabetes relative to control. Despite similar physical activity level and heart rates at exhaustion (158.2±21.6 vs. 166.2±10.5 bpm, respectively), individuals with T2D had lower VO2max than controls. There were no significant differences in arterial blood gas analyses (PaO2 and PaCO2) between groups.

CONCLUSION: Pulmonary function is normal in individuals with uncomplicated T2D at rest. The defect in maximal oxygen consumption may be due to impaired skeletal muscle oxygenation during exercise, related to reduced limb blood flow and altered muscle deoxygenation in uncomplicated type 2 diabetes.

BRAIN HEALTH AND FITNESS CLASSES IN OLDER ADULTS: INITIAL FINDINGS OF A PILOT PROJECT

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INTRODUCTION: Research suggests that learning and being actively engaged in a community can be beneficial for neurological health. The purpose of this study was to assess the feasibility and initial findings of brain health and fitness classes on subjective hope and heart function.

METHODS: Ten participants completed brain health and fitness classes over 8-weeks. The classes educate the participants about exercise, sleep, stress, nutrition, and socialization. Each class is interactive and includes activities based on the topic of the week. The Adult Hope Scale was completed prior to beginning the courses and after 8-weeks. Participants were given a cardiac sensor that measures vibrational heart activity using seismocardiography (LLA RecordisTM) to take home and take their recordings once per week. The sensor provides cardiac cycle timing intervals, including heart rate, systolic time, diastolic time, and isovolumic contraction and relaxation times (IVCT and IVRT, respectively). Finally, participants were given a Actigraph (Phillips RespironicsTM) to wear before sleeping to record percent sleep efficiency (time asleep/total time spent in bed).

RESULTS: All 10 participants completed the full 8-week course and had no issues with data collection or concerns with the study length (100% retention and adherence to the study procedures). Six (60%) participants had an increase in the Adult Hope Scale at the follow-up in comparison to baseline. All participants collected cardiac data with no difficulties reported, and there were minimal variations in any of the cardiac intervals on a week-to-week basis. There was a non-significant decrease in heart rate from the first 4-weeks at 68 bpm to 63 bpm during the last 4-weeks. All participants reported no issues associated with the use of the Actigraph. Sleep efficiency per participant ranged from 79 to 91%, with minimal week-to-week variations.

CONCLUSION: The Brain Health and Fitness classes can be effectively completed for research purposes, with the methods being simple for the participants to understand and adherence remaining high, suggesting good feasibility. Future research will include larger sample sizes and stratification of the patient population by neurological conditions.

IMPROVING RESISTANCE TRAINING PRESCRIPTION THROUGH THE LOAD-VELOCITY RELATIONSHIP IN FEMALE BREAST CANCER SURVIVORS: THE CASE OF THE BOX SQUAT EXERCISE

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INTRODUCTION: Breast cancer is the cancer type with the highest incidence in women worldwide, with almost 2.1 million new patients diagnosed every year [1]. A negative side effect of the treatment is the loss of approximately 25% of the lower body muscle mass compared to healthy subjects [2]. Resistance training is an effective method to increase muscular strength levels in breast cancer survivors [3]. Movement velocity allows to accurately quantify relative load to prescribe an effective resistance training program [4]. Due to a close relationship has been found between movement velocity and the relative load (%1RM) during the bilateral leg-press exercise in breast cancer survivors [5], the aims of this study were to

analyze the load-velocity relationship during the box squat exercise in female breast cancer survivors and to examine what type of adjustment and velocity variable allows to predict with greater precision the velocities associated with each %1RM.

METHODS: Nineteen breast cancer survivor's women (age: 50.2 ± 10.8 years, weight: 69.6 ± 15.2 kg, height: 160.51 ± 5.25 cm, 1RM box squat exercise: 50.1 ± 10.3 kg), as part of the EFICAN project [6], performed an incremental load test until 1RM in the bench press exercise. The mean propulsive velocity (MPV) and the peak velocity (PV), measured using a linear velocity transducer (T-Force System), were analyzed by lineal (LA) and polynomic (PA) regression models.

RESULTS: A very close relationship between MPV and relative load (%1RM) was observed (R2 = 0.900; $p < 0.0001$; SEE = 0.06 m.s-1 by LA and $R^2 = 0.900$; $p < 0.0001$; SEE = 0.06 m.s-1 by PA). Whereas for PV a worse relationship between %1RM and PV was observed ($R^2 = 0.704$; $p < 0.0001$; SEE = 0.15 m.s-1 by LA and $R^2 = 0.704$; $p < 0.0001$; SEE = 0.15 m.s-1 by PA). The MPV of 1RM was 0.22 ± 0.04 m·s-1, whereas the PV at 1RM was 0.63 ± 0.18 m.s-1

CONCLUSION: LA and PA allow to predict the velocities associated with each %1RM and the estimated 1RM with a great precision during the box squat exercise in female breast cancer survivors. MPV was considered the most recommended velocity variable to prescribe the relative load during resistance training.

EFFECTS OF A SIXTEEN-WEEKS HIGH-SPEED RESISTANCE TRAINING PROGRAM ON BONE MINERAL DENSITY AND CONTENT IN INDEPENDENT OLDER ADULTS

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INTRODUCTION: The United Nations estimates 1.5 billion people aged over 65 years in 2025, compared with 703 million in 2019 (1). Unfortunately, the aging process involves the development of many chronic diseases, namely osteoporosis. Osteoporosis is characterized by low bone mass and microarchitectural deterioration of bone tissue (2). Reduced bone mineral density (BMD) and bone mineral content (BMC) with age increase the likelihood of fall-related fractures (3). A recent meta-analysis recommended the use of resistance training programs for increasing BMD and BMC in older adults (4). This study examined the effects of a 16-weeks high-speed resistance training (HSRT) program on BMD and BMC.

METHODS: This study included 21 independent older adults (age, 69.00±4.32 years). The HSRT program lasted 16 weeks, with 3 sessions per week of 50–60min, each session of 5–6 exercises, 2–3 sets, and 6–10 reps/exercise. The intensity was gradually increased after each session in accordance with the movement velocity (>1.3–0.75 m/s) representing approximately 20% to 60% of one repetition maximum. Participants executed the exercises rapidly and explosively, making all repetitions for each shortening phase (concentric phase) performed as quickly as possible with the lengthening phase of the muscle (eccentric phase) being controlled for 2–3sec. The velocity of the concentric phase in each exercise was monitored by a BEAST™ sensor (Beast Technologies, Brescia, Italy). BMD and BMC for whole-body and dominant femoral neck were measured by dual-energy X-ray absorptiometry. The Ethics Committee of the University of Évora approved the study. The protocol was registered at the ClinicalTrials.gov (NCT05586087).

RESULTS: After the intervention period, the bone indicators demonstrated significant improvements: whole-body BMD ($p>0.001$; effect size (ES)=-0.29 [-0.43, -0.17]); whole-body BMC ($p>0.001$; ES=-0.15 [-0.24, -0.07]); and dominant femoral neck BMD ($p=0.040$; ES=-0.10 [-0.20, -0.01]). No significant difference was found for dominant femoral neck BMC.

CONCLUSION: The results suggest that the HSRT program is an effective and safe exercise approach to improve BMC and BMD in independent older adults.

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THE ASSOCIATION BETWEEN PHYSICAL ACTIVITY AND BONE MINERAL LOSS IN KOREAN OLDER ADULTS WITH MAJOR DEPRESSION DISORDER: FINDINGS FROM A CROSS-SECTIONAL SURVEILLANCE STUDY

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INTRODUCTION: Research shows that major depression disorder (MDD) is associated with bone mineral density (BMD) loss in both male and female older adults, which may increase the risk of osteoporotic fractures [1, 2]. Unhealthy behaviors that are detrimental to bone health (e.g., physical inactivity and/or poor diet), physiological changes (e.g., elevated proinflammatory cytokines and/or disruption of sex hormones), and negative side effects of anti-depressant (e.g., TCAs, SSRIs) are thought to be potential mechanisms of BMD loss [3, 4]. Therefore, we hypothesized that doing more physical activity despite MDD condition may alleviate the BMD loss. The purpose of this study was to examine the moderating

effects of physical activity on the association between MDD and BMD loss in representative samples of Korean older adults.

METHODS: Data were retrieved from a subsample (n=2,527) of 2007-2011 Korea National Health and Nutrition Examination Survey, population-representative surveillance data. MDD was measured with a single-item questionnaire ("have you ever been diagnosed with MDD by a doctor?). Time spent in moderate- to vigorous-intensity physical activity (MVPA) and walking were measured using IPAQ. Bone mineral density was measured using DXA and dichotomized into osteopenia (BMD loss) vs. normal. Sex-specific logistic regression analyses were performed with BMD loss as dependent variable, and MDD, MVPA, and walking, as independent variables. To test the moderation effects, interaction terms between MDD and MVPA and walking (hours per week) were included. Variables that may be associated with BMD loss (i.e., age, total energy intake, smoking, drinking alcohol, vitamin D and calcium intake, BMI, marital status, and socioeconomic status) were included as covariates.

RESULTS: In the male model, MDD was associated with 95% increased risk for BMD loss (OR=1.95, p=.030). Doing 1 hour per week of additional MVPA (OR=0.96, p=044), however, not walking (OR=0.89, p=.110), significantly alleviated the risk for BMD loss associated with MDD in males. In the female model, meanwhile, MDD was not significantly associated with odds of BMD loss (OR=1.63, p=.393).

CONCLUSION: In the current study, MDD was a significant risk factor for BMD loss in older men but not women, despite BMD loss being a more prevalent health burden for menopausal women. We also found that doing more MVPA but not walking seems to protect against BMD loss in older male MDD patients. The results of this study suggest that MVPA should be proactively included as a regimen by mental health professionals.

THE IMPACT OF AEROBIC DANCE EXERCISE ON COGNITIVE FUNCTION IN YOUNG ADULTS: EXAMINING THE ROLE OF MOTOR COMPLEXITY

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INTRODUCTION: Recently, emerging evidence has revealed that a combined exercise program involving physical and cognitive tasks can improve and maintain various psychological functions, such as cognitive and mental health. Similarly, research has shown that physical exercise, such as dance, can play an important role in maintaining the psychological health of the elderly and children, particularly when the exercise is tailored to the individual's task complexity. However, it is still unclear whether motor complexity itself could have a positive effect on cognitive function. The present study conducted a 12-week exercise intervention involving aerobic dance, in which motor complexity was systematically controlled. The study aimed to investigate how motor complexity in dance exercises affects the executive cognitive function of young adults.

METHODS: More than 60 people aged 18–20 years participated in this study. They were randomly divided into three groups: 1) Dance exercise (DE), 2) Aerobic exercise (AE), and 3) Control (Co). The participants in the DE group participated in aerobic dance exercises, while the AE group participated in aerobic exercise using a stationary bike. The participants in both groups attended the 30-min workout three times a week for three months (12 weeks). The Co group were not provided any instructions or targets regarding their daily physical activity. Throughout the dance exercise intervention, the instructor gradually increased the level of motor complexity every three weeks. The intensity of physical exercise between the DE and AE groups was controlled in the same range of 50%–60% HRR. Computer-based cognitive reaction time tests were administered to investigate the effects of training on cognitive function (i.e., cognitive flexibility and working memory). All participants took part in the tests before and after the three-month exercise intervention.

RESULTS: Task performance (i.e., reaction time and correct response rate) of the cognitive tests was analyzed to compare the effect sizes between groups. The 2-way ANOVA (time by group) was conducted to reveal the effects of the dance exercise intervention on cognitive performance.

CONCLUSION: This study demonstrates that regular physical exercise interventions that incorporate motor complexity may have a greater effect on cognitive function compared to simple aerobic exercises.

EFFECTS OF LIFESTYLE ON THE PHYSICAL ACTIVITY OF THE ELDERLY

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INTRODUCTION: In addition to the number of steps and the levels of moderate- and high-intensity activities, recently, sedentary activity time has also been evaluated in physical activity studies. In studies using accelerometers, a common condition for data analysis is that the device must be worn for at least 10 hours each day. However, this device-wearing time does not take into consideration the effects of each persons lifestyle. Therefore, in the present study, the effects of lifestyle on daily physical activity were investigated.

METHODS: The participants were 55 elderly individuals who understood the purpose of the study and had given informed consent to participate. From July to November 2021, each participant was requested to wear an M430 running watch (Polar, Inc.) for 24 hours each day as well as a wGT3X-BT activity monitor (ActiGraph, LLC) from the time they wake up in the morning until going to bed at night. The waking and sleeping times were evaluated using the M430 watch, whereas

the times spent at each activity intensity level and the step counts were evaluated with the wGT3X-BT monitor. Data were collected on seven consecutive days, including weekends. Days on which the participant did not wear the device for more than 10 hours and/or when waking and sleeping times could not be confirmed were excluded from the analysis. Only those participants with valid data for at least three days, including one day of the weekend, were included finally. Analysis-target days were classified as (i) early-rise days, when the individual got up before 6:00 a.m.; (ii) late-night days, when the individual went to bed after 11:00 p.m.; and (iii) standard days, on which neither (i) nor (ii) applied.

RESULTS: Of the 385 days when the accelerometer was worn, 334 days were included in the analysis. Classification of the analysis-target days by lifestyle type revealed 95 as early-rise days, 84 as late-night days, and 155 as standard day. On early-rise days, approximately 2,790 steps were taken by 7:30 a.m., and the individuals tended to go to bed early in the evening. By contrast, on late-night days, the participants showed a tendency to increase physical activity in the evening, with 2,540 steps found to have been taken after 8:00 p.m. The step counts were significantly higher on early–rise days than on late-night and standard days. The ratio of moderate- and high-intensity activity time to total device-wearing time was significantly lower on standard days than on the other two groups of days. By contrast, the ratio of low-intensity activity time to total device-wearing time was significantly higher on standard days.

CONCLUSION: It was shown that the characteristics of physical activity differed according to lifestyle, with individuals who rose early tending to take more steps before breakfast and those who stayed up late taking more steps in the evening.

ASSOCIATION BETWEEN CAROTID INTIMA MEDIA THICKNESS AND FRAILTY AND PHYSICAL ACTIVITY IN OLDER ADULTS

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INTRODUCTION: Frailty is widely prevalent geriatric condition whereby individuals experience age-related functional decline. Although frailty is a risk factor for cardiovascular diseases (CVD), the relationship between frailty and preclinical atherosclerosis remains unclear. Moreover, physical activity has been shown through scientific evidence to be an effective way to improve CVD markers. However, most of these studies were conducted in younger and middle populations. Therefore, the aim of the present study was to clarify relationship between frailty, preclinical atherosclerosis and physical function in older adults.

METHODS: A total 186 older adults (mean age: 77.0 ± 3.5 years) participated in the study. Participants were divided into non-frail, pre-frail, and frail groups using Fried's frailty index (weight loss, low physical activity, exhaustion, slow walking speed, and muscle weakness). Carotid intima-media thickness (CIMT) was measured by high-resolution ultrasound, and divided into three group according to tertiles. Moderate-to-vigorous intensity physical activity (MVPA) time was measured by triaxial accelerometer. Pearson's correlation, one-way ANCOVA and multivariate logistic regression analysis was used to examine the relationship between level of CIMT and frailty and physical activity.

RESULTS: The frailty status of the participants was 94 (50.5%) non-frail participants and 92 (49.5%) pre-frail or frail participants. Physical function such as gait speed ($p < 0.05$) and grip strength ($p < 0.05$), which are used to evaluate frailty were negatively related to CIMT, while MVPA ($p < 0.05$) was reversely related to CIMT. The CIMT in highest tertile had 2.42 times (95% confidence intervals: 1.30-4.09) higher risk of frailty compared to those with CIMT in the lowest tertile. MVPA was higher in lowest tertile of CIMT than middle and highest tertile (respectively, $p < 0.05$).

CONCLUSION: This study showed the strong association between the frailty and increased CIMT. These results suggested that CMIT was an earlier marker of frailty identification. Moreover, physical activity has been shown to be effective in the age-related decline in cardiac autonomic activity and artery structural changes. Longitudinal studies will be needed to confirm the effect of physical activity on the progression of carotid atherosclerosis and frailty among older adults.

ECHOCARDIOGRAPHIC ANALYSIS OF THE HEART OF FEMALE ADOLESCENT ATHLETES

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INTRODUCTION: Athletes develop a combination of cardiac alterations known as athlete heart. There is scientific evidence that in the population of adolescent athletes this also happens. Analyzing the echocardiographic parameters based on reference values by age group it improves the diagnostic accuracy in the possible abnormalities to be identified in this population.The objective of this study is to analyze the heart measurements of the left side of the heart of female athletes, adolescents and to correlate them to age, height, weight, BMI and body surface (BSA), in addition to training time.

METHODS: Retrospective observational cross-sectional study in which the medical records of pediatric patients and female athletes were analyzed. The inclusion criteria were: female athletes who underwent a transthoracic echocardiographic evaluation. The exclusion criteria were: impossibilities in obtaining results of exams for analysis, cardiological alterations and older than 18 years of age. The descriptive analysis of correlated factors (age, height, weight, BMI, body surface and training time) was made. The echocardiographic criteria for morphological were: aortic root (AoR), dimensions of left atrium (DAE), LV end-systolic dimensions (LVESD), LV end-diastolic dimensions (LVEDD), shortening fraction (ΔD), posterior wall thickness (LVPW), interventricular septum thickness (IVS) and left ventricular mass (LVM).

RESULTS: 69 individuals, mean age M= 13,82, DP= 2,10, 41 basketball athletes (59,42%) and 28 volleyball (40,58%). ΔD was not related to any anthropometric variable, BMI was related to DSVE and DDVE (2 out of 8 echocardiographic variables). The training hours were related to AoR, LVESD, LVEDD and LVM. Multiple linear regression analysis considered the following variables: age and BSA. The BSA obtained significant results for all observations, with a percentage of explained

variance of 15,8% (AoR) to 45,8% (LVM), on the other hand, the age variable proved to be an infective predictor for echocardiographic measurements. Nomograms were constructed from the allometric equations by Cavaretta et al *, which demonstrated the non-statistical significance of the age group variable, and a directly proportional correlation of BSA with all echocardiographic measurements, except ΔD.

CONCLUSION: This study suggests an influence of sports practice in the echocardiographic parameters and demonstrated a positive correlation of cardiac measures of the left side of the heart with time of practice and BSA. Standardizing the analysis of cardiac measures related to the development seems to be the right way.

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VALIDITY AND RELIABILITY EVIDENCES OF OBJECTIVE PHYSICAL ACTIVITY MEASURES AND WEARABLE MONITORS: A META-SYSTEMATIC REVIEW

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INTRODUCTION: The purpose of this study was to conduct a meta-systematic review related to the validity and reliability evidences of objective physical activity (PA) measures, focusing on accelerometers and wearable activity monitors for adults.

METHODS: The objective measures of physical activity for the review were including ActiGraph accelerometers (i.e., GT3X+, wGT3X+, wGT3X-BT and GT9X) and ActivPAL due to the most frequently employed for several decades. In addition, wearable devices and Smartphone applications (mHealth APP) were also included. All data were collected from PubMed, Medline (OVID), and Web of Science.

The topic keywords were including 'PA measurement tool name' AND 'accuracy' OR 'validity' OR 'reliability' as well as 'smartphone app' OR 'wearable device' AND 'physical activity' for the smartphones and wearable devices related topics. Four measurement and statistics experts were reviewed the final 156 papers among a total of 2,280 research articles including articles of systematic reviews and meta-analyses based on the review guidelines classified by categories of validity and reliability evidences related to the PA measures. The most current publication for 10 years between 2012 and 2022 were selected for the review.

RESULTS: 1) There were numbers of validity and validation studies of ActiGraph in different versions, and GT3X and GT9X were relatively accurate. Freedson cut-points (1998) has been still widely employed in the PA researches as well as combination equations (Lyden et al., 2011). Wearing the PA devices on the waist were the most accurate compared to other wear-positions. Enough evidences were provided to include weekends and weekdays, at least four days per week and at least 10 hours a day of PA should be measured. The Length of the epoch was frequently set to 60 seconds.

2) ActivPAL was more accurate to wear on the thigh than on the arm. Estimating walking and light activity was more precise than moderate-to-vigorous PA (MVPA).

3) Validation studies of wearable devices were compared to ActiGraph, and seldomly K4b2 (Italy). Among various wrist-worn wearable devices (i.e., Fitbit, Jawbone, Apple Watch, Garmin, Xiaomi Band), Jawbone UP was relatively accurate in light activity and SB, while Fitbit models were accurate during MVPA.

4) Smartphone employed Behavior Change Technology (BCT) including the topics of goal and plan settings, behavior feedbacks, and behavior comparisons, or the utility of the Mobile App Rating Scale (MARS). The higher ranked application provided real-time energy consumption, heart rate, and visualization services, while the lower ranked model provided the number of steps only.

CONCLUSION: The ActiGraph accelerometer has provided acceptable qualities of the validity and reliability evidences to measure PA. Smartphone and wearable devices were able to promote participating in PA in free living, but still not to measure accurately enough.

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THE STIFFNESSES OF PECTORALIS MINOR AND MIDDLE TRAPEZIUS ARE CORRELATED WITH THE KYPHOSIS ANGLE OF THE THORACIC SPINE

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INTRODUCTION: Round shoulder posture (RSP) is a condition of increased thoracic kyphosis and may lead to pain and disabilities. RSP is thought to be caused by an imbalance in the stiffness of thoracic muscles (1,2). However, there are no studies to quantitatively examine whether this imbalanced stiffness influences the kyphosis angle of the thoracic spine. The purpose of this study was to examine association between thoracic muscle stiffnesses and the kyphosis angle of the thoracic spine. Since the change in muscle stiffness of the pectoralis minor is a possible factor in RSP, we hypothesized that the stiffness of the pectoralis minor increases in RSP and that the stiffness of the trapezius muscle consequently decreased by habitual lengthening in RSP.

METHODS: Twenty-seven healthy males (21.4 ± 2.2 years, 173.4 ± 4.9 cm, 67.7 ± 8.1 kg) participated in this study. Shear elastic moduli of the pectoralis minor, pectoralis major (upper, middle and lower), and trapezius (upper, middle and lower) were measured in supine or prone position using ultrasound shear wave elastography. The shear elastic modulus was used as an index of muscle stiffness. The thoracic kyphosis angle was measured in a sitting position using the Spinal Mouse. The Shapiro-Wilk test was used to confirm normal distribution, and then Kendalls rank correlations (r) were conducted between the shear elastic moduli and the kyphosis angles of thoracic spine.

RESULTS: The Kendalls rank correlations showed a significant positive correlation between the shear elastic modulus of the pectoralis minor and the kyphosis angle of the thoracic spine ($r = 0.192$, $p = 0.046$). On the contrary, we found a negative correlation between the shear elastic modulus of the middle trapezius and the kyphosis angle of the thoracic spine ($r = -0.216$, $p = 0.025$). No significant correlations were observed between other muscle stiffnesses and the kyphosis angle of the thoracic spine.

CONCLUSION: Our findings suggest that stiffnesses of the pectoralis minor and middle trapezius are correlated with the kyphosis angle of the thoracic spine in RSP. Stiffness of the pectoralis minor muscle may lead to RSP, resulting in softening of the middle trapezius due to prolonged muscle elongation. Future longitudinal studies are needed to examine the causal relationship between muscle stiffnesses and posture.

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AN EXERCISE PROGRAM INCLUDING LECTURES ON HEALTH IMPROVES PHYSICAL AND MENTAL FITNESS IN ELDERLY WOMEN

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INTRODUCTION: Exercise programs for elderly have been conducted throughout Japan for the purpose of long-term care prevention. We in cooperation with H city, Tokyo, implemented an exercise program which has been introduced as a part of its regional comprehensive care system in order to promote health among elderly residents. The aim of this study was to examine the effects of the exercise program on physical and mental fitness, such as body balance, muscle strength, and flexibility, and health-related quality of life (QOL) in elderly living in the community.

METHODS: The exercise program was held once a week for 14 weeks for 17 female elderly residents aged 65-81 years who have applied on a voluntary basis. Each program included about a 20-minute lecture on health such as exercise, nutrition, and mental health by professionals, which was followed by a 60-minute exercise session. The exercise session consisted of about 10 different exercises which helped promote body balance and build muscle strength of lower limbs, hip, and torso using body weight, elastic bands, and dumbbells. Physical fitness was measured before and after the program through 8 different evaluation methods; open-eyed one-leg standing test, grip strength test, 5-m walk test, timed up and go test, tandem gait test, functional reach test, and sit and reach test. The health-related QOL was assessed using the Short-Form Health Survey 12 (SF-12) such as general health, bodily pain, vitality, and mental health. The amount of physical activity was measured using an accelerometer, which measured the number of daily steps during the 12 weeks. Values between before and after the programs were then compared using a t-test with the significant level set at $p < 0.05$.

RESULTS: The exercise program significantly improved the results of 5-m walk, tandem gait, and functional reach tests and the mental health score of SF-12 ($p < 0.05$, respectively). There were no significant differences in the number of daily steps between before and after the programs.

CONCLUSION: The study showed that weekly exercise program, which incorporate lectures on health as well as exercises designed to enhance body balance and muscle strength, improved mental health in addition to physical fitness in elderly women. Thus, the exercise program including lectures on health may be valuable for the long-term care prevention in elderly.

RESTRICTIVE EFFECT OF VENTILATION WITH THE USE OF DIFFERENT TYPES OF MASKS IN INTENSE PHYSICAL EXERCISE

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INTRODUCTION: During the COVID-19 pandemic, the use of facemasks has been fundamental to control the propagation of the virus. However, there are very few studies of the comparative use of different facemasks in intense physical exercise. It is necessary to be forewarned of new similar situations and to know more precisely the effects of the use of masks on fundamental parameters of the respiratory model in exercise. Therefore, the objective of this study was to compare the use of different masks and their effect on the modification of the fundamental variables of respiration in humans who practice intense physical exercise.

METHODS: Thirteen females (22.08±1.75 years) performed a maximum voluntary ventilation. Thereafter, they performed a grad-ed exercise test on a treadmill until exhaustion. Ventilation during the maximum voluntary ventilation and during the

graded exercise test were measured breath by breath with a gas analyzer (Jaeger-CareFusion, Hochberg, Germany). The maximum voluntary ventilation and the graded exercise test were performed using an ergospirometry mask (Er-goMask) or wearing the FFP2 (ErgoMask+FFP2) or the Emotion mask (ErgoMask+Emotion) below the ErgoMask in tree randomized consecutives days and counterbalanced order. The menstrual cycle was controlled, being all tests performed during the mid-follicular phase (days 6 to 10 of the menstrual cycle) or during the mid-luteal phase (days +5 to +9 after confirmation of ovulation).

RESULTS: Maximum voluntary ventilation showed values of 121 ±16 L/min very similar to those shown by Er-goMask+Emotion 125 ±16.5 L/min (p=0.885) and by ErgoMask alone (114±21 L/min; p=0.095) and very different from those shown in ErgoMask+FFP2 (99 ±14 L/min with F(14,2)=12.4 with p<0.001). At exhaustion in the graded exercise test, it is ob-served a similar behavior pattern. The maximum ventilation with Ergo-Mask was 94±15 L/min, very similar to Er-goMask+Emotion with 90 ±12 L/min (p=0.995) and both significantly different from ErgoMask+FFP2 (75 ±13 L/min with F(14,2)=11.6 with p=0.006).

CONCLUSION: The percentage ratio between the maximum voluntary ventilation and the maximum ventilation obtained during in-tense exercise is known as ventilatory reserve. Our results indicate that exercising with an FPP2 mask can cause a very significant reduction in maximum voluntary ventilation and maximum ventilation during exercise. Since acido-sis is compensated by an increase in ventilation, this reduction in ventilation could lead to increased acidosis in people wearing FFP2 at high intensities. We can conclude that the use of FPP2 masks cause a relevant decline in the bodys ability to ventilate the lungs.

RADIAL BONE THICKNESS, BONE DENSITY, AND BONE QUALITY IN RACKET SPORTS ATHLETES -FOCUSING ON THE RELATIONSHIP BETWEEN MECHANICAL STRESS AND BONE FORMATION-

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INTRODUCTION: Bone strength is determined by bone density and bone quality, but there is no established method for evaluating bone quality. The LD-100 Ultrasonic Bone Densitometer (Oyo Electric Co.: Japan), which uses a two-wave ultrasonic method, can evaluate cancellous bone elasticity, which is considered an indicator of bone quality, in addition to bone thickness and bone density at the distal end of the radius. Bone becomes stronger when it is subjected to mechanical stress. However, the effects of different impact intensities on bone strength (bone density and bone quality) are unknown. Therefore, I focused on racket sports in which the impact on the hand during hitting is considered to differ due to differences in the weight of the racket and the ball (shuttle).

To evaluate the effects of differences in the intensity of repeated impacts on bone formation, we measured bone thickness, bone mineral density, and bone quality at the distal end of the radius using the LD-100 in racket sports athletes with different racket and ball (shuttle) weights.

METHODS: The subjects were 59 healthy male university students aged 18-23 years belonging to Doshisha University (table tennis: n=17, badminton: n=10, soft tennis: n=15, tennis: n=17). Using the LD-100, we evaluated radius bone thickness, cortical bone thickness, transmitted wave attenuation (≒bone density), cancellous bone density, and cancellous bone elasticity (bone quality), and compared them between dominant hand and non-dominant hand, and between groups.

RESULTS: Radius thickness was significantly higher in the dominant hand compared to the non-dominant hand in all groups, and significantly higher in the tennis group compared to the table tennis group ($p<0.05$). Cortical bone thickness was significantly higher in the dominant hand compared to the non-dominant hand in the badminton, soft tennis, and tennis groups ($p<0.05$). Transmitted wave attenuation was significantly higher in the dominant hand compared to the non-dominant hand in the soft tennis and tennis groups ($p<0.05$). Cancellous bone density was significantly higher in the soft tennis group compared to the tennis group ($p<0.05$). Cancellous bone elasticity did not differ significantly between the dominant hand and non-dominant hand or between groups.

CONCLUSION: Bone thickness, cortical bone thickness, and bone mass of the dominant hand were higher than those of the non-dominant hand, and these values tended to be higher when the impact on the hand during hitting was stronger, suggesting that bone formation in the cortical bone may be enhanced when the impact on the hand during hitting is stronger. The effect of impact on bone differed between cortical bone and cancellous bone, with a greater effect on cortical bone compared to cancellous bone. On the other hand, other factors such as age and nutritional status may affect cancellous bone elasticity (bone quality) more than impact.

TEXT NETWORK ANALYSIS AND TOPIC MODELING OF CHANGES IN SHOULDER PAINS AFTER 100 DAY'S SNPE

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INTRODUCTION: The purpose of this study was to synthesize and scrutinize the effects of shoulder pain release after SNPE 100 day's practices by applying the text network analysis and topic modeling.

METHODS: A total of 267 recorded cases for the 100 day's SNPE experiences were adopted from the official website of the SNPE Correct Posture Spine Movement, which was based on the critically developed inclusion and exclusion criteria. Only noun words were extracted, and the user dictionary was constructed to define the similar words, deleted words, and

designated words. Frequency analysis and centrality analysis (degree centrality, eigenvector centrality, clustering) were calculated by participating to cyram 4.0. Keywords of experience cases before and after SNPE 100-day practices were extracted and a Co-occurrence network was created. Network connection structure and centrality analysis were conducted, and major topics were confirmed through topic modeling.

RESULTS: From text network analysis, it was found that the keywords of the SNPE 100-day practices experience were "motion", "pain", and "shoulder", which were high in both frequency and centrality analysis. "Motion", "pain", and "shoulder" can be said to be words that are central to the experience case after 100 days of SNPE training and have an important influence within the text. As a result of topic modeling after 100 days of SNPE training, Topic 1 was categorized as a SNPE shoulder pain relief moves because "motion", "No. 4", "No. 2", and "No. 3" were the main keywords and topics that were effective in relieving shoulder pain. Topic 2 consisted of "improvement," "lumbar spine", "leg", "student", and "cervical spine", and consists of keywords that mean improvement of shoulder pain and uncomfortable areas through SNPE, so Topic was categorized as improving shoulder pain through SNPE. Topic 3 showed "body", "symptom", "acquaintance", "No. 3", and "thymus" as the main keywords. This topic was categorized as an effect of promoting SNPE as it consists of keywords, in which people began SNPE with the recommendation from acquaintances after their pain reduction experiences. Topic 4 was categorized as an SNPE tool effect because it consisted of topics related to the effect of relieving shoulder pain through wave pillows, with "cervical spine", "muscle", "pillow", and "wave" as the main keywords. Topic 5 was categorized as keywords to express gratitude for the participants who helped during the practicing process after 100 days of practicing, with "100 Days", "leader course", "representative", "instructor", and "shoulder".

CONCLUSION: SNPE belt exercises (No. 1, No. 2, No. 3 and No. 4) were confirmed to help release shoulder pain. Thus, more effective exercise prescription of SNPE could be possible for decreasing shoulder pain.

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THE RELATIONSHIP BETWEEN OBJECTIVELY-MEASURED PHYSICAL ACTIVITY AND UNIDENTIFIED SYMPTOMS IN JAPANESE WORKING WOMEN

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INTRODUCTION: Although the social advancement of women has been promoted recently in Japan, the effect of regular employment on working women's health as well as lifestyle has not been fully elucidated. World Health Organization recommended that adults older than 18 years old should spend Moderate-to-Vigorous Physical Activity (MVPA) at least 150 to 300 minutes a week. Previous study1) reported that MVPA for Japanese women were affected by age. In addition, it is also reported that PA in Japanese workers varied among different occupations. Other previous study has pointed out that climacteric symptoms could affect work performance in women. However, Lifestyle related to physical activity of Japanese working women remains unclear. So, the purpose of this study was to investigate the physical activity (PA) of Japanese working women employed in different occupations and their unidentified complaints including climacteric symptoms.

METHODS: Eighty-four women aged from 20 to 65 years old participated in this study. PA was assessed for 7 consecutive days with a triaxial accelerometer (Active style Pro: HJA350IT), and minutes of light physical activity (LPA) and moderate-to-vigorous physical activity (MVPA) as well as sedentary behavior (SB) classified by metabolic equivalents were evaluated. We also asked them to answer questionnaires to evaluate unidentified symptoms including climacteric symptoms (US), perceived stress scale (PSS), and the sense of coherence (SOC-13).

RESULTS: The weekly average LPA in the 20s was significantly lower than that in the 50s.SOC-13 of the 20s was significantly lower than that of those older than 50s. MVPA of working women regularly employed was significantly shorter than that of women non-regularly employed, while SB of regularly employed was significantly longer than that of non-regularly employed. There was no significant difference in PA according to the different occupations of working women during weekends, although childcare teachers showed significantly higher PA than other occupations. There was no significant difference in US, PSS, and SOC-13 among different occupations of working Japanese women. A significant correlation was obtained only between PA during weekends and US. A significant positive correlation between VPA and US and a significant negative correlation between LPA and US were observed.

CONCLUSION: From the results of this study, it is indicated that regular employment would cause an increase in SB and LPA in Japanese working women. Higher PA during weekends would improve working women's health such as fewer unidentified symptoms.

ASSOCIATIONS BETWEEN PHYSICAL ACTIVITY AND FAT-FREE MASS IN JAPANESE YOUNG ADULTS AFTER THE COVID-19 PANDEMIC: A CROSS-SECTIONAL STUDY

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INTRODUCTION: World Health Organization (WHO)'s guideline insists on the importance of moderate-vigorous intensity physical activity (MVPA) and muscle-strength activity [1], because loss of muscle mass has been known to increase the risk of metabolic diseases, frailty and sarcopenia [2,3]. Loss of muscle mass begins early in life and becomes noticeable with age [3]. Thus, physical activity is important for young adults to maintain and increase muscle mass. Additionally, physical activity related to muscle mass may differ between males and females because of gender differences in muscle mass [4].

However, there are no studies on body composition and physical activity among young adults in post-pandemic Japan. This study aimed to investigate the relationship between body composition and physical activity among Japanese young adults and to investigate how gender affects the association between physical activity and body composition.

METHODS: Sixty healthy young adults (33 males: age: 23.0±1.9 years, body mass index: 22.7±3.4 kg/m2 [range 17.3-29.8 kg/m2], 27 females, age: 23.0±2.2 years, body mass index: 20.5±1.8 kg/m2 [range 16.7-23.3 kg/m2]) participated in a cross-sectional study. Body mass, body fat percentage, and lean body mass were measured using a multifrequency bioelectrical impedance analysis, and the fat-free mass index (FFMI) was calculated by the lean body mass and height. Physical activity per week and sedentary time per day were assessed using the International Physical Activity Questionnaire short version. Venous blood samples were collected for measurements in total cholesterol (TC), triglycerides (TG), low-density lipoprotein-cholesterol (LDL-C), high-density lipoprotein-cholesterol (HDL-C) and glucose (GLU).

RESULTS: In all participants, FFMI had significant correlations with vigorous-intensity physical activity (VPA, r=0.591, p<0.001), MVPA (r=0.536, p<0.001), total physical activity (TPA, r=0.491, p<0.001), sedentary time (ST, r=-0.279, p=0.031), TC (r=-0.290, p=0.024) and LDL-C (-0.493, p<0.001). In males, FFMI had significant correlations with VPA (r=0.589, p<0.001), MVPA (r=0.534, p=0.001), TPA (r=0.485, p=0.004), ST (r=-0.448, p=0.009). In females, FFMI had a significant correlation with VPA (r=0.461, p=0.015).

CONCLUSION: In males, FFMI had significant correlations with VPA, MVPA, TPA and ST, while in females, FFMI had a significant correlation only with VPA. It is known that muscle gain can vary between males and females when performing exercise at moderate-intensity due to different sex hormones concentration [4,5]. Thus, in young adult women, moderate-intensity physical activity among MVPA may have no association with fat-free mass. In conclusion, significant correlations between body composition and physical activity were found in young adults, but fat-free mass in females is a significant correlation only with VPA.

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EFFECTS OF A SIX-WEEK COMBINED TRAINING PROGRAM ON BODY COMPOSITION PARAMETERS IN OBESE ADULTS

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INTRODUCTION: Obesity is a major public health issue worldwide, with over 1 billion people estimated to be obese by 2030 (1). Just as excess body weight is an independent predictor of cardiometabolic disease risk, excessive body fat is directly related to the metabolic syndrome. Appropriate dietary changes and exercise are crucial components in the treatment of obesity and several associated diseases (2), however, the comparative effectiveness of different exercise programs remains unclear, mainly due to the lack of systematic reviews and meta-analysis of RCT in this field (3). The aim of this study was to examine the changes in body composition parameters in obese adults after 6 weeks of combined training (High-Intensity Interval Training (HIIT) and Moderate-Intensity Continuous Aerobic Training (MICT)).

METHODS: Thirty-five obese adults were divided into 2 groups: intervention group (IG) (n=20,age,42.73±6.95) or control group (CG) (n=15, age,37.75±9.11). The combined training lasted 6 weeks, with 3 sessions per week of 45min, each session of 6 calisthenics exercises with 2–3 sets, performed for 20 sec, with 10 sec of rest between exercises and 1 min between each sets, the remaining time was applied the MICT in walking form. The intensity was controlled by the %HRmax of each participant, being that during HIIT the intensity was always >75%HRmax and for MICT at 50-65%HRmax. The intensity was monitored using the Polar M430. Anthropometric assessments included the waist circumference (WC) and hip circumference (HC) measured by a specialist and the body composition parameters [weight; fat mass; muscle mass; body mass index (BMI)] were measured by Tanita MC-780 MA.

RESULTS: The IG showed significant reductions on weight (p>0.001; effect size (ES)=0.31 [-0.31, 0.94]); fat mass (p>0.001; ES=0.47 [-0.16, 1.10]); BMI (p>0.001; ES=0.43 [-0.19, 1.06]); WC (p>0.001; ES=0.59 [-0.03, 1.24]); and on HC (p>0.001; ES=0.72 [0.09, 1.38]). No significant difference was found on muscle mass for IG. Lastly, no significant differences were observed in CG for all parameters under study.

CONCLUSION: The combined training is an effective and safe exercise approach to reducing body composition parameters in obese adults.

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REGULAR EXERCISE PREVENTS AGING-RELATED ENDOTHELIAL DYSFUNCTION: LONG-TERM EFFECTS ON PLASMA ANTIOXIDANT ACTIVITY IN THE CUTANEOUS MICROCIRCULATION OF MASTER ATHLETES

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INTRODUCTION: Endothelial dysfunction is an early marker of vascular aging and cardiovascular disease. Advancing age is responsible for increased inflammatory states and oxidative stress with a consequent endothelium damage: in fact, free radicals alter membrane lipids, nucleic acids and proteins leading to the endothelial dysfunction [1]. However, regular exercise positively acts on the oxidative stress improving endogenous antioxidant defenses [2]. The aim of this prospective cohort study was to evaluate long-term effects of physical activity on plasma antioxidant capability and microcirculatory functions in a population of elderly athletes compared to sedentary controls.

METHODS: Between 2002 and 2003 (T0), 36 long-distance runners, (range: 22-74 years, VO2 max 55.1 ± 5.8 ml/kg/min) and 36 healthy sedentary volunteers (range: 20-75 years, VO2 max 34.5 ±3.1 ml/kg/min) were enrolled. Hand and foot baseline and stimulated skin blood flow (SBF) was measured by laser-Doppler flowmetry. Total Oxyradical Scavenging Capacity (TOSC) assay was used to determine plasma antioxidant capacity against peroxyl (ROO•) and hydroxyl radicals (OH•). 50 of the 72 subjects returned for a 20-year follow-up (T1): 28 athletes (range: 42-93 years) and 22 healthy sedentary subjects (range: 41-90 years) evaluated with the same methods.

RESULTS: Similarly to what happened at T0, at T1 athletes exhibited higher hand and foot stimulated SBF when compared to their respective sedentary controls ($P < 0.001$ in both cases). Interestingly, athletes at T1 had significantly higher hand and foot stimulated SBF after ischemia and after warm-up when compared to sedentary controls at T0 ($P < 0.01$ in both cases). Both at T0 and T1, plasma TOSC values against ROO• and OH• were significantly higher in athletes than in sedentary controls (P<0,001). Moreover, there was a positive correlation between plasma antioxidant activity against ROO• (P<0.001) and OH• (P<0.001) and stimulated hand and foot SBF. The same correlation was found in athletes at T1. In sedentary individuals, TOSC values were negatively correlated with age at both T0 and T1 (P<0.001).

CONCLUSION: After a 20-year follow up, regular exercise has been shown to prevent aging-related endothelial dysfunction by improving and preserving plasma antioxidant defenses in the cutaneous microcirculation.

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THE EFFECT OF 10-WEEK RESISTANCE ENDURANCE TRAINING ON THE MUSCLE STRENGTH AND BALANCE IN ELDERLY WOMEN

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INTRODUCTION: Several epidemiological studies show that falls are a common part of elderly population. More than a third of the over-65 population falls at least once a year, and the risk increases with age. The risk of falls also significantly depends on balance skills. Although their level is influenced by muscle strength, maintaining balance is highly dependent on sensory abilities, especially visual control. This study aims to determine the effectiveness of strength endurance training in muscle strength and balance in unstable conditions with or without visual control.

METHODS: A total of 13 active, healthy elderly women participated in this study. Subjects were randomly assigned to a resistance endurance training group (REG: n = 6, sex: 6F, age: 72.8 ± 3.0 y, body weight: 69.9 ± 15.5. kg, BMI: 25.7 ± 7.6) and a control group (CG: n = 7, sex: 7F, age: 69.4 ± 3.4 y, body weight: 68.71 ± 5.7, BMI: 25.2 ± 2.6). REG followed a 10-week training program twice a week. CG was with no intervention. Before and after the intervention, 30 s stance test on an unstable platform with eyes open, 30 s stance test on an unstable platform with eyes closed, 30 s chair stand test and maximal voluntary contraction (MVC) in knee extension (right / left) were performed.

RESULTS: The mean velocity of the centre of pressure (COP) in the 30 s stance test on an unstable platform with eyes open was not significantly improved after intervention (from 14.75 ± 6.79 mm/s to 14.84 ± to 7.84 mm/s). There was a significant difference in the mean velocity of COP in 30 s stance on an unstable platform with eyes closed (from 35.63 ± 17.13 mm/s to 27.26 ± 13.36 mm/s, Z = -1.992, p = .046). Significant changes were also found in the 30 s chair stand test (from 17.83 ± 4.23 reps to 21.5 ± 6.22 reps, Z = -2.207, p = .027), MVC (right) (from 121.15 t± 44.79 N/m to 128.48 ± 44.87 N/m, Z = -1.992, p = .046) and MVC (left) (from 122.85 t ± 36.78 N/m to 128.23 ± 39.61 N/m, Z = -1.992, p = .046).

CONCLUSION: Preliminary data indicate that, in addition to improving lower extremity strength parameters, strength endurance training has a positive effect on balance in unstable conditions without visual control in elderly women, which may be helpful in reducing the risk of falls.

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FOOT GROWTH CHARACTERISTICS OF CHILDREN AGED 5-17 YEARS

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INTRODUCTION: The foot status of children is influenced many factors such as heredity and environment. It is assumed that the Nepal geographical condition such as hill or mountain environment affects the growth status. This study was aimed to investigate foot growth characteristics of JAN children at Nepal hill and lowlands area.

METHODS: The samples were 766 healthy children of JAN at hill area and JAN at Terai (lowlands) area (347 boys and 419 girls) aged 5-17 years, higher secondary school in/around Kathmandu Valley and Terai area, Nepal. Foot sole parameters, foot length, width, width/length ratio, arch type, were measured using a 2D foot scanner during 2015-2023. Their height and weight were also measured. Descriptive statistics of foot sole parameters, height and weight were calculated by age, sex and ethnic groups (Hill JAN and Terai JAN). The difference of these statistics was compared between ethnic groups by age and sex.

RESULTS: Mean height of Terai JAN children aged 5 -17 years ranged from 104.5-161.3 cm for boys and 103.1-149.7 cm for girls. It was smaller to Hill JAN children, which was 99.0-159.2 cm for boys and 98.7-148.0 cm for girls. Mean weight of Terai JAN children ranged from 14.5-50.6 kg for boys and 15.4-46.6 kg for girls. It was smaller than Hill JAN children, which was 17.5-50.9 kg for boys and 16.4-51.8 kg for girls. Mean foot length of Hill JAN children aged 5 -17 years ranged from 16.0-22.1 cm for girls. They are very similar to Terai JAN children, which was 16.3-22.4 cm for girls. However, the Terai JAN boys foot length ranged 18.6-24.7 cm was greater than Hill JAN boys ranged 16.6-23.9 cm. Mean foot width among the Hill JAN children aged 5 -17 years ranged from 6.8-9.7 cm for boys. It was very similar to Terai JAN boy children, which was 6.8-9.8 cm for boys. However, the Terai JAN boys foot width ranged 6.8-9.4 cm was greater than Hill JAN boys ranged 6.1-8.9 cm. Mean height of Terai JAN children aged 5 -17 years ranged from 104.5-161.3 cm for boys and 103.1-149.7 cm for girls. It was smaller to Hill JAN children, which was 99.0-159.2 cm for boys and 98.7-148.0 cm for girls. For the foot characteristics, the mean width/length ratio of both Hill JAN boys and girls was very similar to Terai JAN children. Regarding Arch type, both Terai JAN boys and girls was higher rate of high arch compared with Hill JAN boys and girls. The shape of the foot is classified into three categories; Egyptian type was 98.0%, Greek type was 2.0% and Square type was 0%. Nepal children have a high incidence of high arch and very high arch instead of the low prevalence of flat arch and hallux valgus. The width/length ratio was similar to Japanese.

CONCLUSION: Mean foot length and foot width show a steady increases from 5-14 years in boys and also a gradual increase among girls of the same age group. There is no difference of foot arch construction rate between Hill JAN and Terai JAN ; however, their normal rate is higher than Japanese children.

SOCIAL ENRICHMENT INCREASES THE ENJOYMENT OF EXERCISE BUT NOT AFFECTS SERUM 2-ARACHIDONOYLGLYCEROL LEVELS.

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INTRODUCTION: Endurance exercise increases serum endogenous cannabinoids (eCBs) levels and induces mental status alternations such as antianxiety, euphoria, and difficulties estimating the passage of time. As a result, these phenomena are widely known as runner's high. The 2-Arachidonoylglycerol (2-AG) is one of the significant eCBs, and we reported that a single bout of moderate-intensity exercise increases serum 2-AG levels and euphoria. Therefore, it could be the mediator of the runner's high. On the other hand, a previous study identified that it is harder to feel pain when a romantic partner is in the same space. According to those studies, we hypothesized that moderate-intensity exercise with close friends and conversation could increase serum 2-AG levels more than exercise alone or prohibit dialog. In addition, this situation could better alter the mental status during exercise.

METHODS: Ten subjects (21±1 years) were recruited in this study. Moderate intensity was defined as the lactate threshold. They carried out cycle ergometer exercise for 30 minutes at LT intensity under four situations as follows; Conversation with close friends (CONV), Prohibit Conversation (PROH), Conversation with someone who had never met (SOME), and alone (ALON). Blood samples were obtained before and after the exercise. In addition, rate of perceived exertion (RPE), mental status (Enjoyment, Discomfort, Exhilaration, Elation), and subjective passage of exercise time (e.g., How did you feel the exercise time?) were also evaluated using a 10cm visual analogue scale (0 to 100) simultaneously. Because 2-AG is rapidly isomerized to 1-arachidonoylglycerol (1-AG), the concentrations of 2-AG and 1-AG were measured using LC-MS/MS. The sum of these values (2-AG + 1-AG) was used as the index of blood 2-AG level.

RESULTS: All moderate-intensity exercise increased serum 2-AG levels, RPE, exhilaration, and elation; however, the change in their data showed no significant differences among the situations. The CONV (22 (9-38) vs. 70 (64-76); Median (Quartile), Pre vs. Post, respectively), SOME (11 (7-33) vs. 61 (49-75)), and ALON (30 (22-49) vs. 59 (47-64)) increased enjoyment but not in PROH (28 (11-51) vs. 51 (23-62)) after the exercise. In addition, the change of enjoyment was lower in PROH than in other conversation situations. Although the PROH (2 (0-21) vs. 19 (16-54)), SOME (11 (6-21) vs. 28 (10-56)), and ALON (10 (2-42) vs. 35 (22-59)) increased discomfort, the CONV (6 (0-13) vs. 7 (0-26)) did not significantly changed. Furthermore, CONV and SOME were significantly shorter in the subjective passage of exercise time than that PROH and ALON.

CONCLUSION: This study confirmed that moderate-intensity exercise increases serum 2-AG concentration; however, it did not find the synergistic effect of training and social enrichment. Exercise with close friends and conversation may independent factor for runner's high.

ASSOCIATION BETWEEN PHYSICAL ACTIVITY AND MITOCHONDRIAL DNA COPY NUMBER IN MIDDLE-AGED ADULTS IN SOUTH KOREA

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INTRODUCTION: Mitochondria play a critical role in cellular metabolism, and mitochondrial dysfunction is related to metabolic disturbances. Mitochondrial DNA copy number (mtDNAcn) is considered a useful indicator of mitochondrial function. Physical Activity (PA) has been suggested as a substantial intervention to prevent and improve metabolic conditions. However, few studies have been conducted on the relationship between PA and mitochondrial function. Therefore, we aimed to investigate the cross-sectional association between PA and mtDNAcn in middle-aged adults in South Korea.

METHODS: We examined a total of 256 community-dwelling middle-aged adults using a set of questionnaires, accelerometers, and blood samples. Subjective PA was assessed by the Korean version of the International Physical Activity Questionnaire (IPAQ) short form, and objective PA was measured using the ActiGraph GT3X+ accelerometer for 3 consecutive days. MtDNAcn was measured in whole blood using a qPCR-based assay.

RESULTS: The IPAQ continuous score was calculated as metabolic equivalent of task (MET)-min/week. A total PA MET-min/week was 2422.78 ± 2915.55, walking was 1299.18 ± 1936.65 MET-min/week, moderate activity was 444.53 ± 851.45 MET-min/week, and vigorous activity was 679.06 ± 1849.92 MET-min/week. Among these indicators, total MET and walking MET were positively associated with mtDNAcn (r=.19, p=.002; r=.19, p=.002, respectively). Objective PA was based on triaxial counts, and the mean of total activity counts (TAC) was 559481.43 ± 182232.41 TAC/day (n=204). Sedentary time spent was 740.82 ± 121.96 min/day, light-intensity PA was 299.43 ± 93.35 min/day, moderate-intensity PA was 37.48 ± 25.54 min/day, and vigorous-intensity PA was 1.08 ± 3.82 min/day. Among these variables, only light-intensity PA was positively associated with mtDNAcn (r=.21, p=.003).

CONCLUSION: Our data indicate that total MET, walking MET, and light-intensity PA are positively associated with mtDNAcn. The findings suggest that PA may have positive effects on mitochondrial function, and that specifically low-intensity levels of PA appear to be beneficial. These results could be used to explain the underlying mechanism by which PA improves metabolic disturbances at the mitochondrial level.

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A MULTICOMPONENT EXERCISE INTERVENTION IMPROVES GAIT IN NURSING HOME RESIDENTS

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INTRODUCTION: Nursing home residents are known to reduce their physical activity and mobility along with aging. Additionally, falls at older age are a major risk for prolonged immobility and resulting health burdens. Therefore, the objective of this study is to investigate the efficacy of a multicomponent exercise intervention on gait performance in nursing home residents.

METHODS: Nursing home residents from 6 institutions were allocated to either a multicomponent exercise programme or to a waiting list control group. The intervention participants exercised twice a week for 16 weeks, each time 45 to 60 minutes. Individually tailored strength, endurance, balance, and flexibility exercises were combined with cognitive tasks. Pre- and post-intervention the step length and width as well as gait speed and double support phase were assessed at preferred and maximum gait speed. We conducted repeated measures analyses of variance including the age of the participants as covariate.

RESULTS: At preferred speed, only the changes of gait speed differed significantly between groups ($F = 10.144$; $p = .003$). Whereas the intervention group showed steady values, the gait speed of the control group decreased. At maximum speed, the changes in step length ($F = 6.815$; $p = .013$) and double support phase ($F = 4.364$; $p = .044$) differed significantly. The intervention group was able to improve their average step length (increase) and double support phase (reduction), whereas the average values of the control group deteriorated. The step width showed no significant group*time effects in neither of the captured gait velocities ($p > .05$).

CONCLUSION: A multicomponent training programme in nursing home residents seems to have the potential to improve specific gait parameters. Unfortunately, changes varied between different gait velocities and parameters. Interventions to promote gait performance in general and independent of varying velocities need to be further investigated. Overall, multicomponent exercise interventions to improve the gait performance can be recommended in nursing practice.

ASSESSMENT OF MECHANICAL PROPERTIES OF MUSCLE TISSUE IN HEMODIALYSIS PATIENTS

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INTRODUCTION: Decreased exercise capacity due to muscle weakness and exercise intolerance reduces the ability to perform activities of daily living in patients with end-stage kidney disease. The chronic inflammatory state and uremic sarcopenia impact muscle tissue, causing morphological changes and muscle loss. After hemodialysis patients often report fatigue, muscle weakness, and stiffness. Changes in muscle properties during dialysis may provide a valuable assessment tool for detecting those at risk of painful cramps and pain. Data on the influence of the hemodialysis process itself on muscle tissue are scarce. There is still an open debate about the usefulness of hand-held myometric devices. AIM: The aim of the study was to evaluate the influence of dialysis sessions on the mechanical

properties of muscle tissue in HD patients.

METHODS: The research was carried out in stable (> 6 months) 20 chronic hemodialysis patients (dialysis time 3 – 192 months; mean age ±59,8; 11 males and 9 females) at the dialysis station. The stiffness of the quadriceps muscles was assessed with MyotonPro device, before and right after the hemodialysis session.

RESULTS: It was found that the muscle stiffness depended on the age of the patient and

was not related to the duration of dialysis. After the hemodialysis session, quadriceps stiffness increased in 16 patients (80%) in the right limb, and in 15 patients (75%) in the case of the left limb. In the case of the right limb, the average increase in stiffness was statistically significant, while in the case of the left limb, it was smaller and statistically irrelevant.

CONCLUSION: During the 4-hour hemodialysis session, the stiffness of the quadriceps muscle increased in the majority of patients. Although more studies on larger patient groups are needed, it can be assumed that myometry can be a helpful toll in the assessment of changes in mechanical muscle properties.

EXERCISE ENVIRONMENT, SEDENTARY LIFESTYLE AND AGING: IMPACTS ON BONE MASS

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INTRODUCTION: In a terrestrial environment, low levels of physical activity have been negatively associated with bone mass [1]. On the other hand, some findings suggest that swimming practice in a low-gravitational environment (i.e., aquatic) has no effect on bone mass and, therefore, no osteogenic effect when compared to the effects observed for weight-bearing sports [2]. In addition, lack of physical activity and advancing age are factors that accelerate the osteoblastic process [3]. Therefore, this study aimed to compare athletes practicing exercise in different environments with non-active young and elderly men and women regarding bone mineral density (BMD), hypothesizing that BMD values differ between athletes according to the environment of exercise practice, but those training in a low-gravitational environment have no different stimuli to BMD increasing if compared with healthy peers experiencing reduced exercise involvement, whatever the age group and sex.

METHODS: One-hundred and four participants of both sexes were selected according to the environment of exercise practice [swimmers (N = 26) and judo fighters (N = 26)], and exercise level of involvement [non-active young (N = 26) and older adults (N = 26)]. Dual-energy X-ray absorptiometry provided BMD, lean mass, and fat mass (FM) for the whole body (WB), upper (UL), and lower limbs (LL).

RESULTS: For the BMD in WB, UL and LL no effects of group and sex were observed ($p > 0.05$). Post-hoc analyses detected higher values of BMD in UL for female swimmers compared to non-active older adults ($p < 0.05$), while judo fighters showed higher BMD in WB, UL, and LL than other participants whatever the sex ($p < 0.01$). Lower FM was observed for WB, UL, and LL when swimmers and judo fighters were compared to non-active young and older female peers ($p < 0.01$).

CONCLUSION: The findings emphasized that BMD stimuli with swimming are reduced when compared to judo, and despite the stimuli in swimming is not distinguishable from that affecting BMD in WB, UL and LL of non-active young, it is effective in differing BMD in UL among non-active older for women.

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OBJECTIVELY MEASURED PHYSICAL ACTIVITY AND MENTAL HEALTH IN ASYLUM SEEKERS IN A GREEK REFUGEE CAMP.

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INTRODUCTION: In recent years a significant increase in forced displacement has been observed as a result of wars, natural disasters, and violations of human rights with forcibly displaced people reaching the dramatic number of 100 million. People who have been forcibly displaced frequently face physical and mental strain, which can lead to traumatic experiences and poor mental health. Though data for refugees are scarce, physical activity has been associated with better mental health. Nonetheless, most of the studies have been based on self-reported physical activity, which has been questioned as patients with mental health disorders in general and refugees in particular tend to overreport physical activity levels. Thus, research assessing physical activity through objective measures is warranted. Accordingly, the purpose of the present ongoing study was to explore the relationships of objectively measured physical activity with anxiety and depression in asylum seekers residing in a refugee camp in Greece.

METHODS: Participants were 64 asylum seekers (24 women) from Afghanistan, the Middle East, and sub-Saharan countries, with a mean age of 30.27 years. Participants were asked to wear a triaxial accelerometer device on the right hip during waking hours for seven consecutive days. Upon completion of the seventh day the device was collected from participants, who were subsequently asked to complete questionnaires assessing anxiety (General Anxiety Disorder-7) and depression (Patient Health Questionnaire-9) in their native language.

RESULTS: The analysis revealed that participants wore the accelerometer device for an average of 6.30 days. Regarding the levels of physical activity, the accelerometers showed on average 8 hours and 51 minutes of sedentary time, 2 hours and 24 minutes of light physical activity, 34 minutes of moderate and 6 minutes of vigorous physical activity per day. Regression analysis showed that light and moderate-vigorous physical activity could predict 10 % of the depression variance (p=.04) and 10 % of the anxiety variance (p=.04), with moderate-vigorous physical activity being the sole significant predictor (beta= .34 and beta= .35, respectively, p= .12).

CONCLUSION: The findings provide useful insights for the beneficial impact of physical activity on mental health indices and stress the need for the promotion and facilitation of physical activity in asylum seekers living in refugee camp.

PHYSICAL ACTIVITY CHARACTERISTICS IN INLAND OLDER ADULTS

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INTRODUCTION: The benefits of physical activity (PA) for the quality of life and functional capacity of the elderly are widely disseminated. However, Portugal is still one of the countries with the lowest prevalence of PA among the elderly population, and in the regions with lower population density, solid information on this is lacking. The objective of this cross-sectional study was to characterise the elder population of an inland region regarding PA levels, associated barriers, functional capacities, and perception of quality of life.

METHODS: The study sample consisted of 234 individuals (130 women and 104 men) living in the municipality of Guarda. The age of the participants ranged from 60 to 96 years (75.2 ± 8.3 yrs). They were evaluated regarding PA levels (YPAS-PT), clinical and sociodemographic parameters, body composition (Inbody 270), functional capacity [Short Physical Performance Battery (SPPB) and handgrip test] and quality of life (SF-36v2 questionnaire).

RESULTS: It was observed that 66.3% of the sample presented excessive fat accumulation (44.2% in overweight and 21.1% in obesity). 46.6% of the participants reported to practice PA, on a regular basis, for more than six months and only 9% intended to start doing it (13.7% of them were in the "contemplation" and 22.6% in the "pre-contemplation" state). AF levels (YPAS-PT Scores) do not differ between genders, except for the time spent in movement, which was higher in women. Significant differences were observed between different age groups regarding PA dimensions, except for the time spent standing. The group aged 85 years or older is the one that accumulates the longest sitting time. In the walking 4-meters test, women in the older group spent, on average, 3.62 seconds more than those in the lower age group. Also, among men, a significant decline in walking speed was observed as they aged. In the five times sit-to-stand tests, the time increased, especially after age 75, for both men and women. In the handgrip strength, a negative effect of age was observed for both genders. The most reported barriers were unfavourable climate (56.3%), having an injury or disability (46.9%), fear of being injured (41.4%) or already sufficiently active (42.2%).

CONCLUSION: It is important to know the variables that characterise the older adults in inland regions will allow for better planning of public policies that promote PA and functional capacity in this population.

EFFECTS OF NONCONTACT ELECTRICAL STIMULATION BY A CONTACTLESS CURRENT STIMULATOR UNDER DIFFERENT ENERGIZING CONDITIONS UNDER REDUCED LOADING

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INTRODUCTION: It has already been observed that electrical stimulation with a non-contact electrical stimulation device (VP electrical stimulation) suppresses bone loss in the femur under reduced weight bearing. It has been reported that low-power ultrasound pulses (LIPUS) in bone defects have different osteogenic results depending on the energizing conditions.

Therefore, we believe that effective energizing conditions exist in the energizing stimulators used in research. We believe that the electrical energization time can be reduced by studying efficient energization conditions. The purpose of this study was to investigate effective VP electrical stimulation.

METHODS: 32 male Wistar rats were used and classified into hindlimb suspension (HS, n=8) and non-contact stimulation during load reduction (VP) and control (CO, n=8) groups. VP was classified by intervention time as 15 minutes (VP15, n=8) and 30 minutes (VP30, n=8), and VP electrical stimulation conditions were 200 kHz frequency and 2.5 A current, 5 days a week for 3 weeks.

RESULTS: HS and VP15 bone Trabecula were thinner than CO, but were observed to be comparable to CO in VP30. Furthermore, cathepsin K-positive cells were more common in primary trabecular bone in HS and VP15, but the number of positive cells in CO and VP30 was lower than in those groups.

CONCLUSION: In general, bone loss is associated with osteoclast activation. Cathepsin K is also synthesized in active osteoclasts. In this study, fewer cells were positive for cathepsin K in VP30 than in VP15. Based on the above, the effect of bone mass maintenance using VP appears to emerge from 30 minutes or longer.

EFFECT OF STATIC STRETCHING AND PNF STRETCHING ON SHORT-TERM RECOVERY OF TIRED MUSCLES

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INTRODUCTION: To observe the difference of short-term recovery effect between static stretching and PNF stretching on tired muscles, and to provide theoretical basis for rapid recovery of muscles after fatigue and prevention of sports injury

METHODS: Recruited 15 male college students of grade 2 or above in sports training major of physical Education College and randomly divided into PNF stretching group, static stretching group and control group. Methods: Using isokinetic muscle force tester, the fatigue model of dominant quadriceps femoris muscle was modeled at 60°/s angular velocity in centrifugal-centrional motion mode. After the exercise program, the experimental group was respectively restored by static stretching and PNF stretching for 10min, while the control group remained in situ and rested. Before exercise, immediately after exercise and 10min after recovery, the maximum isometric muscle strength and muscle burst were tested, and the data were analyzed and processed by SPSS.

RESULTS: The MVIC and MP values of static stretching group and PNF stretching group were significantly decreased ($P < 0.05$), and quadriceps femoris muscle fatigue was obvious. After recovery, MVIC and MP values in PNF stretching group were significantly increased ($P < 0.05$), while the recovery effect in static stretching group was not statistically significant ($P > 0.05$). The recovery effect of MVIC and MP in PNF stretching group was significantly different from that in static stretching group ($P > 0.05$).

CONCLUSION: Compared with static stretching, PNF stretching can restore the maximum strength and explosive power of tired muscles in a short time, and can be used as an effective method to quickly recover muscle fatigue during training or competition intervals.

THE EFFECT OF SCHOOL-YEAR AND SUMMER BREAK IN HEALTH-RELATED CARDIORESPIRATORY FITNESS: A 2-YEAR LONGITUDINAL ANALYSIS

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INTRODUCTION: Some studies have suggested that summer break has a negative impact on children and adolescent's cardiorespiratory fitness (CRF), however evidence is still scarce. Therefore, this study aimed to assess the trends of health-related CRF during two school-years with a 3-month summer break in children and adolescents.

METHODS: A 2-year longitudinal study, including 440 6th to 8th graders (218 boys), mean age 12.3 years, was conducted. The Progressive Aerobic Cardiovascular Endurance Run (PACER) was used to assess CRF at the beginning and end of each school-year. Physical activity was measured using accelerometers. Repeated measures general linear models were used to analyses differences and trends in VO2peak and health-related CRF.

RESULTS: Overall differences between time-point VO2peak were significant for both boys ($p<0.001$) and girls ($p=0.003$). Pairwise comparisons showed that VO2peak improved from the beginning of each school-year to the end of the same school-year for boys (49.1 to 50.6 ml/kg/min, $p<0.001$; 51.0 to 52.8 ml/kg/min, $p<0.001$) and girls (41.7 to 42.5 ml/kg/min, $p<0.001$; 42.2 to 43.3 ml/kg/min, $p<0.001$). However, differences in CRF between the end of school-year 1 and the beginning of school-year 2, i.e. during summer break, were not significant (boys: $p=0.543$; girls: $p=0.343$).

CONCLUSION: Improvements in CRF were only observed during each school-year and remained unchanged during summer break. These findings provide relevant information for the health education community, suggesting the need for additional efforts to counteract the summer break effects on CRF.

History

SPORTS AND MUSIC: A HISTORICAL GLANCE

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The relationship between sports activities and music is well-known throughout history. Many sports such as ice -skating, water aerobics, and rhymical gymnastic include playing recorded music. Ballet, which requires physical training, is accompanied by live music.

While music seems to be essential in many sports, the relationship between composers, their lifestyles, and sports activities is an interesting field to explore.

The body habitus of some classical composers could potentially reveal their lifestyles. Historical paintings of J.S. Bach and G. F. Handel portrayed them as having heavy body sets. Sedentary lifestyles while composing, unhealthy diets, and lack of exercise could explain that. The photos of the Finnish composer J. Sibelius in his late life show that he was obese. He has suffered from chronic depression and was known for smoking and drinking heavily. On the other hand, photos of S. Rachmaninoff always showed his slender tall figure from a young age. Igor Stravinsky described Rachmaninoff as six feet of Russian gloom. Rachmaninoff was known for his love of canoeing, a physical activity he had enjoyed during his stay in his house on lake Lucerne. He was also an avid luxury car enthusiast; he enjoyed driving cars in nature. Stravinsky was slim as well, he was known for his love of daily gymnastics including eye-rolling exercises.

Felix Mendelssohn was a vigorous gymnast, a swimmer, and a good horseman.

Benjamin Britten is a well-known English composer, conductor, and pianist. He was also a champion in tennis and cricket.

Tennis has attracted many composers: Debussy was a keen tennis player; he often played it with his friend the composer Maurice Ravel. Debussy even tried to describe a tennis game in his last orchestral composition: Jeux (Game). The score was originally composed to accompany a ballet about two girls and a man playing tennis. Similarly, Gershwin used to play a weekly tennis match with Schoenberg. Despite the risk of getting an injury that could affect his performances, Prokofiev enjoyed tennis games in between composing his masterpieces. He was also known to be a champion in chess.

Exploring sports history from a humanistic and artistic point of view is a good reminder of the importance of sports and exercise in our lives.

TRANSLATION AND EVOLUTION OF THE CONCEPT OF “PHYSICAL EDUCATION” IN CHINA

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Introduction

Greek philosophers, thinkers and educators studied the concept of “sport” or “physical education” and described a large number of athletic sports in Homer’s epic poems around the 9th and 10th centuries B.C. . By combing the development history of the concept of physical education and its translation, introduction and evolution in China, combined with the theoretical basis of many scholars’ research on the concept of “physical education”, this study finds that the concept of sports is related to specific social strata and closely linked with politics. It can be said that physical education to a certain extent represents the will of the country, and also reflects the guidance and planning of the national sports cause.

Background

In modern China, there are two main concepts of “sports”: “gymnastics” and “physical education”, both of which were translated and introduced from Japan. At the beginning of the 20th century, during the late Qing Dynasty school period, the modern education system began to be established in China, and “gymnastics” was made a compulsory subject in all levels of schools. After the May 4th Movement in China, especially the “New School System” (Renxu school system) issued by the Beiyang Government in 1922, it was obvious that the influence of American pragmatism pedagogy could be seen. At that time, China’s “gymnastics” was changed to “physical education”, free hand exercise, acrobatic sports and games, which introduced the Western physical education content into China.

Discussion

As people look at sports from multiple perspectives and dimensions, they also have a variety of understandings of sports. Indeed, there is no single attribute of sports, such as fitness, education, culture, competition, skill, recreation, and sociality are all important characteristics of sports. How to find out the decisive attribute that determines the development direction of sports or distinguishes physical education from other cultural activities from the numerous attributes of sports, that is, the essence of physical education.

Conclusion

The Chinese “physical education” vocabulary is the result of translation and borrowing from Western “sports” concepts. In chronological order, the main nouns and terms of the Western concept of “sports” from ancient times are athletics, gymnastics and sports, while “physical training” and “physical education” are terms that were formed successively after the Renaissance, and are the product of the development of disciplines and schooling in the formation of modern Western civilization, indicating that modern physical exercise, supported by physiology, psychology and other disciplines, has developed into a normative activity with the characteristics of modern experimental science. Compared with the historical

process of the generation of the notion of "physical education" in the East and the West, the concept of "physical education" in modern China experienced a reverse growth process.

MR. HYOZO OMORI WAS NOT THE FIRST TO INTRODUCE BASKETBALL TO JAPAN

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Introduction

In Japan, the first person who introduced the basketball to Tokyo YMCA in 1908 is generally believed to be Mr. Hyozo Omori, who graduated from the International YMCA Training School in 1907.

However, I found a new sentence: "The second day after landing, the field sports of the girls school were held at Aoyama. The pupils exercised with dumb-bells, played basket-ball, and most of the day was spent in exercise out of doors. These gymnastic games are an innovation in the education of the Japanese girls, and they promise a healthier and broader womanhood in the future." in "The Quarterly" of Womans Missionary Friend (February 1903). If this statement is true, it could be strong evidence that basketball was introduced into Japanese girls schools before the establishment of the theory.

The purpose of this study was to verify whether or not basketball was introduced in the Aoyama Girls School in Japan before 1908.

Methods

At the Aoyama Gakuin Archives, where the archives of Aoyama Girls' School are housed, 10 historical documents with the keyword "basketball" prior to 1908 were identified. In addition, using the History of Aoyama Girls' School (Aoyama Sayuri Kai, 1973), I investigated the descriptions of basketball in the School during the same period.

Results

The earliest historical document on basketball held by the Aoyama Gakuin Archives is the first issue of the Aoyama Girls School Alumni Bulletin published in August 1903, in which a basketball game was identified in the field day order held on November 6, 1902, at the Aoyama Girls School new playground. The collection also contains a November 28, 1903 issue of TIDINGS FROM JAPAN (Vol. 6, No. 3, 1903), which states in a section titled "FIELD DAY SPORTS AT THE AOYAMA GIRLS' SCHOOL" that "Tennis and basketball proved that the Japanese girl does not intend to remain far behind her sisters across the water, and that she is going to enjoy that phase of life which means so much to the American and English girl." In addition, the collection contained a copy of the Aoyama Girls' School Field Day held on November 4, 1905, in which a basketball game was identified. Additionally, a photograph of a basketball game taken at the 6th Aoyama Girls' School Field Day held on November 2, 1907 was in the collection. On the other hand, the history of Aoyama Girls' School did not mention that basketball was played in physical education classes or extracurricular activities at that time.

Conclusion

The Aoyama Girls' School played basketball at its Field Day held on November 6, 1902, six years earlier than Omoris introduction. Therefore, it is clear that Mr. Omori was not the first person to introduce basketball to Japan.

Acknowledgments

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Mentoring/Coaching

COACHING BEHAVIOUR IN ELITE SPORT IN JAPAN: A COACHING PERSPECTIVE

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Abstract

The purpose of this study to analyse the behavioural characteristics of elite Japanese coaches and clarify the coaches' educational factors. Participants were four elite sports coaches (three men and one woman). To be included in the study, coaches were required to have worked with, or to be currently working with Olympic-level athletes. The interview guide comprised of three sections: coaching behaviour in training; coaching behaviour in competition; and athlete's skills related to coaching behaviour and summary questions. Findings revealed 11 higher-order themes, which we categorised into the following four general dimensions: analysis of situation and information (getting the latest information, social context); interpersonal relationships (teaching ability of a coach depending on the athletes' skill levels, communication, team atmosphere); intrapersonal knowledge (external self-awareness, internal self-awareness); professional knowledge (athlete safety, competitive performance, competition preparation, training performance).

Keywords: coaching behaviour, elite sport coach, high-performance coaching, interviews

DOES SUPERVISOR SUPPORT IMPROVES BETTER WORK PERFORMANCE OF SPORT COACH? IT DEPENDS ON PERSONALITY

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Introduction

Grounded in the job demands-resources model, this study examines the moderating role of supervisor support and the mediating role of sports coaches' work engagement in the relationship between proactive personality and perceived work competence.

Methods

261 participants were sports coaches at all education levels in public schools in Taiwan. Convenience sampling was used to recruit participants for this study. All participants volunteered and provided informed consent. The focal variables were measured with a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree). Proactive personality was assessed by the Chinese version (Lu & Kuo, 2016) of the Proactive Personality Scale (Bateman & Crant, 1993). Work engagement was measured by 12-item Work Engagement Scale (Schaufeli et al., 2006). Perceived Supervisor Support was measured with an 4-item scale (Chien et al., 2012). Perceived work competence was assessed by an 6-item scale (Warr, 1990).

Results

The results indicated that work engagement positively mediates the relationship between sports coaches' proactive personality and perceived work competence. Separately, supervisor support weakens the link between proactive personality and work engagement but strengthens the relationship between work engagement and perceived work competence;however, taken together, supervisor support weakens the indirect effects of proactive personality on perceived work competence through job engagement.

Discussion

Under the boundary condition of perceived supervisor support, the sports coaches' proactive personality is a critical antecedent of perceived work competence through work engagement. We suggest that proactive sports coaches are assets for schools because they possess the drive and energy for self-improvement, promoting organizational progress automatically.Moreover,the other important theoretical implication of the current study is that perceived superior support plays an important role in interpreting the boundary conditions of the JD-R model and further contributes to the interaction effect in predicting perceived work competence. Future research should incorporate other personal and situational factors to examine the dynamic process of predicting in-role and extra-role work performance

Keywords: proactive personality; work engagement; supervisor support; perceived work competence; job demands-resources model

ELITE SWIMMING ATHLETE'S CAREER DEVELOPMENT: THE PERSPECTIVE OF THE COACH-ATHLETE WORKING ALLIANCE

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Elite swimming athlete's career development: the perspective of the coach-athlete working alliance

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Abstract

INTRODUCTION: With the development of sport performance, the quality of the relationship between coach and athlete is becoming more and more important. Coaches and athletes must set on goals, agreement the tasks, and accomplished the tasks to achieve the goals. This study is based on coach-athlete working alliance, discuss the interaction between coaches and athletes how to influence athletes career adaptation and career transition.

METHODS: From the perspective qualitative research, this study applied in-depth interview with domestic excellent swimming coaches and the athletes they have coached. By understanding the relationship between coaches and athletes, as well as planning of athletes career adaptation and career transition, and analyzing the content of the interviews, explores the influence of the coach-athlete working alliance on career adaptation and career transition.

RESULTS: The results of the study are as follows : (1) The coach will divide the goals into competitive goal and goal college entrance goal, and assign tasks to different athletes according to their abilities, coach and the athletes can feel a sense of achievement in pursuing the common goal. (2) The coach will pay attention with the athletes to focus on the career they want to work in in the future at first, and let the athletes make their decision for college, If athletes want to engage in non-sports field, they will fully show their curiosity about the careers they interested and vice versa; Compared with coaches who believe in athletes, athletes lack confidence in their careers. (3) In athletic level, the coach will enrich himself, cooperate with talents in various fields, and provide the athletes with a high-quality training environment; In psychological level, coaches not only care about active athletes, but also contact graduates through in communication software; In psychosocial level, the relationship between the athletes and the coach like a teacher as well as a friend, the athletes can maintain

a good interaction even they are graduate; In academic vocational level, It is not only the coach who can help, but the graduates can also provide a lot of assistance to solve the doubts of their junior brother.

DISCUSSION:

Based on the conclusions of this study practical suggestions, Coaches can take the initiative to care about the athletes situation, build self-confidence, and cooperate with graduates to assist the career development of student athletes; The suggestion for Future Research can compare with different theoretical models, and expand research sample to make future research more completely.

THE STUDY OF KORAN COACH'S LEADERSHIP STYLE IN CHINESE TAIPEI ARCHERY TEAM

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Purpose: Chinese Taipei archery team has achieved international elite performance in recent years. Besides athletes' hard-work training and the intervention of sport science, the coach leadership played as an important factor. Chinese Taipei Archery Association hired Korean coach Koo Ja-Chung during 2013-2017. Chinese Taipei archery team started to reach out top-ranked performance among international tournaments stably, allocated 32 golds, 22 silvers and 33 blonde medals in the international competition within 4 years. Therefore, this study aimed to explore the coach Koo's leadership style by interviewing athletes and coaches. Methods: This study used quantitative research method via semi-structured interview approach (Patton, 1990). The participants were Coach Koo, two assistant coaches, and athletes who coached by coach Koo in national team more than 6 months. The study used triangulation analysis to verify the interview data. Results: The results indicated Coach Koo showed a rather democracy leadership style, so that athletes receive greater autonomy-support behaviors. Meanwhile, Coach Koo gave out feedback for athletes accroding to thier individual needs. Therefore, the athletes formed higher self-recognition and the team created optimum competing climate. The athletes also agreed that Coach Koo established a sense of trust within the team by guiding leadership. Specifically, the support from coach Koo brought great confidence and peace of mind during competitions. Conclusion: the coach Koo's leadership style was identified in this study as a decisive role led to the optimal archery performance worldwide for Chinese Taipei archery team. The leadership style of Coach Koo can be used as a reference for Taiwanese coaches.

Key word: autonomy-support, self-recognition, semi-structured interview, quantitative research

ECOLOGICAL DYNAMICS PERSPECTIVE FOR SPORTS TALENT DEVELOPMENT IN ADOLESCENCE: A SCOPING REVIEW

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Introduction

The evolution of sports talent development programs, especially during the pivotal maturation period in adolescence, dances between mechanistic perspectives and integrated approaches. Positively, there are unified agreements in general talent traits. However, the skills acquisition of higher-order attributes such as adaptability, reactivity, and creativity (dexterity) may be influenced by the design, implementation, and management of the sports ecosystem. Reviewing the value of nonlinear pedagogical strategies is critical to opening up boundaries for exploration and facilitating enriched skill acquisition, further highlighting a sports talent identification index, and bioecological influences. This study was therefore to summarize the current literature and examine the main implications within the theoretical framework of ecological dynamics, for sports talent development, in adolescence.

Methods

In this prospective study, rooted within the theoretical framework of ecological dynamics, three important areas that may enhance adolescent skill acquisition for sports talent development were reviewed. (1) Sports talent identification index: including fundamental movement skills, psychosocial skills, and dexterity; (2) Nonlinear pedagogy: including representative learning design, affordance landscapes, constraints manipulation; (3) Bioecological environment: including coaching, and relative age effects.

ERIC, MEDLINE, SPORTDiscus, Scopus, and Web of Science were searched from 2012-2022. A manual search of the literature was also performed, and reference lists of the retrieved articles were examined. We considered those studies in which ecological dynamics or sports talent development were adequately described and assessed in adolescent populations. Findings were organized to form both a descriptive and thematic summary.

Results

A total of 53 articles were included. They encompassed 45 original research, as well as eight conceptual theory papers in ecological dynamics on representative design, affordances, and constraints across a variety of sports. The findings indicate that the theoretical framework of ecological dynamics supports sports talent development in adolescence and there was near consensus that reductionist and mechanistic perspectives are outdated. An integrated approach that fosters skill adaptation and creativity is recommended, featuring the importance of motor learning, multi/donor sports, and exploration.

Discussion

The implications of this review encourage coaches to consider nonlinear approaches to support the emergence of elite sport talent skills during the critical maturation period between childhood play and senior-level competition. Further research is needed to clarify talent development across transdisciplinary platforms, which may support athlete training programs, sport academy cultures, and physical education curriculums.

ON THIN ICE: REDUCING CHOKING IN ELITE ICE HOCKEY

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In their quest to be successful in major sport competitions, sport federations' stakeholders must master the aspects that lead to efficient selection procedures. However, the players who perform best in physical tests or intra-team games are not necessarily the ones who will perform best in big games when the pressure is on. In fact, the predisposition to perform at the right time becomes an important variable. Frequently used in popular culture, the concept of player's choking susceptibility is an emerging construct in the domain of applied sport psychology. Choking is defined in the scientific literature as a significant decrease in performance in a competitive pressure situation, which is attributed to an increase in anxiety and when the athlete recognizes that the standards they have set for themselves would otherwise be met (Mesagno, 2013). To date, a few interventions have been conducted to attempt to reduce choking, but few studies have focused on team sports at the elite level.

The purpose of this study is to measure the impact of sports psychology intervention aimed at preparing to perform optimally (by reducing choking susceptibility) among athletes representing their province at the 2023 Canada Games, in the discipline of ice hockey. The initial measurement for choking susceptibility of male (N=22 M age =15) and female (N=22, M age=17) athletes was done 6-months before the competition according to the calculation established by Mesagno (2008), then the anxiety state was measured during a minor competition 2 months later, and 1-week previously to competition. One month prior to the Games, 3 sessions, which consists of sports psychology conferences as well as individual consultations were offered to the athletes of both teams. Results reveal that athletes identified as susceptible to choking vary greatly in their level of on-ice performance, and that the interventions appear to have had a modest effect on player performance at major sporting events such as the Canada Games.

In consideration of the results, alternatives will be proposed for future interventions in team sports with adolescents who evolve in highly competitive ice hockey settings. In addition, comments will be made on the measurement of the pressure choking concept and on the experience of the practitioners who participated in the study.

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Molecular Biology and Biochemistry

TO EVALUATE THE EFFECT AND MECHANISM OF WHOLE BODY VIBRATION (WBV) TRAINING ON BRAIN MICROVASCULAR ENDOTHELIAL CELL-DEPENDENT BRAIN INFLAMMATION

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INTRODUCTION: It is known that endothelial cells of Blood-Brain-Barrier (BBB) in patients with neurodegenerative diseases usually have an inflammatory state, but the mechanisms are still unclear. However we find the whole body vibration training can enhance our immune function, anti-oxidant and anti-inflammation ability. Therefore, whole body vibration training (WBV) could be used for the prevention or treatment of chronic inflammation-related diseases. We want to do the WBV to evaluate the effect on the endothelial cells inflammatory responses .

METHODS: The RBA and bEnd.3 cells were pretreated with various level of vibration (level 2, 4, 5, 6, and 7) for 30 min and then stimulated with or without TNF- α (15 ng/ml) for 24 h. After treatment, the conditioned media were collected and analyzed by gelatin zymography. The cell lysates were analyzed by Western blot using an antiserum reactive with GAPDH as a control. The bEnd.3 were treated with various level of vibration (level 2, 4, 5, 6, and 7) for 30 min and then incubated for 24 h. After treatment, the cell lysates were analyzed by Western blot using an antiserum reactive with COX-2 or cPLA2 antibody and membranes were stripped and re-probed with total GAPDH as a control. Data are expressed as mean or mean ± SEM of three independent experiments (n=3). *P<0.05; **P<0.01, as compared with the respective values of untreated cells. The image represents one of three similar experiments.

RESULTS: The data showed that pretreatment of vibration attenuated TNF- α -induced MMP-9 expression in RBA cells, suggesting that vibration may be have a anti-inflammatory effect by inhibiting the TNF- α -induced MMP-9 expression in RBA cells, attenuated TNF- α induced COX-2 expression in RBA cells, suggesting that vibration may be have a anti-inflammatory effect by inhibiting the TNF- α -induced COX-2 expression in RBA cells, attenuated TNF- α -induced MMP-9 expression in bEnd.3 cells, suggesting that vibration may be have a anti-inflammatory effect by inhibiting the TNF- α -induced MMP-9 expression in bEnd.3 cells. attenuated TNF- α -induced MMP-9 expression in bEnd.3 cells, suggesting that vibration may be have a anti-inflammatory effect by inhibiting the TNF- α -induced MMP-9 expression in bEnd.3 cells.

CONCLUSION: A thirsty minutes WBV training have an anti-inflammatory effect by inhibiting the TNF- α -induced MMP-9 expression and the TNF- α -induced COX-2 expression in RBA cells. It is suggesting that vibration may be have a brain protective effect by reducing the basal level of inflammatory proteins' expression in bEnd.3 cells.

ALCALASE POTATO PROTEIN HYDROLYSATE AND SHORT PEPTIDE ENHANCES MYOGENIC DIFFERENTIATION AND ENHANCES SKELETAL MUSCLE PROTEIN SYNTHESIS UNDER HIGH GLUCOSE CONDITION IN C2C12 CELLS

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INTRODUCTION: Aging is inevitably associated with progressive decline in bodily function and composition with decline in muscle strength and mass, a phenomenon known as sarcopenia. The consequence of this effect includes reduction in the aerobic capacity causing reduced mobility and quality of life in elderly subjects. The annual cost, in the United States, on the health effects of sarcopenia accounts to 18.5 billion dollars and the scenario is likely to be global as the aging population grows in most developed countries. In spite of huge allocation of resources there has been no drug therapy identified for this condition. Present treatment strategy recommends Protein nutritional uptake and physical exercise to maintain muscle function. APPH is an alcalase hydrolysate of potato protein fraction possessing lipolysis-stimulating with efficient anti-obesity potential. Nevertheless, the effect of APPH and short peptide on skeletal muscle protection is not determined yet. In this study, the effect of APPH and short peptide supplementation on the skeletal muscle atrophy and high glucose induced myogenic aversions is investigated.

METHODS: APPH treatment in C2C12 cells showed dose dependent activation of Akt/mtor signalling pathway that is involved in skeletal myogenesis. According to Western blotting analysis, APPH and a short peptide induced the phosphorylation of Akt, mTOR proteins and induced myogenic differentiation of C2C12 myoblasts in a differentiation medium

RESULTS: The phosphorylation myogenic transcription factor Foxo3A was also found to be increased in the cells treated with APPH and it's short peptide . In addition, reduction in cell viability caused by high glucose was also found to be reduced when treated with different doses of high glucose in a dose dependent manner. Moreover, number of myotybules in a differentiation medium reduced upon high glucose challenge, but treatment with APPH increased the number of differentiated myotubules. Further, the phosphorylations of AMPK and mitochondrial-related transcription factors such as PGC-1α were suppressed upon high glucose challenge but APPH treatment restored the protein levels.

CONCLUSION: We demonstrate for the first time that a specific potato peptide has a therapeutic effect against sarcopenia. In addition, APPH and it's short peptide improved the myogenic differentiation and their mitochondrial biogenesis and further improved mygenic protein and inhibited muscle protein degradation in C2C12 cells challenged under high glucose condition.

THE EFFECT OF THE ACE, ACTN3 AND PPARGC1A GENES POLYMORPHISMS ON HIGH-INTENSITY INTERVAL TRAINING OF ELITE CHINESE ROWERS

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INTRODUCTION: To identify molecular genetic markers in ACE I/D rs1799752, ACTN3 R577X rs1815739 and PPARGC1A Gly482Ser rs8192678 that predict initial aerobic capacity and training sensitivity in rowing athletes to improve athletic performance in high-intensity interval training.

METHODS: Methods: Fifty four athletes（33 males and 21 females） were selected from the national rowing group. The average age was 17.82±0.88 years, the average height was 180.46±8.04m, and the average weight was 77.53±12.48kg. Maximal oxygen uptake, functional conservation and 1000m/800m running were measured before and after a 4-week period of high-intensity interval training. DNA was extracted from saliva sample, genotype was identified by PCR-RFLP. A chi-square test was used to determine whether the SNPs met the Hardy-Weinberg equilibrium law. The association between genetic polymorphisms and the effects of high-intensity interval training was analysed by comparing aerobic phenotypes, training sensitivity between groups and pre- and post-training for each genotype.

RESULTS: 1. In male athletes, the ACE I/D polymorphism was associated with the initial value of RE/VO2 as II genotype > DD genotype; 2. In female subjects, the rate of change of RE/VO2 was significantly higher in the ID genotype than in the DD genotype (P=0.045); 3, ACTN3 XX genotype and RX genotype VO2max change rate was significantly higher than RR genotype (P<0.05); ACE II genotype VO2max change rate was significantly higher than the DD genotype and ID genotype (P<0.05); 4. In male subjects, PPARGCIA polymorphism was associated with RE/VO2 In male subjects, PPARGC1A polymorphisms were associated with RE/VO2 initial values, showing GG genotype > GA genotype and AA genotype.

CONCLUSION: 1. ACE I/D and PPARGC1A Gly482Ser can be used as genetic markers to predict the initial value of RE in males, and genotype II and GG carriers have RE higherly ; 2. ACTN3 R577X can predict the effect of high-intensity interval training intervention for maximal oxygen uptake in females, and XX and RX are the dominant genotypes. Sex differences and genotypic characteristics should be taken into account for the effectiveness of exercise training in superior rowers.

MUSCLE ACCRETION ACTIVITY OF ALCALASE®-ISOLATED SOY PROTEIN HYDROLYSATE IN SKELETAL MUSCLE C2C12 CELLS BY ACTIVATING PI3K/AKT/MTOR PATHWAY AND INHIBITING FOXO PATHWAY

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INTRODUCTION: Skeletal muscle development is strictly regulated process involving formation of mesodermal into myoblast, following the differentiation and fusion, finally changed into multinucleated myotubes. Myogenic regulatory factors play an important role in muscle fusion during differentiation (1). Among these factors, phosphoinositide 3-kinase (PI3K), protein kinase B (Akt) and mammalian target of rapamycin (mTOR) in protein synthesis PI3K/Akt/mTOR pathway as well as Forkhead Box O3 (FOXO3), muscle atrophy F-box (MAFbx) and muscle ring finger protein 1 (MuRF1) in protein degradation FOXO pathway, are plays critical role in muscle formation (2). This study aimed at evaluating the possible myogenic mechanism for enzymatic protein hydrolysate in C2C12 skeletal muscle cells.

METHODS: The C2C12 cells were cultured at 2.4 x 10 ∧ 5/12-well plate in the growth medium (DMEM containing 10% FBS) and differentiated in the C2C12 differentiation medium containing DMEM and 2% horse serum. Differentiated C2C12 cells were further induced atrophied by 5 uM dexamethasone (DEX) and then treated with or without selected protein hydrolysates. Protein expression of signaling factors associated with PI3K/Akt/mTOR pathway and FOXO pathway were analyzed (3, 4).

RESULTS: In preliminary study, four types of plant protein were hydrolyzed by three proteolytic enzymes, respectively. Alcalase®-isolated soy protein hydrolysate (AISPH) was selected due to its highest muscle accretion activity and product yield among hydrolysates. AISPH was prepared by hydrolyzing 6% ISP for 8 h with Alcalase® at 50 °C and pH 8.0. Based on simulated gastrointestinal digestive test, there was little effect of gastrointestinal proteases on muscle accretion activity for AISPH. Effects of AISPH concentrations on signaling factors in PI3K/Akt/mTOR pathway and FOXO pathway were also investigated after DEX-induced atrophied of C2C12 cells. The results indicated that AISPH was not only activating PI3K/Akt/mTOR pathway for muscle protein synthesis by upregulating the protein expression of PI3K, p-AKT and mTOR, but also inhibiting FOXO pathway for muscle protein degradation by downregulating the protein expression of FOXO3, MAFbx and MuRF1.

CONCLUSION: AISPH showed the effect of increasing muscle accretion in skeletal muscle cells, suggesting the application potential of AISPH in promoting the growth of skeletal muscle mass. The mechanism of muscle accretion for AISPH was to activate PI3K/Akt/mTOR pathway and inhibit FOXO pathway in skeletal muscle C2C12 cells.

EFFECTS OF HIIT AND MICT ON THE PROTEOMIC CHARACTERISTICS OF LIVER LIPID METABOLISM IN AGING RATS

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INTRODUCTION: Current research has not fully understood the overall situation of liver lipid metabolism and related pathway changes caused by different exercise methods in the dynamic process of aging. Therefore, based on TMT proteomics technology, this study explored the effects of different exercise modes on the changes of liver lipid metabolism in rats during natural aging and the differences in pathway characteristics.

METHODS: Sixty 8-month-old SPF male SD rats were selected and randomly divided into groups B, C, H and M. Group B was sacrificed after 1 week of adaptive feeding; Group H used 90% VO2max and 65% VO2max running speed to alternate treadmill exercise, a total of 40 minutes/day, 3 days/week, HIIT exercise intervention for 24 weeks. Group M used continuous treadmill exercise with 70% VO2max, and the training time was the same as group H. Group C received no exercise intervention. Rat body fat percentage, body weight, serum LDL-C and HDL-C were collected every 4 weeks. Three rats from each group that had completely completed the intervention process were selected for liver TMT proteomics testing, and differential proteins were screened for bioinformatics analysis.

RESULTS: 24 weeks of HIIT and MICT did not significantly improve the increase in body fat content of rats caused by natural aging process, but they could significantly reduce the body weight of rats ($P<0.05$). 2. 24 weeks of HIIT and MICT can significantly reduce the increase of serum LDL-C content caused by natural aging ($P<0.05$), and promote the further increase of serum HDL-C content ($P<0.05$). 3. The results of proteomic functional enrichment showed that after 24 weeks, there were 117 proteins with significant differences between group C and group B; 52 proteins with significant differences between group H and group C; 38 proteins between group M and group C. There were significant differences in 25 proteins between group H and group M.

CONCLUSION: 1. The 24-week natural aging process will lead to the weakening of liver lipid metabolism, which is related to bile acid secretion and lipid absorption pathways. 2. 24 weeks of HIIT and MICT can significantly reduce the body weight and serum LDL-C of the rats, and significantly increase the serum HDL-C, and there is no significant difference in the intervention effect of the two exercise methods. 3. 24 weeks of HIIT can delay the decline of liver lipid metabolism through cytochrome P450 and linoleic acid metabolism. At 24 weeks, MICT can affect liver lipid metabolism through protein processing in endoplasmic reticulum, valine, leucine and isoleucine biosynthesis, cysteine and methionine metabolism, and tyrosine metabolism. In addition, both HIIT and MICT can affect liver lipid metabolism through linoleic acid metabolism and steroid hormone synthesis pathways. There were certain differences in peroxisome and endocytosis pathways between H and M groups.

LACTATE INCREASES FATTY-ACID OXIDATION BY TCA CYCLE AND MITOCHONDRIAL UNCOUPLING IN SKELETAL MUSCLE OF OBESE MICE

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INTRODUCTION: Exercise training (Ext) is a productive way to reduce risk factors of metabolic disease. Lactate is largely increased by exercise, even when oxygen is sufficiently provided in muscle (1). Circulating lactate enters the muscle fiber and can stimulate the tricarboxylic acid (TCA) cycle for oxidative metabolism (1, 2), thereby suggesting the possibility of lactate's role as an efficient oxidative metabolic regulator for lipids. However, the molecular mechanism behind lactate's role in the oxidative metabolism in skeletal muscle (SKM) is not fully understood. Here we investigated the mechanism behind lactate-driven regulation of FAO in SKM, a process involved in the lowering of SKM lipids in subjects with diet-induced obesity (DIO).

METHODS: Animal exercise study, after 18 mice were fed high-fat diet (HFD) for 8 weeks, mice were randomized to three different groups (sedentary, exercise, and exercise + lactate administration). Lactate or saline was injected intraperitoneally (IP) immediately after moderate treadmill exercise for 3 weeks. For lactate and HFD study, mice were injected with saline or lactate under a normal chow diet (NCD) or HFD for 8 weeks. To understand metabolic pathways, gene silencing studies were performed using C2C12 myotubes. Fatty acid oxidation, mitochondrial oxygen consumption, enzyme activity, NADH/NAD+ assay, flow cytometry for fatty acid uptake, immunofluorescence staining, and other molecular biology assays were performed.

RESULTS: We found that increasing lactate levels enhanced energy expenditure mediated by fat metabolism during exercise recovery, decreasing triglyceride levels in SKM of DIO mice. To determine lactate-specific effects without exercise, lactate was administered to mice on a high-fat diet for eight weeks, and similar to our exercise condition, we found that lactate increases fatty acid (FA) uptake and oxidation in SKM. When FAs were provided as substrate to these same mice, TCA cycle activity and mitochondrial uncoupling-driven respiration is also enhanced. The increase in FAs promotes the movement of lactate into muscle cells, which in turn augments uncoupling protein-3 expression via enhanced NADH-NAD+ shuttling.

CONCLUSION: Exercise-induced lactate amplifies an adaptive increase in FAO capacity mediated by the TCA cycle and mitochondrial uncoupling in SKM when fatty acids are increased, and ultimately increases oxidative capacity.

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LAMP : NEW DNA AMPLIFICATION TECHNOLOGY AS A POINT OF CARE TOOL TO HELP DIAGNOSTIC OF THEILERIA EQUI AND BABESIA CABALLI PATHOGENS CAUSING REDUCTION OF PERFORMANCES IN HORSES

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ENALEES

INTRODUCTION: LAMP technology (Loop mediated isothermal AMPlification) is a NAAT technology (Nucleic Acid Amplification test) which can occur at constant temperature, unlike PCR which need thermal cycles. This allow the use of this technology near a sick animal and the obtention of the result in only 30 min. This technology can be really useful to detect highly contagious pathogens causing loss of performances, ie : detection of Theileria equi and Babesia caballi in horses causing loss of performances during a sportive competition.

METHODS: Specific LAMP primers for Theileria equi and Babesia caballi were designed and LAMP reactions were performed on viral genome and on blood samples extracted by our own specific quick extraction. Performances of these tests were evaluated in our lab and compared to PCR performed in an external lab.

RESULTS: The limit of detection of LAMP tests to detect Theileria equi and Babesia caballi of all method (quick extraction and LAMP test) is similar or better of the limit of detection of all method (extraction on column and PCR test) obtained in a conventional analysis laboratory. LAMP test which was designed are really specific for the target (>95% specificity) and are really sensitive for the target (>90% sensibility).This technology is really fast (<30 min) and can be performed near a sick animal.

CONCLUSION: LAMP tests are a new generation of DNA/RNA amplification test, really specific, really sensitive which can be performed near a sick animal and can give a result in only 30 min. These parameters allow the consideration to use this technology to detect pathogens infecting a sick horse causing loss of performances before a sportive event as a horse race.

EFFECTS OF SPRINT INTERVAL TRAINING ON SKELETAL MUSCLE FIBERS IN DEVELOPING RATS

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INTRODUCTION: Many ball sports require higher performance in a shorter period of time. Therefore, sprinting ability and endurance at a higher level are necessary for athletes. Recently, it has been reported that rest time during interval training is important for training effectiveness.

We performed different types of running training in developing rats to investigate the effects of exercise intensity and rest time on skeletal muscle using histochemical methods.

METHODS: The experimental conditions were as follows. Twenty 13-weeks-old female Fischer 344 rats were used in the experiment. The rats were trained to run by different conditions on a treadmill for small animals. The Training began at 6 weeks of age. It was performed once a day, 5 days a week for 8 weeks.Rats were divided into four groups: Control (C), Sprint Interval Running training (SP), Interval Running training (IT), and Interval Uphill Running training (IU). The SP group consisted of 10 sets of 45-60 seconds of running at a speed of 35 m/min-40 m/min followed by 4 minutes of rest. The IT group consisted of 10 sets of 30 seconds of running at 30 m/min followed by 2 minutes and 30 seconds of rest, and the IU group consisted of the IT group training with a 15-degree uphill incline.

Gastrocnemius muscle (GAS) was used for histochemical staining, and ATPase staining and α-GDPH staining were performed to confirm the SDH staining results, and myofiber types (SO, FOG, FG) were determined. The analysis items were number occupancy, cross-sectional area, and myofibril optical density for each myofiber type. Fisher PLSD method was used for statistical processing. The significance level for all tests was set at 5%.

RESULTS: The composition ratio by muscle fiber type showed 13.60±7.54% for the C group, 21.32±14.42% for the SP group, and 19.56±6.12% for the IU group in FOG fibers at the superficial layer. The SP and IU groups showed an increasing trend compared to the C group. The muscle fiber cross-sectional area of superficial FOG fibers was 1318.8±232.8 μm2 in the C group, 1713.5±211.6 μm2 in the SP group, and 1688.2±171.3 μm2 in the IT group. SP group and IU group showed significantly higher values than C group ($p<0.05$).

CONCLUSION: In the SP group Changes in myofiber type composition, cross-sectional area, and oxidative enzyme activity concentrations were observed. In the FOG fiber of the training group showed higher values in myofiber type composition and cross-sectional area by myofiber type. These training-related changes occurred in the superficial gastrocnemius muscle (fast-twitch area).

In the present study, the SP group increased the oxidative capacity of fast-twitch muscle fibers while maintaining a fast contraction speed. That is, FOG fibers showed increased strength and FG fibers showed increased endurance. The results suggest that longer rest periods during intervals are effective. Therefore, sprint interval training is an effective training method to enhance athletic performance.

ELECTRIC PULSE STIMULATION OF DIFFERENTIATED HUMAN MUSCLE CELLS: THE MODEL FOR STUDYING EXERCISE-INDUCED ADAPTIVE RESPONSE IN VITRO.

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INTRODUCTION: In vitro methods are an important tool to study muscle related adaptations to exercise, especially on cellular and molecular level. Electrical pulse stimulation (EPS) of muscle cells in culture provides an in vitro model of exercise, where motor neuron activation of muscle fibers is replaced by external electric stimulation, resulting in repeated contractions of cultured myotubes (1). The aim of our work is to develop a protocol for electric stimulation that can mimic exercise more physiologically than the most frequently used continuous stimulation.

METHODS: Skeletal muscle cells were derived from vastus lateralis muscle of healthy, lean men (n = 4, age: 37 ± 12.7 years; BMI: 23.7 ± 1.4 kg/m2). Cells were differentiated for 5 days, and exposed to EPS (Ionoptix, USA), using two protocols: (i) continuous 24 h stimulation aimed at mimicking low-intensity exercise (frequency 1 Hz, pulse duration 2 ms), and (ii) intermittent 24 h stimulation where higher frequency stimulation was preceded and followed by subthreshold frequency stimulation (pulse duration 4 ms). After the 24 h stimulation, oxidation of radioactively labelled glucose and palmitate and incorporation of glucose into glycogen were measured. Exercise-related myokines released into the media (ELISA) and gene expressions (qPCR) were quantified.

RESULTS: Both types of electric stimulation (continuous and intermittent) resulted in visually detectable contractions of differentiated myotubes. Similarly, both protocols facilitated the incorporation of radiolabelled glucose into myotube glycogen store ($p<0.05$). However, an increase of glucose oxidation was observed only after the intermittent stimulation ($p<0.05$), where we have also observed a tendency to higher oxidation of palmitate (CO_2+ASP: +20%; $p<0.1$). Secretion of the contraction-regulated myokine, IL-8 was increased after the continuous ($p<0.05$), but not the intermittent stimulation. However, there was no uniform increase of IL-6 secretion with neither type of stimulation. The gene expression of these two myokines tended to increase only after the continuous stimulation ($p<0.1$), which has also led to a significant increase of Myh2 gene expression ($p<0.05$), the marker of fast intermittent fibers. There was no change in Myh7 gene expression, the marker of slow oxidative fibers.

CONCLUSION: Both EPS protocols led to the manifestation of specific adaptation mechanisms. However, the intermittent dosing of higher frequency EPS combined with low-frequency subthreshold stimulation elicited stronger response in the

myotube capacity to oxidase substrates, while continuous stimulation tended to have effect on the myokine expression in cultured primary human myotubes.

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NOVEL HUMANIZED G6PD DEFICIENT MICE REVEAL MECHANISMS OF INCREASED TOLERANCE TO EXERCISE AS GLEANED BY MULTI-OMICS IN MODELS OF CRITICAL SPEED

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INTRODUCTION: Glucose-6-phosphate-dehydrogenase deficiency (G6PD) is the most common enzymatic deficiency in humans, affecting ~500 million people or ~6% of mankind. G6PD is the rate limiting enzyme of the pentose phosphate pathway (PPP) that generates NADPH, an essential reducing equivalent for antioxidant metabolism that protects against intra- and extra-vascular hemolysis in response to oxidant stress. Impaired G6PD activity may cause hemolytic anemia due to exogenous stress. As such, individuals with G6PD deficiency are recommended to refrain from strenuous exercise as they are deemed to be at increased risk for hemolytic events in response to exercise-induced hemolysis. However, knowledge is limited regarding molecular impacts on exercise capacity in those who have the deficiency. While biochemically sound, this rationale has never been tested mechanistically, owing to ethical and technical limitations.

METHODS: Here we generated novel humanized mouse models carrying either (i) human canonical G6PD (normal activity), or the common G6PD variants (ii) African (V68M - < 10% residual enzymatic activity) or (iii) Mediterranean (S188F - <1% residual enzymatic activity). We leveraged these mouse models to assess critical speed (CS), a functional measurement of the speed-to-duration relationship. To expand the molecular resolution of genetically associated adaptations to exercise, CS tests were combined with multi-omics (mass spectrometry-based metabolomics, lipidomics and proteomics) characterization of plasma, RBCs, and multiple tissue matrices including liver, heart, kidney, lung, spleen, and muscle. All mice underwent hemodynamics tests to obtain cardiovascular data.

RESULTS: Unexpectedly, G6PD deficient mice showed ~10% faster CS compared to mice carrying the canonical human G6PD ($p<0.0001$ and $p<0.02$, respectively). Pathway analysis of metabolomics data generated from RBC and plasma fractions showed significant decreases in arginine metabolism, increased glycolysis, and elevated Krebs cycle intermediates, in addition to the expected differences in PPP. G6PD deficient mice had a significant ($p<0.02$) higher cardiac output. Multiomics analyses identified five major tissue clusters between heart, muscle, liver, kidney, and spleen, with G6PD function having the most significant metabolic impact on liver and soleus.

CONCLUSION: Novel humanized G6PD deficient mice maintain faster CS compared to mice without alterations to the PPP. Omics approaches afford the opportunity to identify metabolic correlates to measurements of performance in relevant animal models, such as the CS model, which offer expanded mechanistic understanding of molecular bases of CS and the associated impact of G6PD deficiency. Our results not only challenge the assumption that exercise-induced oxidant stress predisposes the ~500M individuals with G6PD deficiency worldwide to increased hemolytic propensity, but rather indicate a metabolic advantage of functional polymorphisms to G6PD with respect to exercise performance.

Motor Learning and Motor control

VISUAL REACTION TIMES OF PROFESSIONAL ESPORTS PLAYERS COMPARED TO UNIVERSITY ATHLETES

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INTRODUCTION: Interests in esports have surged these days, and esports players have shown superior performance in detecting a visual stimulus and reacting to it. Esports players are required to make decisions as quickly as possible. This ability is vital while playing esports as well as traditional sports. Previous studies revealed gaming activities could enhance reaction time, eye-hand coordination, and visual information processing skills. However, less is known about the differences in reaction time between traditional athletes and esports players. Luu et al. (2021) attempted to compare college football athletes visual, auditory, and tactile reaction times to esports gamers. Both groups showed faster reaction times than non-athletes but no significant difference in eye-hand reaction time. This study aimed to examine the reaction times of esports players, such as eye-hand and eye-foot reaction times, compared to athletes.

METHODS: Ten esports players (EP) aged 19.6 ± 2.0 and twenty-five university athletes (UA) aged 23.9 ± 1.7 from tennis, volleyball, and soccer teams participated voluntarily after signing informed consent. All participants are healthy young males who are ambidextrous. The Vienna Test System provided the eye-foot reaction time. Additionally, the conventional reaction timer measured the eye-hand reaction time in terms of simple and choice reaction time. A series of independent samples t-tests were performed at the significance level of 0.05.

RESULTS: There was no significant difference in simple and choice reaction times between the two groups for the eye-hand reaction times. The mean simple reaction time was 0.26 ± 0.03 seconds for EP and 0.28 ± 0.03 for UA. The mean

choice reaction time was 0.44 ± 0.07 seconds for EP and 0.44 ± 0.06 for UA, respectively. Interestingly, the foot reaction time took longer than the hand reaction time, and there was a significant difference in foot reaction time between EP and UA. The EP group showed 0.71 ± 0.07 whereas 0.62 ± 0.07 seconds for the UA. More specifically, there was a significant difference in the right foot. It might be that all the participants were right-handed and right-footed.

CONCLUSION: This study attempted to compare different types of reaction times between esports players and university athletes. There was a significant difference in eye-foot reaction time. University athletes showed a faster reaction time. The simple and choice reaction times showed similar values, and these results were consistent with the previous study of Bickmann et al. (2021) comparing esports players and traditional sportspeople. It is known that the ability of reaction time can improve with practice and experiences in sports as well as in esports. The difference in foot reaction time might be induced from that esports players use hands rather than feet while traditional sportspeople use hands and feet. In the future, it will be necessary to consider other influencing factors, such as the type of sports with an increased sample size.

RELATIONSHIP BETWEEN MOTOR SKILL AND RETENTION TRANSFER RACKET PERFORMANCE

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INTRODUCTION: A study of multivariable behavior naturally raise the question of which reference frames the central nervous system may use to coordinate motor actions. Previous studies were focused planar reaching movements and showed that translation and rotation of the start and target positions evoked joint kinematics. This investigation of the retention at highly skilled motor performance about tennis racket simple task by findings from arm hand motor behavior. Moreover, it were applied tennis and badminton educational program and extra lesson for acquired physical education in Japanese schools.

METHODS: Seven female university students with a mean ± SD, age 21.29 ± 0.89 years, volunteered to participate in the study. The protocol was explained and subjects gave the informed consent prior to the participation in this study. Two subjects were physically activity in additionally they had experiment tennis and badminton in childhood. All subjects had abstained from alcohol, caffeine and exercise for 24 hours preceding the investigation to ensure reliability. They had performed to put it basket which has distance 4m by same tennis racket until 2000 times trials. And the sensor device of three dimensional which recorded acceleration put on top their grip of their racket during swing.

RESULTS: There was significant difference between subject with retention and novice. It was observed clearly motion skills to control tennis racket by badminton player. Two retention player were rapidly increased encage goal by racket.

CONCLUSION: We examined three dimensions acceleration and true-false simple racket shot in tennis until 2000 times, major found that the retention has been acquired in two subjects. However all subjects had appeared learning-curve over 200 trials, especially in a short amount of time more than continued long-winded trails until 2000 times. It was appeared that once acquired similarity motor skills were retention as same as badminton and tennis. It was consider that motor control skills under age applied similarity retention of motor learning.

INTRACORTICAL INHIBITION AND EXERCISE: PAIRED-PULSE SOMATOSENSORY EVOKED POTENTIALS IN ATHLETES

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INTRODUCTION: Long-term exercise has been shown to modulate somatosensory excitability as assessed by single-pulse somatosensory-evoked potentials (SEP) in athletes (1). These neuroplastic adaptations appear to be use-dependent and limb-specific (2). Paired-pulse SEP (PP-SEP) are used to assess the intracortical inhibitory function of the somatosensory cortex known as paired-pulse inhibition (PPI). This study aimed at investigating the influence of exercise on PPI induced by tibial nerve stimulation in two groups of athletes, who primarily use 1) upper-extremities (UEX) and 2) lower-extremities (LEX).

METHODS: In total, 30 healthy athletes were enrolled in this study. Athletes were divided into 2 groups according to their respective sports disciplines: 1) UEX (n = 16 (12 female), age = 23.3 ± 3.8 yrs, training age: 12.4 ± 4 years, training per week: 4.7 ± 3 hours) & 2) LEX (n = 14 (1 female), age = 23.8 ± 3.8 yrs, training age: 12.6 ± 6 years, training per week: 7.4 ± 5 hours). Bilateral tibial nerve PP-SEP were applied at the ankle (3 Hz, 400 pulses, 0.2 ms square wave pulse, 60 ms ISI). SEP responses were recorded at the scalp with an Fz-Cz' EEG montage according to the international 10-20 system. PPI of short-latency peak-to-peak amplitudes (N30-P40, P40-N50, N50-P60) were calculated.

RESULTS: PPI was reliably induced for all SEP amplitudes (all $p < 0.001$). While no group differences in PPI could be observed between UEX and LEX (all $p > 0.05$), a significant negative correlation between PPI (N30-P40) and the amount of training hours per week could be observed ($rs = -0.516$, $p = 0.004$).

CONCLUSION: These results suggest that exercise modulates intracortical inhibition of the somatosensory cortex in athletes. Enhanced inhibitory function in athletes might provide performance benefits related to gating of task-relevant information in sports contexts (3). The lack of group differences could be explained by the fact that lower extremity information processing is also necessary for performance in UEX.

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RELATIONSHIP BETWEEN A REACTION TEST AND HISTORY OR FEAR OF FALL IN OLDER PEOPLE

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INTRODUCTION: Fall prevention requires recognizing and reacting to disturbances and using strategies appropriate to the situation. Therefore, measuring and evaluating agility (i.e., quick reaction to disturbance) and equilibrium (i.e., postural control ability after the reaction) are essential because these two abilities comprise fall avoidance movements. Although studies have reported that agility and equilibrium were associated with falls in each measure used, they only examined these two abilities in relation to another specific ability. Evaluating fall avoidance ability in a sequence of movements is important because avoiding falls involves a sequence of two phases, namely, rapid body reaction and postural control, using appropriate response strategies. Although we have developed a reaction balance test (RBT) by combining agility and equilibrium and have confirmed its reliability and validity, we have not been able to examine its relationship to falls. Therefore, this study was designed to examine the relationship between the RBT and history or fear of fall.

METHODS: The RBT was conducted on 31 older people (9 males and 22 females). The RBT is a task in which the participants are instructed to quickly raise one leg when they feel a light stimulus on the stabilometer and then stand on the other leg for 10 s. Agility was evaluated using the single-leg reaction time to raise one leg, which is the time from when the red light flashed to when one leg left the ground. Equilibrium was evaluated using the center of pressure (COP) during the 10 s of single-leg standing after the participant raised one leg, and four parameters were evaluated: Max COP excursion, total length per second, stable time, and total length of stable time. An unpaired t-test was used to compare the RBT in the two groups with or without a history of falls and with or without fear of falls.

RESULTS: No differences in agility and equilibrium were observed between the fall and non-fall groups. In contrast, the fear of fall group tended to have a longer time to raise one leg and poorer COP parameters than the group without fear of fall. Particularly, a moderate difference was observed in the stable time.

CONCLUSION: The RBT, which evaluates agility and equilibrium during a series of movements, also suggests that both agility and equilibrium are impaired in people who have fear of falls. The fact that there was no association with history of fall, but only with fear of fall, should be further examined in detail.

TRAINING TO ENHANCE DRIBBLING AND PASSING PERFORMANCE IN FOOTBALL

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INTRODUCTION: The purpose of this study suggests the training to enhance a dribbling and passing performance in Football.

METHODS: Subjects were 32 junior high school soccer players; 17 in the training group, and 15 in the control group. Both groups did 2 hours of training three times a week for 16 months with the following drill: training group did dribbling training while control group did agility and pass & control training for the first 40 minutes. The dribbling tests and 11 vs 11 games with the third group were carried out before each group's training, after 3 months, 6 months, 10 months, and 16 months.

RESULTS: The results showed Time in the dribbling test greatly decreased more in training group than control group. At the 11 vs 11 game performance, the success and failure number of times on the ball keeping, Taking the opposite and breaking through in dribbling showed no significant in both groups as training progresses. However, the success number of times on carrying to space in dribbling showed significant improvement only in training group. The failure total number of dribbling showed significant decrease only in training group. Furthermore, the success number of times passing showed significant increase only in training group. The success rate in dribbling showed significant improvement only in training group. The success rate in passing showed decrease in both groups after 3 months, but it showed significant increase only in training group.

CONCLUSION: This study clarified the dribbling training intended for junior high school soccer players decreased Time in dribbling test, it improved dribbling skill, and it is suggested the improvement contribute to enhancing a game performance regarding dribbling and passing.

EFFECT OF TARGET CHANGE ON MOVEMENT TIME OF REACHING MOVEMENT

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INTRODUCTION: Sportspersons are required to perform their movements quickly and accurately according to the changing situations on the field. For example, during a soccer game, the pass course may be narrowed during a kick because of interference by an opposing competitor.

From this perspective, Fautrelle et al. (2011) examined a reaching movement task in which the size and distance of the target changes during the movement. The results showed that the movement time (MT) increased when the target changed during the movement. However, the timing of the target change was only at the start of the movement, and the target change up to the point of reaching the target was not examined. Therefore, a new experiment was developed with different timings to the target change and verified anew.

The study examined changes in reaching movement using a laboratory replication of a sporting situation in which the situation changes and a task in which the size of the target changes at the three timings during the reaching movement.

METHODS: Five right-handed males participated in this experiment. The experiment consisted of a reaching movement task in which participants moved from a starting to an ending point (target) on a tablet using a stylus. There were three conditions in which the target size changed from medium to larger or smaller or did not change during the movement from the starting point to the target (larger, smaller, and no change conditions). In addition, the target changed three times of which the target size change timings were (1) at 1/3 of the travel distance (early), (2) at the middle of the travel distance (center), and (3) at 2/3 of the travel distance (late). Data analysis was conducted from the time of the start of the pen tip movement until the target was reached (MT).

RESULTS: The MT for target change timing for early, center and late were as follows: (1) 582±125 ms for the larger, 651±254 ms for smaller, and 590±132 ms for no change conditions; (2) 585±108 ms for the larger, 631±187 ms for smaller, and 591±143 ms for no change conditions; (3) 577±110 ms for the larger, 660±287 ms for smaller, and 578±117 ms for no change conditions. The results indicate that the smaller conditions at all target change timings increased MT more than the larger and no change conditions.

CONCLUSION: The smaller target size is thought to have increased MT to improve accuracy. The results support the findings of Fautrelle et al. (2011). Their study revealed to tracking changes in target points at the start of movement, and this study shows the possibility for this using the coordinate position of a pen and changing the size of the target during movement.

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EVALUATION OF THE EFFECTS OF STOCHASTIC RESONANCE ELECTRICAL STIMULATION OF SENSORY RECEPTORS AND NERVES ON POSTURAL SWAY

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INTRODUCTION: Stochastic resonance (SR) electrical stimulation is used to improve postural sway in standing posture by applying weak noisy electrical signals that unable to be perceived by the somatosensory system. Previous studies have reported that SR electrical stimulation of sensory receptors in the feet and median nerve in the wrist improved in postural sway, but the mechanism by which SR electrical stimulation improves postural sway is not clear, and it is unclear whether it has a greater effect on sensory receptors or nerves. In addition, the effects of SR electrical stimulation on the body have been studied at the neuronal level, but the mechanisms of action have not been elucidated and there have been few studies on neural networks. Therefore, we have two hypotheses. First, we hypothesized that SR electrical stimulation would improve postural sway by exerting a significant effect on the nerves. Second, we hypothesized that the information enhanced by SR electrical stimulation would be integrated at the nerve junctions, further enhancing sensation. The purpose of this study was to test these hypotheses by simultaneous or single SR electrical stimulation of sensory receptors and nerves.

METHODS: The subjects were five healthy male adults (23±1.7 years old) in a static standing posture for 30 seconds with eyes closed, and postural sway was measured. The median nerve (MN) at the wrist, the axillary nerve (AN) behind the scapula, and the ventral thumb receptor (VTR) were the targets of stimulation (dominant hand). To evaluate postural sway, the standard deviation (SD) of the anteroposterior (AP) direction of the center of pressure measured with a force plate was calculated. The SR electrical stimulation applied to the subject was white noise, and a self-made SR electrical stimulator was used.

RESULTS: Single stimulation of VTR, MN, and AN tended to reduce AP SD more in VTR stimulation than in nerve stimulation. AP SD tended to be reduced by simultaneous stimulation of the VTR and MN, the VTR and AN, or the MN and AN, compared to no stimulation or single stimulation at one location.

CONCLUSION: Contrary to the first hypothesis, SR electrical stimulation seems to have a greater effect on the sensory receptors, since the effect on the sensory receptors was greater than that on the nerves, indicating that SR electrical stimulation has a greater effect on the sensory receptors. The second hypothesis of SR electrical stimulation seems to be valid, since simultaneous SR electrical stimulation of the two locations reduced AP SD. In addition, not only simultaneous stimu-

lation of nerves, but also simultaneous stimulation of sensory receptors and nerves reduced AP SD, suggesting that the effects of SR electrical stimulation may be superimposed regardless of the stimulation site. We will model the biological response to SR electrical stimulation of sensory receptors to elucidate the mechanism of postural sway in the future.

CHARACTERISTICS OF TWO PLAYERS' MOVEMENTS DURING A COUNTERATTACK

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INTRODUCTION: Introduction

According to Bohrs law, movement time (MT) of a responder who moves in response to the leader is shorter than that of a leader who moves intentionally. This law holds true for (1) hand and (2) whole-body movements. Thus, the phenomenon of successful counterattacks frequently observed in sports such as kendo can be explained by the fact that the MT of the responder (counter attacker) is shorter than that of the leader (opponent). However, using a gun duel as an example, it was concluded that the leader wins even if the responder's MT is short, since the reaction time of humans is about 0.2 s (1). This suggests that the phenomenon of successful counter attacks in sports is not caused solely by differences in MT; however, previous studies were unable to experimentally confirm this. Therefore, it is necessary to focus on sports in which counterattacks can be confirmed and examine whether responders who move later win over leaders who move first. In this study, we experimentally reproduced a scene from a kendo match. Thereafter, we examined characteristics of the two players' movements when debananawaza (i.e., a counterattack) occurs and both players' striking times were examined.

METHODS: Methods

The players were paired up. They faced each other on a force plate, and after the experimenter had signaled hajime (start), the subjects played the game. After the signal, the players struck ("men") in their own time, and 10 trials were performed. Ground reaction force data were obtained from all trials using a force plate (1,000 Hz), and movement of the shinai was filmed using a high-speed camera (250 Hz) to determine the striking moment. The ground reaction force data helped identify the start of the two players' movement as they entered the striking motion (threshold set at ±10% of the body weight) and classifying them into two groups: the first mover (leader) and second mover (responder). Striking time (MT) from the start of movement to the striking moment was calculated for each group. The test's winner was the player who had struck first. One test that could not be measured correctly was excluded, and nine tests were included in the analysis.

RESULTS: Results

The leaders won 1/9 trials (a), the responders won 6/9 trials (b), and 2/9 trials ended in a tie (c). The MT was 0.46 s for the leaders and 0.37 s for the responders in scenario (a); it was 0.47±0.02 s for the leaders and 0.32±0.03 s for the responders in scenario (b); and 0.50±0.01 s for the leaders and 0.40±0.07 s for the responders in scenario (c).

CONCLUSION: Conclusions

This study showed that when debananawaza occurred, the responders won most trials. Although the relationship between two players' MTs supports previous studies, this study suggests that we can experimentally reproduce a phenomenon frequently observed in actual sports.

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NEURAL CORRELATES OF SLACKLINE PERFORMANCE FOLLOWING A SINGLE TRAINING SESSION

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INTRODUCTION: Previous studies demonstrate positive effects of long-term slackline training on static and dynamic balance ability 1. Neural correlates of balance improvements resulting from several weeks of slackline training have already been demonstrated at the structural and functional level 2. Critically, neural correlates of initial and acute slackline performance remain insufficiently explored. For this purpose, the present study aimed to investigate neural correlates of 1) initial slackline performance as well as 2) improvements in slackline performance following a single supervised training session.

METHODS: In total, 15 healthy participants (n = 10 (male), age = 25.4 □ 3.4 yrs.; n = 5 (female), age = 23 □ 1.7 yrs.) without prior slackline experience were enrolled in this study. Resting-state brain activity (5 min.) was recorded using a wireless 32-channel EEG system before (PRE) and after (POST) a 45-minute slackline training session. Slackline performance was evaluated by way of 6 standard dynamic and static balance tests on a Slackline. Power spectral density (PSD) was estimated across alpha (8-12 Hz), beta (13-30 Hz), and gamma (31-44 Hz) frequency bands for each electrode per condition (PRE and POST). Frequency-band specific PSD's were compared per channel between conditions using paired t-tests. Channels showing significant differences in PSD between conditions were further used for correlation analyses. Here, we correlated frequency-band specific PRE and POST PSD with initial Slackline performance (SPpre) and performance improvements following a single training session (SPpost-pre) using Spearman's rank correlation.

RESULTS: We found significant differences in PSD between PRE and POST for alpha and beta frequencies (all p-values were adjusted using FDR-correction). Correlation analyses revealed 1) significant positive correlations between occipital channels and SPpre (pooled rs = 0.6, p = 0.03) as well as SPpost-pre (pooled rs = 0.58, p = 0.04) for alpha frequencies and 2) significant positive correlations between parietal channels and SPpre (pooled rs = 0.64, p = 0.02) for beta frequencies (all p-values were adjusted using permutation-testing).

CONCLUSION: Our findings imply that resting state dynamics at alpha and beta frequencies relate to initial slackline performance as well as performance improvements following a single training session. These results further suggest that alpha and beta bands relate more to slackline performance and performance improvements compared to gamma bands.

DIFFERENT HURDLE CLEARANCE MOVEMENT PATTERNS BETWEEN YOUNG HURDLERS

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INTRODUCTION: Hurdling performance depends on the maintenance of an inter-hurdle accelerating running rhythm and hurdle clearance techniques. Hurdle clearance technique is related to the height of the centre of mass (CoM) during take-off and over the hurdle as well as with lead and trail leg joint angle characteristics (1). Different hurdle clearance techniques between elite hurdlers (1) and different locomotion patterns while negotiating the first two hurdles between novice hurdlers (2) suggests that each individual interact differently with the performance environment. Given the unique individual characteristics, hurdlers are expected to exploit hurdling parameters and adjust their movement pattern according to their needs, in order to satisfy interacting constraints during hurdling. The purpose of this study was to assess the manifestation of individual differences between young hurdlers while clearing the first two hurdles (0.76m) in a) knee joint angle configuration of the lead and trail leg, b) the trajectory of the CoM, c) horizontal velocity of the CoM during take-off and at landing.

METHODS: Five female hurdlers (under 16 years) were video recorded with three synchronised video cameras while clearing the first two hurdles during running, in practice conditions. The APAS software (Ariel Dynamics, 2010) was used for 3D movement analysis and data processing which included the calculation of lead leg and trail leg knee angle, CoM positional data as well as horizontal velocity of the CoM during take-off and at landing. The duration of each hurdle clearance stride was normalized in terms of percentages. Consequently individual athletes' data were analysed and expressed to a percentage of hurdle's phase total time.

RESULTS: Differences were observed between young hurdlers while clearing the first two hurdles in lead leg knee angle configuration and in CoM trajectory. Participants did not extend in a similar fashion their lead leg neither during flight nor at landing (for the last 70% of the hurdle clearance stride). Different values were also observed in raising the CoM during the first 20% of the hurdle clearance stride and in the position of the CoM during flight and at landing (the last 70% of the hurdle phase). Participants who maintained a higher position of the CoM at landing attained higher horizontal velocity after clearing both hurdles, indicating an accelerating running rhythm.

CONCLUSION: The manifestation of different hurdle clearance movement patterns, associated with the unique individual characteristics and the exploitation of different or variable execution parameters, indicates that each individual can vary motor behaviour and search for his/her own functional movement solutions which satisfy multiple, interacting constraints during task performance (3).

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RELATIONSHIP BETWEEN SKILL PROFICIENCY AND SUBJECTIVE EVALUATION IN TRAMPOLINE ATHLETES

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INTRODUCTION: Previous studies have shown that changes in regional cerebral blood volume in the forehead during skill recall differ depending on the skill level of the athlete.

It is not possible to judge from these results whether it is due to the individual characteristics of the athletes or whether the difference in skill acquisition affect in brain activity.

Therefore, the purpose of this study was to examine the relationship between changes in brain activity during the skill acquisition process of trampoline players and subjective skill perfection from a longitudinal study to clarify issues mentioned above.

METHODS: The subjects were three female trampoline athletes at a university. The subjects were athletes who gave sufficient explanation about the experiment and obtained consent. An optical topography was used to measure brain function in the frontal lobe. Brain activity in the forehead was measured using optical topography. Measurements were taken once a month. At the time of measurement, we asked them to answer using the Visual Analog Scale about their subjective proficiency of the double twist, which they felt in the practice just before that. The brain activity data obtained was evaluat-

ed by the number of channels that showed a significant increase in blood volume when recalling the technique, out of the 47 channels that were measured.

RESULTS: The number of significant channels tended to increase as the skill became more difficult, and the results were similar to previous studies. However, there was no constant trend over the months, resulting in repeated increases and decreases. The Double Twist rose as the month progressed, but the tendency was not found and there was a period of stagnation.

CONCLUSION: This study showed that the simpler the trick, the lower the number of channels showing a significant blood rise, and the smaller the frontal lobe blood rise during recall.

It is known that when motor learning establishes movement automation, the brain activity area changes and shifts to memory-dependent brain activity areas. The results of this study also suggest that there was a similar tendency for the two skills already learned.

On the other hand, it was expected that brain activity would decrease as skill acquisition increased. However, in this study, despite the increase in subjective proficiency, there was no consistent trend in the number of significant channels.

The double twist technique that we focused on in this research is classified as a difficult technique even for athletes with a long competition history. It is thought that the technique was highly difficult even for the subjects who cooperated this time.

In this study, the subjective degree of perfection rose to 40 in about 5 months after starting practice, but considering the difficulty of the technique, it is possible that this evaluation was not appropriate. In the future, we will need to consider how subjective evaluations differ from objective evaluations by instructors and others.

THE RELATIONSHIP BETWEEN PEDALING EXERCISE PHASES AND PERFORMANCE FOLLOWING RESPONSE INHIBITION

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INTRODUCTION: Response inhibition of cognitive functions plays an important role during sports activities. Though there have been many studies on cognitive function during exercise, the results show little consensus. Furthermore, there have been few studies of response inhibition during exercise. In this study, we investigated the relationship between the performance following response inhibition and the muscle activities of the lower limbs during pedaling exercise.

METHODS: All participants were right-handed, healthy adult males. Participants were asked to perform a visual stop-signal task (SST) while pedaling (50%HRR) on a bicycle ergometer. During the SST, participants were required to respond by pressing a key on their right fingers in the Go condition and suppress the response in the Stop condition. Surface EMG signals were recorded from the vastus lateralis, vastus medialis, biceps femoris, and medial gastrocnemius. Event-related potentials (ERPs) were recorded from the scalp. The analysis period was divided into three periods: the lower limb muscle activities period on the ipsilateral side of the responding limb, the lower limb muscle activities period on the contralateral side, and the resting period.

RESULTS: The reaction time under the Go condition was the fastest for the resting period among the three periods (ipsilateral: 386.2±15.5 ms, contralateral: 402.7±40.6 ms, resting: 375.2±27.0 ms). In the Stop condition, the success rate of response inhibition was highest in the resting period (ipsilateral: 42.9±20.2%, contralateral: 25.5±18.4%, resting: 60.0±14.1%). In the P300 component of ERPs, the peak latency was shorter for the resting period than the other periods.

CONCLUSION: Participants exhibited better motor output responses and information processing related to response inhibition during the resting period. It is possible that information processing related to the pedaling activity of the lower limb muscles and upper limb responses formed a dual-tasking situation. Therefore, the allocation of limited attentional resources to each may have reduced performance in response inhibition during the lower limb muscle activities period.

Neuromuscular Physiology

RELATIONSHIPS BETWEEN COMPETITIVE ABILITY AND PRE-ACTIVATION TIME IN LEG MUSCLES DURING SPRINT RUNNING AND DROP JUMPING IN COLLEGE TRACK AND FIELD ATHLETES

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INTRODUCTION: Pre-activation (PA) of agonist/antagonist muscles prior to ground contact during running and jumping movements is one of the human motor control mechanisms, and according to previous reports, it has a positive impact on motor performance. There is, however, little information available regarding the relationship between the onset time of PA and subsequent motor performance in Japanese college track and field athletes. We investigated the relationships between the onset time of PA in the lower leg muscles during drop jumps (DJs), sprint running and jumping performance, and competitive ability in Japanese college track and field athletes.

METHODS: Fourteen male college track and field athletes performed both DJs from a 60 cm-high platform and sprint running for 20 m. We recorded surface electromyographic (sEMG) signals from their tibialis anterior, lateral gastrocnemius (LG), medial gastrocnemius, and soleus muscles during these tests. We calculated a DJ index by dividing the jumping height (m) by the ground contact time (s). The best International Association of Athletics Federations (IAAF) score of each runner was used as a variable representing individual running performance. The sEMG signals were normalized (ex-

pressed as a percentage of the maximum voluntary contraction) and the PA time for each muscle was measured as the interval between the onset of muscle activation and ground contact, assessed via sEMG.

RESULTS: There was no significant correlation between the DJ index and PA time for any of the muscles during DJs. However, PA time in the tibialis anterior during the sprint running was significantly correlated with IAAF score ($r = -0.68$, $p < 0.05$). There was also a strong, although nonlinear, relationship between the IAAF score and PA time in the LG during the 20 m sprint running ($R2 = 0.928$).

CONCLUSION: Our data suggest that the PA time in the LG during the 20 m sprint running and competitive ability can be modeled using a second-order regression, revealing a link between muscle pre-activation strategy in the LG and sprint-running performance in college sprint runners. The concept of pre-activation time in the leg muscles predicting the sprint-running performance of athletes may thus be worthy of further discussion.

MECHANICAL ACTIVITY AND INTERACTION OF ACTIVITY ON VASTUS LATERALIS AND VASTUS MEDIALIS OBLIQUE UNDER THE DECREASE OF KNEE EXTENSION TORQUE.

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INTRODUCTION: Muscle function has been evaluated by electromyography method from viewpoint of physiological [1,2,3]. Recently, muscle contraction (MC) sensor is possible to evaluate the mechanical activity during muscle contraction [4]. It has been reported that muscle activity and MC signal was related to the elbow flexion force in isometric contraction [5]. However, interaction activity of knee extensor muscles with decrease of knee extension torque caused by a continuous knee extension task is not clear. In this study, the characteristics of the muscle activity and the interaction activity on knee extensor muscles under the decrease of knee extension torque caused by a continuous knee extension task were evaluated by electromyography and MC sensor methods.

METHODS: Eighteen males (age: 24.7±5.1yrs, height: 174.3±7.5cm, weight: 69.4±11.7kg) without disabilities to knee joint were participated in this study. The continuous task on 30 times knee extension and flexion isokinetic contraction (180 deg/sec) with maximal effort was performed by dynamometer (Biodex co.). And measurement of maximal knee extension torque under isometric contraction at knee angle 70 degrees was measured the pre and post continuous task. At the same time, the electrical muscle activity for vastus lateralis (VL) and vastus medialis oblique (VMO) were measured by surface electromyography (Nihon Koden co.). And also, the muscle deformation amount (FMC) for VL and VMO as a mechanical activity were measured by MC sensor (TMG. BMC). MC signals indicate the tension of muscle belly on contraction [4, 5]. These measurement parameters were calculated the mean value based on each 5% per maximal knee extension torque.

RESULTS: The knee extension peak torque reduced 10% by continuous knee extension task. In addition, the electrical muscle activity at VMO and VL in post showed higher values than pre. On the other hand, FMC in post were lower value than pre during over the 30% peak torque. Moreover, significant correlations were observed between VL and VMO for electrical activity in pre ($r=0.997$, $p<0.001$) and post ($r=0.998$, $p<0.001$). And FMC of VL and VMO were significantly correlated in Pre ($r=0.993$, $p<0.001$) and Post ($r=0.993$, $p<0.001$), respectively.

CONCLUSION: From these results, it was cleared that the electrical and mechanical information of the muscles differ in the muscle activity under the decrease of isometric knee extension torque. However, relative electrical muscle activity and relative FMC were significantly correlated between VL and VMO pre and post the continuous knee extension task, respectively. Therefore, the mechanical activity by the MC sensor method also observed interaction of muscle activity at VL and VMO as well as the electrical muscle activity.

1. Babault et al. (2003) 2. Balogunet al. (2010) 3. Claes et al. (1991) 4. Srdjan et al. (2011) 5. Srdjan et al. (2014)

TIME COURSE OF PERFORMANCE DECREMENT WITHIN 10 MAXIMAL SERIES PERFORMED ON A FLYWHEEL SQUAT EXERCISE

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INTRODUCTION: The flywheel squat exercise (FWsq) has become very popular thanks to its positive effects on the athletic performance (jumps, speed) and injury prevention. Proportion of force and power improvements depends on the duration of the task and the magnitude of the inertial load applied on the flywheel, thanks to diverse neurological and morphological adaptations (1). During eccentric contractions, there is an elongation because the external resistance exceeds the force produced by the muscle (2). This mechanical condition explains why the force is superior during the eccentric phase than in the concentric one, partially due to the inertia accumulated during the maximum concentric effort (3).

OBJECTIVES

The aim of this study was to characterize the loss of strength and power throughout the 10 repetitions performed within the 10 sets of a maximal flywheel squat protocol.

METHODS: 34 volunteers performed a 10x10 flywheel half squat exercise using a load of 1270 Kg/cm2. Preceding the 10 effective repetitions of each set, three additional repetitions were used to develop maximal momentum. Three minutes of rest between series was allowed. Force and Power were measured using the Chronojump Boscosystem® (Spain) and

averaged from three proportional sections (Sc1-3) of each set (1x set = 3x sections). Two-way Anova of repeated measures was used to analyse the time-course of change of these two parameters.

RESULTS: No significant decrements (P >1.00) in force and power were found in neither of the two phases (CON-ECC) within the first two series. Nevertheless, significant decrements (P≤0.001) were found in both parameters when comparing the three sections of each set from the 5th set onwards. Focusing on the first section (Sc1) of each set throughout the test, participants showed less force generation capacity (P≤0.011). Also, standing out that an interaction effect (F≥3.04; P≤0.02) confirmed that the relative decrement of force and power becomes increasingly more pronounced at the end of each set (Sc3) in comparison to their onset (Sc1).

CONCLUSION: Participants became less capable of maintaining their force and power within the successive sets as the FWsq progresses. Loss of performance is particularly dramatic from the 8th set. In earlier studies (4), we reported that participants could maintain their level of muscle activity throughout the 10 sets of the FWsq. According to Carmona et al. (5), we suggest that muscle contractile mechanisms can be negatively affected by this type of exercise.

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EFFECT OF THE RESIDUAL TORQUE ENHANCEMENT ON ISOMETRIC SHOULDER ADDUCTION.

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INTRODUCTION: Isometric action preceded by an eccentric action (ECC-ISO) can produced greater torques than purely isometric actions (ISO) at similar joint position and level of muscle activation [1]. This phenomenon is known as residual torque enhancement (rTE). At a similar level of submaximal torque, rTE can be observed as a muscle activation reduction compared to the ISO [2]. No studies focused on rTE have been conducted in complex joints like shoulders [3]. Our aim was to assess the rTE effect across submaximal and maximal intensities during a shoulder adduction.

METHODS: Seventeen male participants (23.8±6 years) were equipped with electrodes to measure the muscle activity of the pectoralis major, latissimus dorsi, trapezius, teres major, serratus anterior, and triceps brachii. Force output was recorded and displayed on screen for feedback purposes. At first, the 100% maximal voluntary contraction (MVC) in ISO followed by 7 trials (ISO: 40%, 60%, 80% MVC; ECC-ISO: 40%, 60%, 80%, 100% MVC) ordered randomly. During ISO trials participants had 3 s to achieve the requested force level and then 5 s to hold it; while for the ECC-ISO trials they were instructed to use 3 s to move arms in the frontal plane from the body side to 90° relative to the trunk (eccentric phase) and hold this position for 5 s. The isometric phase in both conditions was used to calculate the mean of the applied force (F) and the root mean square (RMS) for each muscle. Also, F and RMS values were normalized in relation to the 100% MVC in ISO. Repeated measures ANOVAs (Condition x MVC level) were conducted to establish muscle activation differences between the ISO and ECC-ISO in the different force intensities. Normalized values were used to assess muscle activation-torque relationship with linear regressions.

RESULTS: All muscles showed higher muscle activation for the ISO in contrast to the ECC-ISO. Planned comparisons indicated that this ISO higher muscle activation appeared in all the levels of force performed, except for the 40% MVC of the serratus anterior. The relative muscle activation and force level data across all MVC intensities had very good fit with the linear regression in both conditions. Comparing regressions and scatter plots from conditions, in all muscles values for the ECC-ISO conditions were rightward shifted (less RMS for similar MVC level) in relation to the ISO values.

CONCLUSION: The results suggest that rTE affected the shoulder muscles involved in the adduction when isometric actions were preceded by an eccentric action in a wide range of force intensities. In addition, it seems that the presence of the rTE improves muscle efficiency, seen as lower muscle activity at similar force intensities. These findings prove that rTE can be observed even in complex joints.

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DOES PRIOR KNOWLEDGE OF SPRINT NUMBER AFFECTED ON PACING STRATEGIES DURING REPEATED-SPRINT SETS

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INTRODUCTION: The purpose of various different pacing strategies in training for sport is to ensure that maximal performance can be attained by a performing athlete (Baron et al., 2011). An athlete's performance can be affected by a number of different extraneous factors such as their prior level of experience, their competitive level and their knowledge of the demands of a particular task (Abbiss & Laursen., 2008, Swain et al., 2020). To this end, the extent to which an athlete

knows that they will engage in strenuous exercise appears to have an effect on their ability to optimize their performance during bouts of training. In addition to these strategies, coaches could also choose to deceive athletes with regard to the specific workloads that will be executed within a given session. However, to date, the effect of various different forms of deception on the in-session performance of athletes is unequivocal and so further study is required to determine optimal strategies. Therefore, this study explores the influence of prior knowledge of sprint number on mechanical work, surface EMG (RMS, MF), countermovement jump (CMJ) Heart rate (HR), feeling scale (FS) and RPE during repeated-sprint sets (RSS).

METHODS: Twenty-two athletes performed three RSS protocols in random order. In one trial, subjects were informed that they would perform 2 sets of 5×20 m with 15-second recovery between sprints and with 1-minute recovery between sets (control trial, CL). In a second trial, subjects were invited to perform 1 set of 5×20 m, but after the second set of 5×20 m, they were also asked to perform an additional five sprints (deception trial, DC). In a third trial, subjects were not told how many sprints they would be performing but were stopped after 2 sets of 5×20 m (unknown trial, UN). Performance measures recorded included total sprint time for the 5 sprints (TST), sum of sprint times performed during the two sets (SST) and best 20 m sprint time (BST) for each set. The CMJ, RMS, MF, HR, FS and RPE were recorded before and immediately after each RSS protocol

RESULTS: The BST and TST of first set were significantly better than in the second set of RSS ($F \geq 77.8$, $p \leq 0.001$, $\eta p2 \geq 0.79$). No significant effect of condition was found in the BST and SST in set 1, 2 or over the whole protocol with no significant interaction effect. In addition, the RMS, MF, HR, FS and CMJ performance recorded at the RSS protocol were not significantly different in the three conditions. However, the RPE was significantly higher ($F \geq 9.6$, $p \leq 0.001$, $\eta p2 \geq 0.31$) after the unknown trial and after the first RSS compared to the CL and DC trials.

CONCLUSION: The main findings of our analysis were that even though the best sprint times were observed in the second trial of each protocol, there was no actual significant difference between any of the protocols in overall sprint times. In this way, the level of prior knowledge that the study participants were provided with prior to sprint execution did not affect their performance of those sprints.

ACUTE EFFECTS OF A STATIC AND A NEUROMUSCULAR PROPRIOCEPTIVE FACILITATION STRETCHING PROTOCOL ON DIFFERENT STRENGTH PROFILES

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INTRODUCTION: A variety of stretching techniques has been widely used to enhance ROM, aiming to improve performance and prevent injuries [1]. However, several studies have observed adverse effects on maximal muscle strength and power after static and dynamic stretching modalities, raising interest in other stretching modes [2]. Neuromuscular proprioceptive facilitation (PNF) continues to be an effective practice, and its impact on neuromuscular performance is not well known. The purpose of this study was to evaluate the acute effect of two stretching protocols on different strength profiles and muscle activity (EMG) of knee extensors and flexors.

METHODS: Twenty volunteers (8 women and 12 men), amateurs trail amateurs (mean age = 28.7 ± 7.59 yrs.) participated in the study. They were submitted to a static and a PNF protocol in a random order on separate days. Each participant performed the sit and reach test, countermovement jump (CMJ), maximal isometric force (90° of knee flexion) and maximal isokinetic peak torque of the quadriceps and hamstrings (60°.s-1), pre-and post-stretching protocols. EMG of the femoral biceps (BF), vastus medialis (VM) and lateral gastrocnemius (LG) muscles were measured during the isometric and isokinetic tests.

RESULTS: After both protocols, sit and reach test performance increased (time effect: $P < 0.001$; + 12.93% after static and + 11.03% after PNF protocol), whereas CMJ performance decreased (-4.11% and -6.51%, after static and PNF, respectively; $P < 0.01$ for both protocols). The MVC of the hamstrings was significantly affected by the PNF protocol (-9.61%; $P = 0.02$), while peak torque increased after static stretching (+4.14%, $P = 0.056$). No changes were observed in the MVC and the peak torque of the knee extensors following both stretching protocols. Force-length relationship, hamstrings to quadriceps (H: Q) ratios and VM, BF and GL muscle activity were not affected by any of the stretching protocols.

CONCLUSION: Both protocols induced an increase in flexibility but decreased muscle power. During maximum force tests, the PNF protocol affected the performance of the hamstrings, reducing their capacity to produce isometric force but increasing their capacity in a dynamic situation. Depending on the force profile, the stretching protocols may have a distinct impact, but it does not alter the agonist/antagonist ratio nor the curve-force-length relationship.

Nutrition

EFFECTS OF ORAL GARLIC EXTRACT SUPPLEMENTATION ON CYCLING TIME TRIAL AND EXERCISE-INDUCED OXIDATIVE INFLAMMATION IN HEALTHY ADULTS

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INTRODUCTION: Garlic extract has been shown to enhance antioxidant and anti-inflammation activities in humans. The present study investigated the effects of garlic supplementation on 40-km cycling time trial performance, exercise-induced oxidative stress, and inflammatory responses including blood biomarkers of oxidative stress, inflammation, and muscle

injury in healthy adults. We hypothesized that four weeks of daily garlic supplementation (1000 mg/day) would improve cycling performance by relieving systematic oxidative stress, inflammation, and muscle injury.

METHODS: Eleven physically active males (mean age: 22.0±4.8 years old, height: 174.9±7.7 cm, 77.0±13.3 kg, VO2 max: 45.3±5.5ml/kg/min) were recruited to perform this single-blind crossover study. Participants were randomly assigned to either garlic (garlic extracts 1000 mg/d for 4 weeks) or placebo trials. Following 4 weeks of supplementation, participants performed a 40-km cycling challenge and Total cycling performance time and respiratory exchange ratio (RER) were recorded. Blood samples were collected every 10 km to determine exercise-induced oxidative stress, inflammation, and muscle damage. A paired t-test was used to analyze the time recorded from participants during the 40 km time trial. Data for blood and gas samples collected at different time points were analyzed by repeated measure two-way ANOVA (trial × time). If a significant interaction was observed between treatments and time points, we further conducted a simple main effects analysis. In this regard, for post hoc analysis, Fisher's least significant difference (LSD) was used. The α value was set at $p < 0.05$.

RESULTS: The 40-km cycling time trial performance was not improved following 4 weeks of garlic supplementation. However, 4-wk garlic supplementation significantly increased whole-body antioxidant capacity (total antioxidant capacity, TAC), and subsequently attenuated MDA, TNF-α, and LDH during the 40-km cycling exercise period ($p < 0.05$). There were no significant differences among the blood biomarkers glucose, NEFA, IL-6, UA, and CK respectively. The respiratory exchange ratio was similar between garlic and placebo trials.

CONCLUSION: Four-week oral garlic supplementation attenuates exercise-induced oxidative inflammation and muscle damage during a 40-km bout of cycling. However, it appeared that 4-wk oral garlic had no ergogenic effect on cycling performance in healthy males.

THE RESEARCH OF ENZYME HYDROLYZED OKARA PROMOTE ENDURANCE EXERCISE PERFORMANCE AND RESIST EXERCISE FATIGUE IN MEN

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INTRODUCTION: Exercise fatigue was a common problem caused by intense or prolonged exercise, that had adverse effects on health, and needed to be solved. Okara, a residue of soybean processing, was a good protein resource, and was full of branched-chain amino acid (BCAA) which were confirmed with benefits for reducing fatigue. Furthermore, the BCAA content of the protein was elevated after enzyme hydrolysis processing. Thus, the aim of this study was to access the effects of enzyme hydrolyzed okara (EHO) on endurance exercise and its anti-fatigue property.

METHODS: In this study, sixteen healthy men (20 to 40 years old) who exercise at least 2 times a week were recruited in this study. All participants received one dose of EHO supplement for 4 weeks and performed the same exhaustive exercise test before and after 4 weeks of intervention. The exercise time and the blood markers relative to fatigue (pre-exercise, during exercise, and at the end of exercise) were measured.

RESULTS: The results showed that the time to exhaustive was significantly increased after 4 weeks of EHO supplementation, and the lactate content was significantly decreased during exercise and the end of exercise. Furthermore, the level of insulin at the end of exercise was significantly lower after EHO supplementation.

CONCLUSION: Our research indicated that EHO supplementation could promote endurance in exercise, decrease the accumulation of fatigue substances, and increase insulin sensitivity, which showed an anti-fatigue function.

DIETARY INTAKE ANALYSIS FOR PERSONS WITH STANDARD LEVEL AND OVERWEIGHT LEVEL OF BMI

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INTRODUCTION: Physically active persons could optimize physical functions by following to nutritional recommendation. Diet, which is adapted to energy expenditure, support physical health, welfare, and physical working capacities. Health status and body composition are indirectly related to dietary habits (Farina, et al., 2017; Dyal, et al, 2022). Nutritional knowledge level and readiness succeed to nutritional principles applicable to benefit physical activity and physical performance. Aim of the study evaluate differences in diet of young physically active person chord with standard BMI index and with overweight BMI before and after nutritional education course

METHODS: Participants of study group were men in aged from 22 to 35 years, the average age was 25.4 years, who had daily physical training. The study group participants were divided into two subgroups: respondents with standard level of BMI <25, the BMI level is into interval 18.5-24.9(N=20), and respondents with overweight level of BMI >25, when BMI is into interval 25.0-29.9(N=22). Dietary diary questionnaire developed according to standardized dietary epidemiology guidance (Willett, 2013). Daily dietary components % (proteins, carbohydrates, fat) as well total diet energy (in kcal) were calculated. We used nonparametric statistical analyses with Independent-Samples Mann-Whitney U Test summary, MS Excel and SPSS 27.0 version

RESULTS: Statistical tests analysis revealed no statistically approved differences between respondents' groups, the distribution of fat (p=0.624), carbohydrates (p=0.999), and proteins (p=0.521) in respondents` groups with standard BMI and overweight BMI in diet before nutritional education course. We revealed statistically significant differences of increasing of fat level (p=0.011) and decreasing carbohydrates (p=0.002) in study subgroups with standard BMI and overweight BMI

after nutritional education course, but there are no statistically approves differences in distribution of proteins (p=0.853), in respondents` subgroups after nutritional education course

CONCLUSION: Respondents from the study group showed a wide spectrum of individual habits of daily intake. The median of carbohydrates consumption energy level (%) was beneath compare to recommendation (till 60%) of carbohydrates consumption energy for general population, but above carbohydrates consumption energy level in recommendations (till 5%) of keto diet. The median value of proteins consumption energy level (%) was higher than recommended (till 15%) proteins consumption energy value for general population, but closed to recommended proteins consumption energy level in (till 20%) of keto diet. The fat consumption energy level median (%) was above fat consumption energy value in recommendation (till 25%) for general population, but below fat consumption energy value in recommendations (till 75%) of keto diet.Nutritional education has an impact on dietary intake of participants with standard and overweight level of BMI.

ACUTE EFFECTS OF RESISTANCE EXERCISE WITH DIFFERENT INTER-SET REST INTERVALS ON SUBJECTIVE APPETITE AND ENERGY INTAKE

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INTRODUCTION: This study examined the effects of resistance exercise (RE) with different inter-set rest intervals on subjective appetite and energy intake.

METHODS: In total, 12 healthy young men (age = 22.1 ± 1.5 years, body mass index = 22.7 ± 1.6 kg/m2) were included. Participants completed 3 moderate-load RE trials (3 sets of 70% 1RM) with different inter-set rest periods (60 sec, 120 sec, and 180 sec) and a control trial (CON; no exercise), in a randomized, crossover design. Subjective appetite ratings (hunger, satisfaction, fullness, and prospective food consumption) and levels of lactate were evaluated before exercise and 90 minutes after exercise. Ad libitum energy intake was determined 90 minutes after rest periods. Participants recorded over 3-day (the test day and one day before and after the test day) energy intake.

RESULTS: Recovery of appetite suppression was slower in the 60 sec trial ($p < 0.05$ vs. CON at post 0, 30, and 60 minutes). The area under the curve (AUC) of overall appetite was significantly lower in the 60 sec trial ($p < 0.05$ vs. 180 sec and CON). The AUC of lactate levels during the trial period was significantly higher in the 60 sec trial ($p < 0.05$ vs. 120 sec, 180 sec, and CON). There were no differences in energy intake responses, including ad libitum energy intake and 3-day food diary between 4 trials ($p > 0.05$).

CONCLUSION: These findings suggest that moderate-load RE with a short inter-set rest interval induces greater inhibitory responses on subjective appetite. RE with different inter-set rest intervals seems not to affect post-exercise energy intake.

EFFECTS OF SHORT-TERM ALTERNATE DAY FASTING ON WEIGHT LOSS AND BODY COMPOSITION

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INTRODUCTION: Obesity is a public health epidemic. While many weight loss diets like alternate day fasting (ADF) have been shown to be effective in curtailing obesity, these diets typically require long durations to see positive results. The effectiveness of shorter-term ADF interventions in tackling obesity is less well studied. Another concern is that of muscle loss, which commonly occurs during weight loss. Therefore, this study investigates the effects of short-term (four weeks) ADF on weight loss and body composition.

METHODS: A total of 46 healthy young men were recruited, with 37 completing the intervention. Participants were aged 25 (3) years, with an average body mass index (BMI) of 26.7 (3.6) kg/m2. They completed 28 days of ADF, alternating every 24 hours between 'feeding' (ad libitum) and 'fasting' (400-600 kcal consumed between 12 to 2 PM). Body mass (BM), fat mass (FM), and fat-free mass (FFM) were measured using direct segmental multi-frequency bioelectrical impedance analysis (InBody 720). Within-subjects t-test was performed for repeated measures analyses.

RESULTS: There were significant reductions in all outcome measures post-intervention ($p < .001$). On average, the participants experienced a change of -2.4 [95% CI -2.9, -1.9] kg in BM (80.9 to 78.5 kg), -0.8 [95% CI -1.0, -0.6] kg/m2 in BMI (26.7 to 25.9 kg/m2), -1.6 [95% CI -2.0, -1.2] kg in FM (19.7 to 18.1 kg), -0.8 [95% CI -1.2, -0.3] kg in FFM (61.2 to 60.5 kg), and -1.4 [95% CI -1.9, -0.9] % points in percentage body fat, PBF (23.6 to 22.2%).

CONCLUSION: Short-term ADF over four weeks is effective in combating obesity through reductions in BM, BMI, FM and PBF. Expectedly, it also has a significant deleterious effect on FFM, an indicator of muscle mass. However, it should be noted that out of the total weight lost (2.4 kg), participants lost twice as much FM (1.6 kg) as compared to FFM (0.8 kg). These findings may have important implications for individuals who are looking to lose weight while preferentially losing more FM relative to FFM.

ASTAXANTHIN SUPPLEMENTATION IMPROVES CYCLING TIME TRIAL PERFORMANCE AND ATTENUATES EXERCISE-INDUCED OXIDATIVE STRESS AND MUSCLE DAMAGE IN HEALTHY ADULTS

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INTRODUCTION: The attenuation of exercise-induced whole-body oxidation stress, inflammation, and muscle damage are vital in sports competitions. However, astaxanthin (AST) is an oxygenated carotenoid and a ketocarotenoid, known for

its powerful biological antioxidant that occurs naturally in a wide variety of living organisms. Therefore, this experiment aims to investigate the effects of 4 days of high-dose AST supplementation (28 mg/day) on endurance performance, exercise-induced oxidative stress, inflammatory responses, and muscle damage in healthy adults.

METHODS: Ten healthy males (n=10, 22.5±0.90 yrs., body mass index (BMI) 22.9±0.83) were participating in this experiment and it was designed as a randomized, placebo-controlled, single-blind study. Participants were randomly assigned to either AST (28 mg/d for 4 days) or placebo trials with a 14-day washout period. On the fourth day of supplementation, a light-calorie breakfast (300 calories) was provided before the exercise challenge. After a one-hour rest, participants were required to perform a 75% maximal oxygen uptake (VO2max) time to exhaustion (TTE) cycling challenge. Blood samples were collected before, at the end of the TTE challenge, and every 20 mins during exercise to determine the physiology of exercise-induced oxidative stress, inflammation, and muscle damage.

RESULTS: The TTE under 75% VO2max cycling challenge has significantly increased after oral AST supplementation (AST: 5226.89 ± 273.493 (sec); Placebo: 4326.67 ± 150.196 (sec), $p < 0.05$). At the same time, the muscle damage marker (lactate dehydrogenase (LDH) and creatine kinase (CK)) were significantly lower at 20 min and at the end of TTE respectively in the AST treatment. The oxidation stress marker (malondialdehyde (MDA)) had a significantly lower response at 40 min and at the end of TTE respectively, compared to the placebo trial. However, no significant differences between AST and placebo trials were shown respectively among the blood biomarkers (glucose), anti-oxidation stress marker (total antioxidant capacity (TAC)) and inflammation marker (tumor necrosis factor-α (TNF-α)).

CONCLUSION: Bringing all the above evidence together, based study including the TTE cycling performance, physiology of exercise-induced oxidative stress and muscle damage, oral AST supplementation (28 mg/day) for 4 days can result in the attenuation in LDH, CK, and MDA indicators and also contain ergogenic properties, which is able to improve TTE cycling performance in healthy adults.

FLUOXETINE IMPAIRS MUSCULAR STRENGTH, POWER AND ENDURANCE PERFORMANCE PARTICULARLY WHEN IT IS CO-INGESTED WITH CAFFEINE: A CASE STUDY

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INTRODUCTION: The prevalence of depression among athletes is high due to several risk factors such as injuries, career termination, decline in performance, catastrophic performance or even as a consequence of the COVID-19 pandemic lockdown. Fluoxetine, a recurrent pharmacotherapy in depression, is one of the preferred treatment drugs in athletes since it does not seem to impair sports performance. Some athletes combine this drug with caffeine intake, a common nutritional supplement that improves muscular strength, power and endurance performance. Thus, the purpose of this study was to analyze the combined effect of fluoxetine and caffeine on muscular strength, power, and endurance performance.

METHODS: In this case study, a female participant (age: 25 years; body mass: 56.7 kg; fat mass: 13.4 kg) was recruited to visit the laboratory for five days to complete a familiarization day and four randomized experimental conditions: a) placebo (PLA); b) fluoxetine plus placebo (FLU+PLA); c) caffeine (CAF); d) fluoxetine plus caffeine (FLU+CAF). A total of 72h were allowed between experimental conditions to ensure recovery. Fluoxetine administration was conducted under medical consent and supervision, while 3 mg/kg of body mass of caffeine or maltodextrin (placebo) was provided 60 minutes after the test. The participant performed a muscular strength and power test for bench press and back squat exercises at 25%, 50%, 75% and 90% 1-repetition-maximum (1RM). Then, muscular endurance was assessed for both exercises at 65% and 85% 1RM performing one set until task failure.

RESULTS: FLU+CAF condition decreased mean velocity and power output in both exercises, bench press and back squat, at 75% and 90%1RM in the muscular strength and power tests. While the FLU+PLA condition decreased peak velocity as well as mean and peak power output at 25%1RM in the muscular strength and power. In addition, in the muscular endurance test, the FLU+CAF condition promotes a reduction in mean velocity and power output in both exercises at 85% 1RM. While the FLU+PLA condition stimulates a decrease in mean velocity and power output in both exercises at 65% 1RM.

CONCLUSION: Previous evidence support that fluoxetine administration did not alter sports performance. However, this case study indicates that fluoxetine could reduce muscular strength, power and endurance performance in isotonic exercise at low-to-moderate loads. Moreover, fluoxetine administration seems to counteract the ergogenic effect of caffeine and impair muscular strength, power and endurance performance when both drugs are co-ingested. Therefore, although further studies are needed, athletes diagnosed with depression on fluoxetine treatment should reconsider caffeine consumption as a nutritional supplement to enhance performance.

EFFECT OF LONG-TERM PRE-EXERCISE CREATINE INTAKE ON NON-INVASIVE MUSCLE DAMAGE MARKERS AFTER ECCENTRIC EXERCISE

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INTRODUCTION: The intake of creatine has attracted attention as a means of preventing exercise-induced muscle damage (EIMD) caused by eccentric contraction exercise; however, there is insufficient knowledge on its effectiveness, including the duration of intake. On the other hand, although the use of repeatable non-invasive evaluation indices such as

imaging and urinary biomarkers for the evaluation of EIMD is expanding [1], the effect of creatine intake remains unclear. This study focused on long-term creatine intake with the aim of verifying how various markers change with EIMD based on 28 days' pre-exercise creatine intake.

METHODS: Twenty healthy young males (creatine group, n=10; placebo group, n=10) were stratified and randomly assigned to a group using the double-blind method and were instructed to take 3 g of either creatine monohydrate or placebo per day for 28 consecutive days. After the end of intake, the participants performed 50 repetitions of dumbbell exercises emphasising on eccentric contraction at 50% of the maximum lifting weight in the laboratory. Based on previous study [1,2], measurements were taken to verify the extent of EIMD at a total of 8 points: pre- and post-exercise, and 1, 24, 48, 72, 96, and 168 h after exercise. The measurement items were muscle shear modulus (SM) from ultrasound elastography images, urinary titin N-terminal fragments (UTF), maximum voluntary contractions (MVC), range of motion (ROM), upper arm circumference (50/75%), and subjective muscle pain (soreness: SOR)/muscle fatigue. Olink Target 48 Cytokine® was used for exhaustive analysis based on inflammatory markers, and exploratory analysis was conducted using urine samples collected at several timepoints. After the two-way analysis of variance, post hoc tests were conducted with the Bonferroni method, and the risk ratio was set as less than 5%.

RESULTS: The peak of change transitioned differently for each marker, as was seen in a previous study. An intergroup comparison revealed that the creatine intake group had significant differences in SM (96 and 168 h), MVC (post 48, 96, and 168 h), arm circumference (72, 96, and 168 h), and muscle fatigue (post 168 h) compared to the placebo group. Fluctuations in several inflammatory markers were also confirmed.

CONCLUSION: This study found that creatine exerted a notable inhibitory effect on the aforementioned markers, and the inhibitory effect was confirmed particularly several days after exercise. Creatine is expected to serve a role in accelerating the muscle recovery after exercise.

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RELATIONSHIP BETWEEN BRANCHED CHAIN AMINO ACIDS AND INSULIN RESISTANCE IN WOMEN'S WATER POLO AND WOMEN'S SOCCER ATHLETES

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INTRODUCTION: To test the differences of branched chain amino acids(BCAA), insulin resistance and dietary intake index of female professional athletes and understand the occurrence of insulin resistance in female professional athletes. This study will provide research basis for the development of precise nutrition scheme for female professional athletes.

METHODS: The index of BCAA and insulin resistance in 54 female professional athletes were measured, and then the correlation between them was analyzed. The differences of serum branched chain amino acids between insulin resistance group and non-insulin resistance group were compared. The differences of serum branched chain amino acids, insulin resistance related indexes and dietary intake levels in different projects were analyzed.

RESULTS: Valine, isoleucine, leucine and BCAA were all positively correlated with blood glucose, HOMA-IR and skeletal muscle weight ($P < 0.05$). The levels of blood glucose, insulin, valine, isoleucine, leucine, BCAA and BMI in insulin resistance group were lower than those in non-insulin resistance group ($P < 0.05$). The BMI, skeletal muscle and blood glucose levels of young womens soccer were lower than that of adult womens soccer ($P < 0.05$), and the levels of total dietary energy, protein and carbohydrate intake were higher than that of adult womens soccer ($P < 0.05$). There was no significant difference between the two groups in insulin, HOMA-IR and HOMA-β ($P > 0.05$). The levels of insulin, HOMA-IR, HOMA-β, Valine, isoleucine, leucine and BCAA of female water polo players were higher than those of adult female soccers ($P < 0.01$). In addition, the levels of dietary total energy, protein, fat and carbohydrate were all higher than those of adult female soccer ($P < 0.01$).

CONCLUSION: Insulin resistance exists in womens water polo and womens soccer athletes who are engaged in high-intensity sports activities. The levels of branched chain amino acids are significantly correlated with insulin resistance. It is suggested that female professional athletes should pay attention to insulin resistance. Young athletes with high energy demands can be administrated with BCAA appropriately. Adult female professional athletes with high BMI and high dietary protein and fat intake should control BCAA intake to prevent the occurrence of insulin resistance.

EFFECTS OF CAFFEINATED COFFEE ON PHYSICAL AND COGNITIVE PERFORMANCE: DOSE, GENDER AND HABITUATION LEVEL

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INTRODUCTION: Although effects of caffeinated coffee ingestion on physical performance is known, whether effects of different doses ingestion on physical and cognitive performance vary between genders and habituation is not known. The aim of this research is to investigate the effects of very low (1,5 mg/kg), moderate (3 mg/kg) and high (6 mg/kg) dose of caffeinated coffee ingestion on lower and upper body muscular strength, muscular endurance, sprint and cognitive performance in low, moderate and high habitually caffeine consumers male and female athletes.

METHODS: 69 athletes participated in this research, attended 4 test days in total by dividing 3 groups according to their habituation level: decaffeinated coffee (PLA), 1,5 mg/kg caffeinated coffee (LDOSE), 3 mg/kg caffeinated coffee (MODDOSE) and 6 mg/kg caffeinated coffee (HIGHDOSE) ingestion and performed skuat and bench press 1 repetition maximum (1RM) strength and 60% 1RM muscular endurance and sprint performance test. Cognitive performance (CP) was measured before coffee ingestion, after 60 min and after test protocol. Further, heart rate (HR) and ratings of perceived exertion (RPE) were measured at different time points.

RESULTS: As a results, caffeinated coffee did not increase muscular strength and upper body muscular endurance but 3 and 6 mg/kg doses increased lower body muscular endurance in only low and moderate habituation group and sprint performance enhanced with 6 mg/kg dose in all consumption groups. Additionally, in high consumption group, lower body muscular endurance performance increased only with 6 mg/kg caffeinated coffee but not with 3 or 1.5 mg/kg of caffeine. 6 mg/kg caffeinated coffee significantly improved cognitive performance but non doses affect heart rate and RPE.

CONCLUSION: This study partially supports the notion that ingest higher dose of acute caffeine than consume habitually to increase exercise performance in athletic population.

DIETARY CALCIUM INTAKE IN HEALTHY MEN AND ATHLETES: EFFECT ON FREE 25-(OH)D AND BIOAVAILABLE 25-(OH)D

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INTRODUCTION: An optimal supply of calcium is necessary for athletes to maintain bone health, skeletal muscle function, cardiac contraction and nerve conduction. Moreover, calcium and vitamin D are metabolically interrelated to serve endocrine functions. In some studies showed that calcium intake might be a significant determinant of serum vitamin D status. According to the "free hormone" hypothesis, current studies suggest that some functions of vitamin D may be more closely related to the free or bioavailable fraction of vitamin D than to total serum 25-(OH)D concentrations. Therefore, the aim of our study was to investigate whether different concentrations of habitual calcium intake influence serum free 25-(OH)D and bioavailable 25-(OH)D in healthy men and athletes.

METHODS: Sixty nine participants (healthy male [n= 27] and athletes – football players, judoists [n = 42]) took part in the study. Calcium intake was evaluated using a 7-days food record method. The subjects were divided into subgroups by dietary calcium intake (≥1000 mg/day versus <700 mg/day). Free (25-(OH)DF), bioavailable 25-(OH)D (25-(OH)DB) concentration were evaluated by calculation, using serum albumin and vitamin D binding protein levels. Total 25-(OH)D (25-(OH)DT) was assessed using LM-MS/MS. Two way analysis of variance, with healthy men/athletes as second variable was performed to analyse the effect of calcium intake on 25-(OH)DT, 25-(OH)DF and 25-(OH)DB. A statistical level of $p< 0.05$ was accepted. Analysis was performed in R for windows (version 4.2.2, Vienna, Austria).

RESULTS: Our study showed decreased 25-(OH)DF serum levels (12.19±5.72 pg/ml) in 33.3% of the healthy men group and the 40.5% (11.28±5.05 pg/ml) of the athletes group. There were no significant differences between groups (differing in calcium intake) in 25-(OH)DF, 25-(OH)DB, 25-(OH)DT. Subjects with low calcium intakes were compared with subjects with high calcium habitual intake, results showed that there was no significant levels of physical activity (healthy men vs athletes) x calcium intake grouping interaction effect on the mean serum 25-(OH)DF, 25-(OH)DB, 25-(OH)DT concentrations.

CONCLUSION: In summary, this study showed that 66.7% healthy men and 57.1% athletes did not covered the daily demand for calcium (RDA>1000 mg/d). It seems that healthy males and athletes with insufficient daily calcium intakes should receive a calcium – enhanced diet and in case of significant deficiency of calcium intake supplementation is necessary (apart from diet modification). Calcium intake grouping and the level of the physical activity had no effect on 25-(OH)DF, 25-(OH)DB, 25-(OH)DT concentrations. We found no evidence of a serum 25-(OH)DF, 25-(OH)DB sparing effect of high calcium intake, which has been referred to by some authors as "vitamin D economy."

THE EFFECT OF PHYSICAL EFFORT ON TOTAL- AND FREE FRACTION OF HYDROXYVITAMIN D IN THE NATIONAL TEAM MALE TRIATHLETES.

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INTRODUCTION: The standard indicator of vitamin D status is a total 25(OH)D concentration in the blood. Approximately 0.03% of this metabolite is the free form and remaining amount is bounded, mainly to vitamin D binding protein (VDBP). The major biologic function of VDBP is the regulation of both fractions of 25(OH)D in blood and the relationship between them [1,2]. Because only free fraction is able to exert their biological effects, it was hypothesized that this unbound form may be a better marker of vitamin D status than the classic measurement of a total 25(OH)D [1]. Recently, determination of free25(OH)D has also been proposed in physically active subjects [3]; however its usefulness in different physiological and pathological conditions has yet to be unequivocally confirmed in scientific studies [1,2].

The study aimed to investigate the direct effects of single, acute, and non-accustomed physical effort on serum of total- and free 25(OH)D concentration in male athletes.

METHODS: The study included 12 triathletes (members of the national team), aged 18.6 ± 2.1 years. They underwent maximal oxygen consumption (VO2max) test on a treadmill, and (1-3 days later) a 30-minute run (at 50% VO2max) on a 1.5-degree downhill treadmill (with an eccentric component), followed immediately by 3 x 3-min sprints at 100% VO2max

intensity, with a 1-min rests between them. Capillary blood was collected before, and 15 min, 3 and 24 hours after the exercise. The concentration of total- and free 25(OH)D (ELISA, DiaSource), VDBP (polyclonal antibodies ELISA, Immuniq), high sensitivity c-reactive protein (hsCRP - immunoturbidimetry, Roche), TNF-alfa (ELISA, R&D Systems) as well as phosphocreatine kinase activity (CK - enzymatic method, Roche), were determined. All post-exercise results were corrected for changes in plasma volume. Friedman's ANOVA with Dunn Bonferroni post-hoc test was used in the statistical analysis of the data.

RESULTS: Despite the lack of changes in hsCRP, significant post-exercise increase in CK activity in 3 and 24 h ($p<0.001$) and TNF-alpha ($p=0.005$) and VDBP ($p=0.002$) concentrations in 15 min were observed. Furthermore, the subjective severe muscle soreness the next morning was reported. At the same time, there were no significant post-exercise changes in the total- and free 25(OH)D concentrations, as well as in the total to free fraction ratio.

CONCLUSION: The presented results indicate that in healthy high-level athletes, acute non-accustomed physical efforts, had no effect on either of both vitamin D metabolites and the ratio of total to a free fraction. This suggests that a total 25(OH)D concentration in physically active subjects is an equally good indicator of vitamin D status as the free fraction.

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ASSESSMENT OF ENERGY AVAILABILITY AND FACTORS ASSOCIATED WITH RED-S IN WEIGHT-SENSITIVE SPORTS AND WEIGHT CLASS ATHLETES DURING COMPETITIVE SEASON

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INTRODUCTION: Relative energy deficiency in sport (RED-S) can negatively affect the health and performance of both male and female athletes. The underlying etiology of RED-S is low energy availability (EA), which occurs when there is insufficient dietary intake to meet exercise energy expenditure. The weight-sensitive sports and weight class athletes often having a high incidence of engaging in unhealthy nutrition and weight loss practices. Especially during the competitive season, weight-sensitive sports and weight class athletes reduce energy intake to achieve target body weight, changes in body composition occur due to fluctuations in energy expenditure and energy intake. LEA is when a higher training load is combined with low caloric intake so athletes are constantly in a state of calorie deficit. We aimed to assess dietary intake, energy expenditure, estimate EA, and assessed factors related to RED-S in weight-sensitive sports and weight class athletes during a competitive season.

METHODS: In a cross-sectional design study design, twenty athletes from judo (n = 10), weightlifting (n = 3) and rowing (n = 7) were included in this study. We measured dietary intake (24 h dietary-record) and exercise energy expenditure (EEE, accelerometry) over 4 days, including 2 weekdays (with training) and 2 weekend days (without scheduled training). Furthermore, we assessed body composition, and bone mineral density (dual-energy X-ray absorptiometry) and venous blood variables. Paired t-tests were used to compare dietary intake, EEE, macronutrient and EA between weekdays and weekend days. Other data expressed using descriptive statistics.

RESULTS: On weekdays, 90% of participants had an energy intake <30 kcal·kg·day–1, 20% had reduced EA (30-45 kcal·kg FFM·day–1), and 80% had low EA (<30 kcal·kg FFM·day–1). On weekend days, 69% of participants had an energy intake <30 kcal·kg·day–1, 62% had reduced EA (30-45 kcal·kg FFM·day–1), and 31% had low EA (<30 kcal·kg FFM·day–1). The EA was higher on weekend days (30 ± 15kcal·day–1) than on weekdays (18 ± 13 kcal·day–1; $p < 0.05$) because of the increase in EEE on weekend days. There were no differences in macronutrient consumption between weekdays and weekend days. Menstrual dysfunctions were reported in 22% of female participants. All participants had adequate bone health (Z-bone mineral density score: 1.6 ± 0.9), but 60% had concentrations of 25-OH vitamin D < 30 ng/ml, which is less than the levels of vitamin D deficiency.

CONCLUSION: There is still a prevalence of low EA in weight-sensitive sports and weight class athletes during competition season, have a high-risk of developing RED-S due to weight restrictions. High energy consumption resulting from sports training during the competition season requires athletes to increase their energy consumption to prevent the prevalence of low EA. Therefore, strategies to support the health of athletes and the energy availability of training are essential to optimize training results and prepare for competition.

EFFETS DE LA FEUILLE DE MORINGA OLEIFERA SUR LE TRAVAIL TOTAL LORS D'UNE EPREUVE D'ENDURANCE

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INTRODUCTION: Moringa Oleifera is a plant found in tropical regions and whose different parts (leaves, seeds, root, bark) are used in food or in traditional medicine to treat different pathologies. Its nutritive, antioxidant, anti-inflammatory, analgesic, antimicrobial, vasodilator and ergogenic properties make this plant a candidate for improving sports performance. The objective of this study is to compare the total work during an endurance test before and after taking a Moringa Oleifera leaf tea.

METHODS: the total work done by 8 participants (5M, 3F, Age: 25.6□1.8 years, Weight: 68.6□5.6 kg, Height: 168.9□3.4 cm, VO2max: 44.1□3 ml/kg/min, SV2: 33.1□2.32 75 %VO2max) during a 20km time trial was measured. During the test, the load was set at a power (150□17.7 Watts) corresponding to the ventilatory threshold 2 (SV2) of the participants. In the back-

ground, the Heart Rate (HR) reached during the test, the perception of exertion (RPE) and the blood lactate level were also measured. We will use a paired-samples t-test to compare the mean of our different variables before and after the intervention. Significant difference will be defined as $p<0.05$. Analyzes will be performed using SPSS 27.0 statistical software for the social sciences.

RESULTS: The total work done by the participants during the endurance test was not significantly different (Δ 263.4□96.1 vs 261.7□100.7 kJ, p = 0.772, d=0.1). HR (Δ 176.9□11.9 vs 182.2□39.7 bpm, p=0.757, d=-0.1), RPE (Δ 14.9□3.5 vs 16.5□2.5, p=0.236, d= -0.5), lactate [La+] (Δ 11.8□2.8 vs 10.6□3.2 mmol/L, p=0.351, d=0.4) are not significantly different.

CONCLUSION: The preliminary study carried out showed that the Moringa Oleifera leaf does not improve the total work at SV2. Faced with this observation, we believe that the Moringa Oleifera leaf will have an effect on the total work at ventilatory threshold 1 (SV1). As the study is ongoing, the final result will be presented at the congress.

SELF-DECLARED PREVALENCE OF SLEEP AIDS USE IN POLISH ATHLETES

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INTRODUCTION: The prevalence of sleep inadequacy is high among elite athletes. Sleep disturbances are observed in 50-78% of athletes, whereas 20-26% experience highly disrupted sleep [1]. Sleep inadequacy management requires a coordinated approach based primarily on non-pharmacological interventions, i.e. sleep education, screening and treatment [1]. Nonetheless, to optimize sleep, athletes and their medical practitioners often turn to supplements (despite the paucity of evidence regarding their efficacy) and pharmacological sleep aids [2], regardless of premises suggesting the side effect profile of some sleep medications, including overreliance and its addiction potential [2,3]. Available evidence regarding prescribed, over-the-counter sleep medication and sleep supplement intake among elite athletes is limited. Thus, the study aimed to assess the use of sleep aids, i.e. medications and/or dietary supplements, in athletes.

METHODS: Doping control forms (DCFs) were assessed to investigate the list of all medications and dietary supplements the tested athletes reported using across the seven days prior to doping controls. DCFs were collected by Polish Anti-Doping Agency between 2018 and 2021. Statistical analyses were performed using the non-parametric Chi-squared test applying a significance level of $p<0.05$.

RESULTS: A total of 3902 DCFs (females: 33.0%, n=1287) from athletes (mean (±SD) age of 25±7 years) representing 47 different sports were included in the study. In 298 DCFs (7.6%), the use of sleep medications (n=149, mostly melatonin (23.8%), zolpidem (4.4%), trazodone (4.0%)), and/or sleep supplements (n=163, multi-ingredient) was declared. There was no significant difference between the prevalence of sleep medication and sleep supplement use ($p>0.05$). Females more often than males reported the use of sleep aids (10.6% vs 6.2 %,$p<0.001$), both psychiatric drugs (5.8% vs 2.8 %,$p<0.001$) and supplements (5.4% vs 3.6 %,$p=0.0095$). The highest incidence of sleep aid use was declared by athletes aged 21-25 (42.3%,$p<0.001$). The difference between the prevalence of sleep aid use reported during in- and out-of-competition doping controls was not significant, $p>0.05$. All data refers to the number of DCFs and not to athletes.

CONCLUSION: Considering that even one in four elite athletes might suffer from highly disturbed sleep, the percentage of Polish subjects declaring using sleep aids seems relatively small. The females reported the highest incidence of sleep aid use, supporting the previous findings that the female gender is a general risk factor for sleep inadequacy. Irrespective of gender, the athletes declared the use of supplements as often as sleep medications. In addition, despite competition being a high-risk period for sleep disruption, an increased rate of sleep aids use was not observed during in-competition doping controls.

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EFFECT OF 7-DAY POLYPHENOL POWDER SUPPLEMENTATION ON CYCLING PERFORMANCE AND LUNG FUNCTION IN AN OZONE-POLLUTED ENVIRONMENT.

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INTRODUCTION: Polluted environments that are high in ozone can adversely affect lung function and limit exercise performance. Evidence suggests that some nutrient supplements may offset pollutions detrimental effects. This study aimed to determine the effect of supplementation of a polyphenol powder at a dose that provided 4.3 mg/kg bodyweight anthocyanins for seven days on exercise performance and lung function in a high ozone environment.

METHODS: The study was a randomised, double-blind, placebo-controlled crossover design. Ten trained cyclists (mean ± SD: age, 43.8 ± 12.38 years; height, 177.75 ± 7.1cm; weight, 76.02 ± 7.88 kg; VO2max 4.23 ± 0.79 L.min-1age) performed a maximal incremental test to determine peak power output (PPO) and a 4-km time trial (TT). Thereafter cyclists completed two experimental trials in an ozone environment (0.25 ppm) following 7-days of supplementation with either polyphenol blend (PB) or placebo (PL). The experimental protocol consisted of cycling for 10-min at 50 %, 10-min at 60 % and 5-min at

70% of incremental peak power output (PPO) achieved in the VO2max test. This was followed by 10 minutes of rest and then a maximal 4-km cycling time trial. Lung function (FVC, FEV1, FeNO) was measured pre- and post-exercise in the experimental trials.

RESULTS: VO'2 (L-1) was significantly higher in the PB group during the 4 km TT (p = 0.01), with significantly higher average power (Watts) in the first km of the TT (p = 0.01). Time to complete the 4 km TT was 4.3% faster following PB supplementation (406.4 ± 50.29 sec) compared to PL (426.2 ± 75.06 sec, p = 0.09, d = 0.31). PB supplementation significantly reduced the severity of cough experienced during ozone exposure (p = 0.03) but did not protect lung function (FEV1, FVC) following cycling in ozone.

CONCLUSION: Supplementation with a proprietary blend of polyphenols at an anthocyanin dose of 4.3 mg/kg bodyweight for 7-days may attenuate the decrease in exercise performance during cycling in an ozone polluted environment and reduce cough symptoms.

PROTECTIVE EFFECTS OF HIGH-FAT DIET AND AEROBIC EXERCISE TRAINING ON EXERCISE PERFORMANCE AND LIPID METABOLISM IN AGING FEMALE MICE WITH DIFFERENT INTRINSIC AEROBIC CAPACITY

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INTRODUCTION: Although aerobic endurance is generally considered an important factor in combating metabolic dysfunction, promoting health, and improving physical fitness and performance. However, there are few studies to investigate whether there is a significant difference in the severity of hyperglycemia, hyperlipidemia, hypertension diseases under high glucose between high- or low- intrinsic endurance capacity, and their possible mechanisms. We have successfully established (via artificial selection) tow mouse models with high and low aerobic endurance capacity, and are designated as the high-aerobic exercise capacity (HAEC) and low-aerobic exercise capacity (LAEC) lines for 22 generations. Through high fat diet (HFD) to simulate the metabolic syndrome caused, and the aim is current study was to investigate the effects of metabolic diseases and physiological and biochemical effects on aging mice with different intrinsic aerobic capacity under HFD and exercise training.

METHODS: We used female HAEC and LAEC mice naturally aged to 19 months, and assigned them to normal diet, high-fat diet (HFD), and high-fat diet combined with exercise training groups, respectively. After 6 weeks of HFD and aerobic exercise training, the exercise capacity and physiological metabolic indicators were tested.

RESULTS: We found that, although both HAEC and LAEC aging mice could cause significant weight gain under the induction of HFD, HAEC aging mice lose 5.56% of body weight and 57.18% ovary fat pad compared with LAEC aging mice, and exercise training was significantly reduced 10% body weight ($p<0.05$). Although both HAEC and LAEC aged mice had decreased muscle strength and endurance performance induced by a HFD, but HAEC aged mice still had better exercise performance maintenance and aerobic training for 6 weeks It has the effect of significantly improving sports performance ($p<0.05$). In addition, under the induction of HFD and the intervention of aerobic exercise training, HAEC aging mice significantly improved glucose tolerance, stable blood pressure, and the metabolism of total cholesterol and triglycerides in blood and liver compared with LAEC aging mice ($p<0.05$).

CONCLUSION: In conclusion, we found that although a HFD is one of the risk factors for metabolic diseases, intrinsic high aerobic capacity has a better protective effect. In addition, under aerobic exercise training, aging mice regardless of HAEC or LAEC have a protective effect on body composition and lipid metabolism, but the natural high aerobic capacity has better and more significant benefits.

CLASS, ORDER, AND FAMILY CHANGES OF GUT MICROBIOME BY AEROBIC EXERCISE

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INTRODUCTION: The gut microbiome can be modified by disease, diet, and others affecting general health. This study aimed to explore whether aerobic exercise can change the Class, Order, and Family of the gut microbiome.

METHODS: Twenty four men were recruited and divided into two groups; Non-Exercise Group (NEG, n=8, 28.6±5.3 yrs, 176.0±7.8 cm, 81.3±14.6 kg, 26.1±3.3 kg/m2), and Exercise Group (EG, n=16, 28.6±5.1 yrs, 175.5±4.4 cm, 76.6±10.6 kg, 24.8±3.0 kg/m2). For the inclusion in the study, their physical activity level, intestinal health status, disease prevalence, medical history, and eating disorder were assessed. EG performed more than 30 min of aerobic exercise per day, 3 or more days per week, for 4 weeks at a moderate intensity predicted from the maximal aerobic capacity test. NEG did not participated in any exercise program during 4 weeks. Their basal level of gut microbiome was examined by stools collected one morning after a 10-hour fasting before and after 4 weeks. Data were analyzed using Wilcoxon. The one level of error was set to α=.05.

RESULTS: In the Class level, EG increased Bacteroidia (44.2±16.7 to 54.6±12.3%, p=0.002) and Deltaproteobacteria (0.09±0.16 to 0.25±0.33%, p=0.03) after 4 weeks, while Bacilli (0.31±0.41 to 0.09±0.09%, p=0.009), Clostridia (38.7±17.4 to 32.0±14.0%, p=0.008), and Negativicutes (9.6±7.1 to 7.1±4.3%, p=0.025) were decreased. In the Order level, EG increased Bacteroidales (44.2±16.7 to 54.6±12.3%, p=0.002) and Desulfovibrionales (0.09±0.16 to 0.25±0.33%, p=0.03) after 4 weeks, while Lactobacillales (0.31±0.41 to 0.09±0.09%, p=0.011), Clostridiales (38.7±17.4 to 32.0±14.0%, p=0.008), and Selenomonadales (9.6±7.1 to 7.1±4.3%, p=0.025) were decreased. In the Family level, EG increased Bacteroidaceae (22.3±13.4 to 28.9±14.9%, p=0.021), Prevotellaceae (19.8±25.7 to 22.6±25.7%, p=0.029), and Desulfovibrionaceae

(0.09±0.16 to 0.25±0.33%, p=0.03) after 4 weeks, while Streptococcaceae (0.21±0.28 to 0.06±0.07%, p=0.021), Lachnospiraceae (26.0±14.9 to 17.6±10.4%, p=0.002), and Veillonellaceae (6.03±8.04 to 3.94±4.78%, p=0.011) were decreased. No changes in any variables after 4 weeks in NEG were noticed.

CONCLUSION: Based on the results, the gut microbiome in the level of Class, Order, and Family strata were changes only in the aerobic exercise group. An additional research for the function and role of the microbiome is warranted.

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CHLORELLA INTAKE COMBINED WITH SHORT-TERM HIGH INTENSITY INTERMITTENT TRAINING FURTHER ENHANCES AEROBIC AND ANAEROBIC CAPACITIES IN ATHLETES: A DOUBLE-BLIND RANDOMIZED STUDY

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INTRODUCTION: High intensity intermittent training (HIIT) enhances aerobic and anaerobic capacities in the athletes. Chronic intake of chlorella (CH), which is a type of unicellular green algae that contains various nutrients, increases aerobic capacity in young men. Our study using rats has demonstrated that chronic CH intake combined with HIIT further accelerated exercise performance as compared with HIIT alone. However, it is unclear whether the chronic CH intake combined with HIIT has more pronounced effects on aerobic and anaerobic capacities in the athletes. Therefore, we aimed to investigate the effects of chronic CH intake combined with short-term HIIT on aerobic and anaerobic capacities in the athletes using both laboratory and field tests.

METHODS: [Study 1: Laboratory test] Eleven female track and field athletes (100m-400m sprinters) were randomly divided into two groups; HIIT combined with CH intake (HIIT+CH) group and HIIT combined with placebo intake (HIIT+PL) group. They completed 4-week of exhaustive HIIT, consisting of 6-7 bouts of 20-second running on a treadmill with a 5% incline at an intensity of 170% maximal oxygen uptake (VO2max) with a 10-second rest between each bout, 3 days/week. They orally took CH or PL (15 tablets) after the breakfast and dinner between the 4-week in a double-blind, randomized, placebo-controlled trial. We measured the VO2max, and maximal oxygen deficit (MOD) before and after the intervention. [Study 2: Field test] Ten female lacrosse players completed 3-week of exhaustive HIIT, consisting of 7 bouts of running at full speed with a 10-second rest between each bout, 5 days/week. They orally took CH or PL between the 3-week in a double-blind, randomized, placebo-controlled, crossover design with a 5-week washout period. We measured the 20 m shuttle run as an index of aerobic capacity and sprint time for 50 m as an index of anaerobic capacity. All statistical analysis were performed using the paired Student's t-test or the unpaired Student's t-test. Significance was set at $P<0.05$.

RESULTS: [Study 1: Laboratory test] After each HIIT intervention, VO2max and MOD were significantly increased in both CH and PL groups ($P<0.05$). However, the changes in MOD were significantly higher in the HIIT+CH group than the HIIT+PL group (HIIT+CH: 6.5±3.0 ml/kg vs. HIIT+PL: 2.0±2.4 ml/kg, $P<0.05$). There were no significant differences of VO2max between the HIIT+CH and HIIT+PL groups. [Study 2: Field test] The 20 m shuttle run in the HIIT+CH group was significantly increased after the intervention (pre: 90.3±9.7 laps to post: 93.7±9.1 laps, $P<0.05$), but did not change in the HIIT+PL group. The sprint time for 50 m in the HIIT+CH group was significantly increased after the intervention (pre: 8.0±0.4 sec to post: 7.8±0.4 sec, $P<0.05$), but did not change in the HIIT+PL group.

CONCLUSION: These results suggest that the CH intake combined with short-term HIIT may further enhance aerobic and anaerobic capacities in the track and field athletes and lacrosse players.

EFFECTS OF SLEEP RESTRICTION AND CAFFEINE SUPPLEMENTATION ON RUNNING TIME-TRIAL PERFORMANCE

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INTRODUCTION: Sleep restriction is a reduction of time in sleep under usual levels, which may impair endurance performance. Caffeine is a widely used supplementation for enhancing endurance performance but it is unclear whether caffeine intake after sleep restriction would be an effective way to maintain endurance performance.

METHODS: 10 physically active healthy young men (Age: 26.9 ± 5.8 years; Body mass: 64.2 ± 5.8 kg) were recruited and completed four trials in a balanced Latin square design. The four trials were sleep restriction + caffeine (SR-C), normal sleep + placebo (NS-P), sleep restriction + placebo (SR-P) and normal sleep + caffeine (NS-C). Sleep restriction was arranged during 03:00 to 06:00 (3 hours) while normal sleep was between 22:00 to 06:00 (8 hours). A 10-km treadmill time trial (TT) was conducted in the morning following SR/NS, and either supplementation of caffeine (6mg/kg body mass) or placebo in capsules was consumed an hour before the TT. Glucose, lactate and free fatty acid (FFA) were measured at post-sleep (Post-Sleep), pre-exercise (Pre-Ex) and immediately post-exercise (Post-Ex). Heart rate, rating of perceived exertion (RPE) and respiratory data were collected during the 10-km TT test.

RESULTS: The 10 km TT was improved by 4.9 % on NS-P (49.4 ± 6.9 min) compared to SR-P (52.0 ± 7.8 min), by 7.7 % on SR-C (47.8 ± 7.3 min) compared to SR-P, and by 2.8 % on NS-C (48.0 ± 6.4 min) compared to NS-P (all, $p < .05$). Respiratory exchange rate, % VO2max, lactate, and FFA were not different between four trials (all, $p > 0.05$), but heart rate was signifi-

cantly higher on caffeine trials (p<.05). RPE were significantly higher during SR-C than SR-P at 6 km and 10 km. Moreover, blood glucose on caffeine trials were higher than placebo trials at Post-Ex (131.5 ± 28.6 vs. 118.3 ± 25.0 mg/dL; p<.05).

CONCLUSION: Caffeine supplementation (6 mg/kg body mass) before exercise would offset the negative effects of sleep restriction on endurance performance.

EXPECTANCY IN CHARGE: AN UMBRELLA REVIEW OF THE PLACEBO EFFECTS IN MOTOR PERFORMANCE AND PERCEPTIONS

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INTRODUCTION: The placebo effect is a response from inert treatments supposedly eliciting a true treatment-like effect through a shared reward circuit mechanism [1,2]. Systematic reviews and meta-analyses (SRMA) from original studies have played an important role in scientific and clinical physical exercise scenarios, as they have confirmed the presence of a placebo-induced enhancement in strength and endurance performance. However, we are unaware of umbrella studies evaluating the quality of the SRMA approaching placebo effects in exercise settings. Therefore, we conducted a comprehensive umbrella review to assess the methodological quality and placebo effects summarized by SRMA.

METHODS: Peer-review literature was searched through PubMed, Embase, Cochrane Library, Virtual Health Library databases, while grey literature was accessed through Prospero and Open Access Theses and Dissertations databases. Reviews assessing placebo and nocebo effects on motor performance, pain, and fatigue outcomes were eligible if: Population: human participants from varied health and training status; Intervention: placebo effect elicited by any active treatment; Comparator: control condition with (i.e. positive control) or without active treatment; Outcome: motor performance (primary outcome) and perceptual responses such as perceived exertion and fatigue sensation (secondary outcome). The effect sizes reported by eligible reviews were presented. The methodological appraisal was assessed using the AMSTAR-2 checklist.

RESULTS: After an initial search retrieving 3.432 reviews, 9 reviews were considered eligible after 2-round screenings performed by 3 independent researchers. AMSTAR-2 checklist indicated that methodological quality varying from low (n = 3) to high quality (n = 2) and the median is moderate (60% of "yes"). Meta-analyses revealed that the the effect sizes varying from 0.02 (small) to 0.67 (moderate).

CONCLUSION: This review demonstrates that despite the placebo effect being widely investigated, the range of effect have a large variability and the quality of SRMA addressed to investigate it is only moderate.

COMBINED EFFECTS OF COCOA FLAVANOL INTAKE AND RESISTANCE EXERCISE ON EXECUTIVE FUNCTION

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INTRODUCTION: Executive Function (EF) and Muscle Strength are important factors in performing sports. Resistance exercise is the best exercise program for maintaining and strengthening skeletal muscle and importantly is known to acutely/chronically improve EF. Generally, relatively higher intensity resistance exercise (HRE) might induce better muscle as well as cognitive function. However, HRE promotes the worsening of arterial stiffness. On the other hand, low-intensity resistance exercise improves arterial stiffness (1). Interestingly, the acute effects of resistance exercise on EF enhancement were comparable between HRE and high-volume and low-intensity resistance exercise (HV-LRE) (2), which is also an effective exercise for maintaining and strengthening a skeletal muscle. Additionally, high cocoa flavanol (HCF) intake has been reported to acutely improve EF. For instance, HCF intake enhances aerobic exercise-induced improvement in EF (3). Therefore, we hypothesized that HCF intake would further enhance resistance exercise-induced improvement in EF (inhibitory control; IC and working memory; WM). To test these hypotheses, we examined the combined effects of HCF intake and HV-LRE on IC and WM.

METHODS: Fifteen healthy young men received either an HCF or low cocoa flavanol (LCF) 1 hour before exercise. Exercise intensity for HV-LRE w 40% of one-repetition maximum for both conditions. HV-LRE was programmed for 5 sets with 25 repetitions per set. Stroop task (IC) and N-back task (WM) were evaluated before intake, 1 hour after intake (before exercise), and immediately after exercise. The data were analyzed by 2-way Repeated Measures ANOVA (Treatment × Time). In addition, a posterior test for significant differences between time points was confirmed by a paired t-test with Bonferroni correction. To compare the effects of HCF and LCF, the amount of change at each time point from baseline was confirmed by a paired t-test.

RESULTS: No significant interaction of HV-LRE and HCF on IC and WM was shown. IC was significantly higher immediately after exercise in HCF ($P < 0.05$) than LCF. In contrast, HV-LRE had no effect on IC. WM was significantly higher in HCF ($P < 0.05$) than LCF before exercise.

CONCLUSION: This study found that HCF enhances IC immediately after exercise and that HCF acutely enhances WM, while HCF intake did not further enhance resistance exercise-induced improvement in IC and WM.

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THE IMPORTANCE OF THE ENDOCANNABINOID SYSTEM AND THE ROLE AND RISK OF CBD IN SPORTS NUTRITION

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INTRODUCTION: It has been revealed that the endocannabinoid system (ECS) plays an important role in several physiologic regulatory mechanisms, including neuronal development, nociception, inflammation, appetite regulation, digestion, energy metabolism, brain plasticity, learning and memory, and regulation of stress and emotions. The two major endocannabinoids, anandamide and 2-arachidonoglycerol (2-AG), interact with cannabinoid receptors, namely CB1 and CB2 receptors, resulting in similar effects to those seen after taking the psychoactive constituents of the cannabis plant. The cannabis plant contains more than 140 cannabinoids with the most notable being Δ9-tetrahydrocannabinol (THC) and cannabidiol (CBD). In addition to the involvement of the ECS and the cannabinoid signalling pathway in certain physiological and pathological functions, the therapeutic potential of legal CBD is becoming increasingly important. Evidence suggesting that CBD has the potential to be used as a part of the strategies to recover from fatigue and muscle damage related to physical and cognitive exertion in sports. Within the realm of elite sport, CBD use has increased exponentially, which is likely due to its removal from the World Anti-Doping Agency (WADA) prohibited list of banned substances. However, other natural and synthetic cannabinoids are still remained prohibited. Furthermore, since 2021 THC has been considered as a "Substance of abuse" by WADA. Therefore the analysis of dietary supplements (DS) and foods containing CBD is of huge importance.

METHODS: Our scope was to analyse DS and foods containing CBD with suitable and innovative chromatographic techniques (liquid (LC) and gas (GC)) coupled to mass spectrometry (MS). Our analytical methods were optimized to obtain low, but also practical limit of detection of the 10 most present cannabinoids. Two well-complementary and substitutive limit test methods were developed using LC-MS/MS and GC-MS/MS techniques prior to a common sample preparation (except for derivatization for GC). At the validation, detection limits of 100 ng/g and 100 ng/ml were determined.

RESULTS: Among 11 different analysed products with cannabis extract or CBD (e.g. chewing gum, chocolate, DS, oil) 4 of them contained almost one prohibited cannabinoid. At the same time in 3 cases the measured content of the desired active substances, CBD, was not detected.

CONCLUSION: The therapeutic potential of cannabinoids in a sporting context is particularly exciting given the ability to interact with the body's own endocannabinoid system. However the use of CBD products are likely to contain other cannabinoids which remain prohibited by WADA, thus the use of CBD at present remains a high risk for an anti-doping rule violation (ADRV). The developed methods can support the choice of safe DS used by elite athletes. It is crucial that practitioners and dietitians educate themselves on the science of CBD and fully understand the complexity of this product when it comes to the potential for an ADRV.

THE EFFECTS OF AN ACUTE DOSE OF NEW ZEALAND BLACKCURRANT EXTRACT ON 5 KM RUNNING PERFORMANCE

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INTRODUCTION: This study investigated the effects of a large (900 mg) acute dose of New Zealand Blackcurrant extract (NZBC) on 5 km running performance and associated physiological responses.

METHODS: Sixteen trained male runners (age 26 ± 5 years, stature 173.4 ± 7.3 cm, body mass, 73.7 ± 6.9 kg, VO2max 55.4 ± 6.1 ml.kg-1.min-1) ingested either capsules containing NZBC (3 x 300 mg CurraNXTM, 315 mg anthocyanins) or a matched placebo (3 x 300 mg gluten free flour) 2 hours before exercise in a double-blind, randomised, crossover design. Performance time and physiological responses were assessed in a 5-km time-trial, preceded by 10 min steady-state exercise at the lactate threshold on a treadmill.

RESULTS: NZBC did not alter the physiological responses to steady-state exercise (V̇O2, RQ, V̇E, carbohydrate oxidation, fat oxidation, heart rate, blood lactate or Rating of Perceived Exertion, P>0.05). The 5-km time-trial was completed in a faster time in the NZBC condition compared to placebo (P=0.001, ES=0.30 ± 0.15; NZBC: 1308.96 ± 122.36 s, Placebo: 1346.33 ± 124.44 s). No differences in physiological responses were apparent between conditions for the 5-km time-trial (P>0.05).

CONCLUSION: Ingesting a large acute dose of NZBC improves performance in trained runners without altering cardiovascular or metabolic responses to exercise. Further research is needed to better understand the mechanisms underpinning improved performance following supplementation.

Philosophy and Ethics

Physical Activity Promotion

THE EFFECT OF THE HUMANITUDE CARE DANCE PROGRAM ON LIFE SATISFACTION OF THE ELDERLY.

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This study was performed to examine the effects of the Humanitude care dance program on life satisfaction of the elderly. Twenty participants were divided into a experimental group (n=10, aged 77.6) and a control group (n=10, aged 77.3). The experimental group performed 12 classes of the Humanitude care dance program for two months(2 days per week, 50 min per session). As the result, life satisfaction score improved ($p<.05$), and changed by the program. These results show that this type of care dance program may help improve life satisfaction of the elderly as well as maintain their health condition.

COMPREHENSIVE ASSOCIATION BETWEEN THE NUMBER OF PEOPLE WHO EXERCISE REGULARLY TOGETHER AND VARIOUS FACTORS.

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Introduction

People engage in regular exercise in a variety of forms, some for health reasons and others for social interaction with the opportunity to exercise with others. Depending on the purpose of regular exercise, it is natural that the number of people who exercise on a regular basis and the purpose and environment of the exercise vary. Thus, this study examines the relationship between the number of people exercising together and various factors.

Methods

A questionnaire survey consisting of 12 items related to the number of people who exercise together was administered to 1,204 Japanese subjects in their late teens to middle age and older, covering sex, age, daily free time, self-evaluation of physical fitness, the purpose of the exercise, liking or disliking physical education as a child, involvement in non-sports activities, introversion and diplomacy, and expenditures for exercise and medical care. The respondents were also asked if they "Want to exercise alone;" "Want to exercise with a few people;" or "Want to exercise with a large number of people." In order to examine the comprehensive relationship between the frequency of the number of people exercising for each of the three patterns and the above factors, a canonical correlation analysis was conducted between the frequency of exercise by the number of people and the various factors, of which data are dummy-transformed.

Results

The canonical correlation coefficient obtained was 0.586 and significant at the 0.1% level ($Fo=2.92$, $df=[423, 10183]$, $P<0.001$). As for exercise orientation by the number of persons engaging together, the regression coefficient for the option "Want to exercise very much" was the largest for all groups and became smaller as the degree to which to want to exercise became less. In other words, it was not the case that only those who exercise with a specific number of people wanted to exercise more regularly, but those who were exercise-oriented tended to want to exercise in general, regardless of the number of people in the group. Among them, the regression coefficient for "Very much" for "With five or more people" was the highest at 0.963, and the structure coefficient was also the largest at 0.700, indicating that the canonical score in this model has a large exercise orientation with a large number of people. Based on this assumption, the structural coefficients for the association with various factors showed that higher values were obtained for the following factors: health benefits (0.600); elementary school physical education enthusiasts (0.537); exercising for health (0.520); boys (0.369); reducing medical costs (0.368); and being physically fit (0.319). In other words, those who exercise regularly tend to be boys, those who are health-oriented, and those who were confident in their physical fitness and had exercised since childhood. However, there was no association with age, free time availability, classes taken, or personality.

AN INVESTIGATION INTO THE EFFECT OF PLAY UPON THE DEVELOPMENT OF SOCIAL SKILLS AND ENGAGEMENT IN PHYSICAL ACTIVITY AMONG JAPANESE CHILDREN AGED 10–12

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Introduction

The objective of this study was to test the veracity of the contention that play is an important factor in child development and that a paucity of play may cause a decline in a childs physical strength and his or her inclination to engage in physical activity. To this end, the study investigated the relationship between the type of play, the development of social skills, and engagement in physical activity among Japanese children in the 5th- and 6th-grades of elementary school.

Methods

The research subjects were 794 children (boys: 391; girls: 403) aged between 10 and 12 years old. Each individual child was asked to assess themselves in response to a questionnaire consisting of (i) 25 items relating to the ability of their play (AP), (ii) 27 items relating to their social skills (SS), and (iii) 3 levels (light: LPA, middle: MPA, and heavy: HPA) relating to their physical activity. The survey was designed to be completed anonymously and to comply with ethical considerations. The resultant data was analyzed using IBM SPSS version 25.

Results

By subjecting the data to factor analysis using the principal factor method and promax rotation, three AP factors were extracted (F1: ingenuity in play, F2: internality and relationships, F3: consideration in play, factor contribution rate = 37.6%), with a further four factors being obtained for SS (F1: sense of responsibility and empathy, F2: aggressive and claim, F3: communication, F4: receptivity, factor contribution rate = 44.0%). As a result of applying the multi-dimensional unfolding (MDU) method and identifying relationships between factors, a correlation was observed between SS relating to a "sense of responsibility and empathy (SS-F1)" and each of the AP factors and, in particular, with "ingenuity in play (AP-F1)" and "consideration in play (AP-F3)". The ordered logistic regression analysis (chi-square value [9] = 44.3, $p < 0.001$) taking into account the effects of gender and age showed that children with more ability in terms of "ingenuity to play" were less likely to engage in LPA (b [1] = -0.517, $p < 0.001$). Meanwhile, and with respect to MPA, children with more ability in terms of "consideration in play" tended to spend more days engaged in physical activity (b [1] = 0.983, $p < 0.05$). For HPA, however, the data for play ability in "internality and relationships" (b [1] = -0.623, $p < 0.01$) and social skills in "communication" (b [1] = -0.509, $p < 0.05$) revealed that children with higher scores in these categories tend to engage in physical activity less.

Conclusion

The results of this study indicate that play does not necessarily enhance social skill or increase a child's inclination towards physical activity. Instead, the study suggests that, in order to facilitate the development of social skills and physical ability, a degree of ingenuity is required in order to determine the most appropriate type of play.

FROM HORIZONTAL TO VERTICAL, AN EXPERIENTIAL MOTOR PATH THROUGH A POST COVID OUTDOOR ACTIVITY

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28th ECSS Congress Paris 2023

INTRODUCTION: With a group of adolescents (13-18 years old), we intervened, after the pandemic period by creating an active motor and social experience immersed in nature localized in Umbria that has an enviable multiplicity outdoor activities, to return to a general balance that is the foundation of the life and well-being of each human. This experience already made in the past years, will repeated at the end of the school lessons, for three weeks,

METHOD: The horizontal dimension meets the vertical one to form a cross. Their intersection represents our individual story, with our limits and virtues, shadows and lights that always existed and will still exist. Daily monitoring through the socialization and cooperation of the various teams and personal questionnaires

RESULTS: Step by step through different paths: Walking orienting in a forest or following a new road with the mountain bike or climbing a rocky wall or Rowing between the rapids of a river to improve the self-esteem, the autonomy and initiative sense and to create collaboration with the group, to overcome our limits and fears.

DISCUSSION: A true active experience through a nature sport journey. A journey inside and outside of ourselves that allows to reach a goal, like a pilgrim and to go beyond our daily horizon, by putting ourselves into play. Promoting a healthier lifestyle should be an integral part of the adolescents overall education

WHERE IS RISKY PLAY OCCURRED AMONG ELEMENTARY SCHOOL CHILDREN DURING RECESS?

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Background:

In recent years, "risky play," defined as "thrilling and exciting forms of physical play that involve uncertainty and a risk of physical injury", has attracted considerable attention. Such risky play practices have been positively associated with physical, mental, and social health. Furthermore, several studies have shown that the natural environment and the playground environment, including playground equipment, can influence risky play. For example, a previous study showed that the number of observed risky play was greater in natural playground than regular playgrounds among Norwegian children. However, limited evidence is available on where risky play is occurred among school-aged children during recess. The aims of the study were to 1) observe free play in various areas of a school and 2) identify where the risky play was occurred during recess among Japanese school-aged children.

METHODS: This study was conducted in November 2022 with elementary school children in grades 1-6 (aged 6-12 years) in Nagano Prefecture, Japan. The playground considered for this study was in the school premises. Using the event sampling method, we collected data on the types of play occurred during recess. We further categorized the observed play as either risky play (i.e., play with great heights, play with high speed, play with dangerous tools, play near dangerous elements, play involving risky elements, rough-and-tumble play, play where children go exploring alone, play with impact, and vicarious play) or non-risky play (i.e., play other than the above mentioned play). Moreover, to examine where the

observed risky play was taking place, we categorized the areas as follows: sandbox area, path area, natural area (trees and water), grass area, open area, fixed playground equipment area (swings, jungle gym, slide), and indoor area (gym).

RESULTS: Of the 42 types of play observed, 38.1**%** were grouped as risky play. The most common type of risky play was "play with high speed (11.9%)," followed by "rough-and-tumble play (9.5**%**)." However, "play with dangerous tools" and "play with dangerous tools" were never observed. The number of observed risky play was greatest in grass area compared to the other areas and the following activities were observed (e.g., tag, rolling on the side, sumo, playing fight, and picking grass and flowers). On the other hand, in the open space, traditional sports activities (e.g., dodgeball and football) were observed; however, no risky play was observed in this area.

Conclusions:

The occurrence of risky play varied depending on the play area; particularly, grass areas were likely to induce the occurrence of risky play among Japanese children.

THE EFFECTS OF THE FITNESS WALKING TRAIL APP ON PSYCHOLOGICAL WELLBEING AND PHYSICAL ACTIVITY LEVEL OF THE UNIVERSITY STUDENTS

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Purpose: Regular physical activity is the prime way for prevention of numerous non-communicable diseases and has been associated with reducing risk of community-acquired infectious diseases (Chastin, et. al. 2021). Despite its beneficial effects on health, the PA levels of young people have been reported to be below the levels sufficient to gain the health benefits exercise can offer (Zimmermann-Sloutskis et al., 2010). Fitness walking is an easy and enjoyable way of doing exercise, especially in green outdoor environment. The purpose of the research was to evaluate the effect of a fitness walking mobile application (app) on the psychological wellbeing and PA level of the university students.

Methods: A fitness walking mobile app was developed to promote fitness walking for university students. A total of 2832 students from a university were volunteers who enrolled in the current study. Eligibility criteria included 1) current full-time undergraduate student; 2) absence of any physical conditions that would severely restrict the ability to be physically active. IPAQ-SF and PANAS Questionnaire were used to collect data of the PA level and psychological wellbeing of the participants. Data collections were conducted online before and after six months of the commencement of the intervention.

Results: At baseline, there were 64.6% females and 35.5% males and age averaged to 18.73 ± 2.16. To investigate changes over time, a sample of participants with repeated recordings were extracted; a valid pair of recordings for comparison has to be separated by a period of 6 months. A subsample of 153 (out of 2,838) participants remained for the pairwise comparison. Paired t-tests, Repeated Measures ANOVA, and GLM analysis were conducted for PA level, Positive Affect and Negative Affect. Most of these analyses did not find any significance ($p > 0.05$). The only significance was found in the Negative Affect for the total sample ($t = 3.14$, $df = 152$, $p = 0.002$) and the females ($t = 2.45$, $df = 106$, $p = 0.02$). The cross-tabulation analysis of PA category (High, Moderate and Low) of baseline and 6th month showed that 45.8% of participants had no change in PA category, while 21.5% got more active and 32.6% became less active.

Conclusion: The results showed that the fitness walking mobile app was not effective in promoting psychological wellbeing and PA level for university students. There were some possible reasons for non-significant results. Sample size was small due to the fact that limited number of participants reported their physical activities and psychological wellbeing after the 6-month period. Roughly speaking, half of the participants did not change in PA levels at all while the rest did change of which one half did better and the other did worst. So, the effect evened out. More efforts are needed to be made to promote proper use of this Walking App and more features have to be built into it so that more participants would get its benefits.

PHYSICAL ACTIVITY DURING PHYSICALLY ACTIVE LESSONS: EXPECTED LEVELS VERSUS REALITY.

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INTRODUCTION

Levels of physical activity (PA) are declining in children and adolescents (1). Physically active lessons (PAL), which is conceptualized as combining PA with academic content (2), has been suggested as a strategy for both counteracting such a decline as well as improving academic outcomes in pupils (3). Although promising, little is known about the actual PA levels during PAL in schools that do not participate in a strict experimental intervention. Thus, this study investigates PA levels among pupils where PAL was already implemented into the schools teaching practice.

METHODS

Fifty-eight pupils were recruited across the 1st, 6th, and 8th grades. PA levels were measured by Actigraph triaxial accelerometers, worn by the pupils only during teaching where PAL was included. Measurements were collected during six months throughout the school year. All PA data were analyzed in one-second epochs. Evenson cut-off points were used to define minutes of sedentary time, light PA (LPA), and moderate-to-vigorous PA (MVPA).

RESULTS

In total, 37 PAL sessions were measured (12 in 1st, 15 in 6th and 10 in 8th grade) and the average duration of the sessions was 22.2 ± 7.2 min. On average, PAL sessions consisted of 57.8 ± 15.7% sedentary activity, 22.9 ± 7.5% LPA and 19.3 ± 10.3% MVPA. Each PAL session contributed an average of 9.8 ± 4.0 minutes with PA. The 6th grade proportionately had significantly higher ($p < 0.01$) sedentary time, and significantly lower ($p < 0.01$) LPA and MVPA compared to 1st and 8th grade, although not in PA minutes. No significant differences in any PA variables were revealed between 1st and 8th grade.

CONCLUSION

Sedentary time dominated the PAL sessions. Thus, PAL contributed a small amount of PA to the World Health Organization's recommendations of 60 minutes of daily PA for children and adolescents. The considerable variance in PA across PAL sessions could be a consequence of the organization of teaching, academic tasks, and selected type of PA. Despite the low amounts of PA, the actual amount may be of importance as a contributor to total PA in children and adolescents and thus in line with the updated PA recommendations that every move count. This may be especially true for those who are least active outside of school.

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THE EFFECTS OF FIVE-DAY ADVENTURE-BASED PROGRAMME ON SELF-ESTEEM AND SELF-DETERMINATION NEEDS IN ADOLESCENTS IN TAIWAN

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Introduction

Adventure programmes have been applied for educational purposes in the West with adolescents for some years. Adolescents are susceptible to low self-esteem and changing perceptions of their identity. However, adolescents increase their global self-esteem and improve their basic psychological needs of Self-Determination Theory following adventure-based programmes. In Taiwan, adventure programmes have expanded in recent years. There may be cultural factors influence programme outcomes. No research has explored the alteration of global self-esteem and the basic psychological needs in Taiwanese adolescents.

Method

Participants were adolescents aged 13-15. In Phase One, a survey examined the effects of adventure-based programme on 37 adolescents' global self-esteem using Rosenberg's self-esteem scale and the basic psychological needs using Basic Psychological Needs Scale at four time points. One-way Repeated measures ANOVA was used, with a P value set at less than .05. Phase Two comprised interviews with 24 participants to investigate their perceptions of self-esteem and basic psychological needs after the programme, and a possible relation between these variables. Content analysis was used, with trustworthiness processes.

Results

For Phase One, analyses showed no significant changes in participants' global self-esteem, overall basic needs scores, or in the scores for relatedness and autonomy at post-test compared to pre-test, although the competence was enhanced. A comparison of these measures across four time points showed no statistical differences after the programme or at one- and three-month re-test. In Phase Two, some participants reported increased confidence, competence and feeling of encouragement. Most participants regained their faith after the dilemmas, and perceived a sense of independence and self-determination during the activity, and an enhanced relatedness level.

Discussion

In quantitative findings, no significant changes showed at the four time points of comparison. Cultural factors such as modesty values, dialectical cognition, interpersonal relationship emphasis, or the importance of social hierarchy, may be one of main reasons to show the different results from the Western studies. The level of perceived competence increased after the programme. It is possibly because of breaking the comfort zone resulting in positive feedback. In qualitative findings, participants regained their self-confidence, encouragement and competence after dilemmas, and they perceived a sense of independence or self-determination during the activity. This may be due to risk sensation-seeking behaviour or an autonomy-supportive climate, different from the environment of hierarchical authority of custom. The need of relatedness is affected by cultural factors such as the importance of interpersonal relationship. Most participants felt supportive of and collaborative towards others.

POSTURAL EVALUATION OF YOUNG CHILDREN BY CHILDCARE WORKERS AND ITS RELATIONSHIP TO MEASURES OF YOUNG CHILDRENS PHYSICAL FITNESS AND MOTOR SKILLS, AND POSTURAL CONTROL FUNCTIONS

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[Introduction] In childcare facilities (for 3-6 years), the number of infants who are unable to maintain posture is increasing. In daily life situations, some toddlers do not put their feet on the floor while eating, face to the side, or cannot maintain a sitting posture. In general, these abilities of young children are often evaluated subjectively by childcare workers. However, such evaluations may deviate from the actual abilities of toddlers. The purpose of this study was to clarify factors associated with the postural evaluation of toddlers by caregivers, using the postural evaluation of toddlers by childcare workers and measurements of physical strength and motor ability and postural control function.

[Methods] The subjects were 28 4- to 5-year-old children (14 boys and 14 girls) attending a nursery school. First, each of the 14 childcare workers evaluated the posture of the subject children on a 10-point scale. The total score of the 14 caregivers was used as the evaluation of each childs posture. Next, seven items of physical fitness and motor ability (shuttle run, standing long jump, softball throw, support one's body with straighten arms, repeated side steps, seated forward bend stretch, and grip strength) were administered, and the motor ability of the subject children was evaluated on a six-point scale. We also evaluated the subjects postural control function using a center-of-gravity sway meter. The length and rectangular area of the center of gravity sway trajectory were measured in the "open-eyed standing" posture using a center of gravity sway meter.

Correlation analysis and multiple regression analysis were used to examine the relationship between the child caregivers ratings and these measurements for males and females.

[Results] Correlation analysis revealed that there was a correlation between the standing long jump for boys and the rectangular area for girls. Multiple regression analysis using postural evaluation as the objective variable and postural control function and motor ability measurements as explanatory variables revealed a strong tendency for boys to be strongly influenced by the factors of standing long jump, softball throw, and support one's body with straighten arms, and for girls by shuttle run, repeated side steps, support one's body with straighten arms, and grip strength.

[Discussion] The results suggest that body support duration is related to postural assessment. Support one's body with straighten arms is said to be an indicator of muscular endurance, and this study suggests that "good posture" is also related to the ability to "maintain upper limb muscle strength. Future research is needed to elucidate the factors related to the evaluation of posture by childcare facilities children. In the future, we will examine ways to foster muscular endurance in young children while they play happily.

CHRONOLOGICAL EXERCISE BEHAVIOR CHANGES AND QUALITATIVE FACTORS IN FEMALE OLDER ADULTS ONE YEAR POST RESISTANCE EXERCISE CLASSES

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INTRODUCTION: Although many studies, including Picorelli et al (2014) and Room et al (2017), have quantitatively examined exercise behavior change in older adults before and after exercise intervention. Few studies have examined qualitative factors of exercise behavior change after the end of exercise intervention. The purpose of this qualitative study was to examine chronological exercise behavior changes and related factors of elderly women one year after the end of exercise classes.

METHODS: The exercise class consisted of self-weighted resistance exercise training devised by Tetsuo Fukunaga for maintaining muscle strength. Twenty eight senior women, the subjects of our study, participated in the exercise class for maintaining muscle strength for care prevention held in F Town, Hokkaido in 2019, 2020 and 2021. In 2020, 2021 and 2022, we used reminiscence method to conduct four semi-structured interviews of them at three months, six months, one year after the end of exercise class. Informed consent was obtained in advance from the subjects, and each interview lasted about 40 minutes. The qualitative factors of exercise behavior change were analyzed using the KH coder, a text mining method, on the text data of the interview contents, which were organized in chronological order. Correspondence analysis was used for time-series changes.

RESULTS: Nineteen subjects (64.3%) continued to exercise at least twice a week until one year after the end of the class. The top common network characteristics of qualitative factors as a set of commonalities in language throughout the one year were "self-efficacy," "social support," "simplicity of exercise," and "engagement status (time and continuation)." The characteristic qualitative factors from the correspondence analysis using the time series of the continuation group as an external variable were that "simplicity of exercise," "positive evaluation of exercise" and "self-efficacy," which were learned in the 3-month period immediately after the end of the class. While some "inhibiting factor" was observed at 6 months, reflecting "environmental barriers" due to the COVID-19 pandemic and "physical disease." At one year, there was "social support," from peers and instructors and "simplicity of exercise," and "positive evaluation of exercise" such as the enjoyment of exercise itself formed by the participation and continuation of exercise.

CONCLUSION: These qualitative factors suggested that the exercise program that are easy for the elderly to practice forms a positive attitude toward exercise, such as the enjoyment of the exercise itself, and that they continue to exercise even one year after the end of the class.

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EFFECTS OF A 10-WEEK DUAL-TASK EXERCISE INTERVENTION ON COGNITIVE FUNCTION AND PHYSICAL FITNESS IN FEMALE ELDERLY WITH MILD COGNITIVE IMPAIRMENT

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Background and purpose:

As the risk of mild cognitive impairment increases with ageing in Shanghai, physical activity as a non-pharmacological intervention has been shown to have a positive effect on cognitive function in older adults with mild cognitive impairment in several studies. The present study was conducted to investigate the effects of a dual-task exercise intervention on the cognitive function and functional fitness of female elderly.

Subjects and METHODS: 85 female elderly residents in Shanghai were randomly selected and their baseline cognitive function (MOCA scale scores) showed a mean score ± standard deviation of 23.612 ± 3.764 (points). The subjects were randomly divided into 30 in the exercise group, 32 in the dual task group and 23 in the control group, with mean ages of 64.133±3.350 (years), 64.250±3.840 (years) and 65.957±4.743 (years) respectively, there are no significant differences between the groups ($p>0.05$). The exercise group was given 60 min/time, 2 times/week for 10 weeks, the dual-task group was given 60 min/time, 2 times/week for 10 weeks, and the control group was not given any exercise intervention. Cognitive function (MOCA) and functional fitness were tested in the three groups before and after the intervention. Within-group comparisons were analysed by paired t-tests and between-group comparisons were analysed by ANOVA.

RESULTS: (1) Compared with the pre-intervention period, the cognitive function (MOCA) of exercise group improved from 22.667±4.105 (points) to 24.067±4.077 (points) ($P<0.05$), and the performance of single leg standing with eyes closed, chair stand test, 2.44m rapid walking and 2-minutes step test improved ($P<0.05$).Compared with the pre-intervention period, the cognitive function (MOCA) of the dual-task group increased from 24.281±3.513(points)to 25.188±3.063(points),($p<0.05$), and the performance of grip strength, single leg standing with eyes closed, chair stand test and 2.44m rapid walking increased ($p<0.05$).Arm curl test decreased in the control group ($p<0.05$), and the rest did not change significantly ($p>0.05$).

(2) There was no significant difference in cognitive function (MOCA) between the exercise group and the dual task group compared to the control group after the intervention ($p<0.05$), and the performance was better in chair stand test and 2-minutes step test ($p<0.05$).

(3) No statistically significant differences were seen between the exercise group and the dual-task group in cognitive function (MOCA) and physical fitness indicators before and after the intervention ($p>0.05$).

CONCLUSION: The 10-week single exercise intervention and dual-task intervention both improved cognitive function (MOCA) and performance on several physical fitness indicators in female elderly with mild cognitive impairment.

EFFECTS OF AEROBIC EXERCISES WITH TRADITIONAL THAI DANCE ON CARDIORESPIRATORY SYSTEM

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Effects of Aerobic Exercises with Traditional Thai Dance on Cardiorespiratory System

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Abstract

INTRODUCTION: Aerobic Exercises with Traditional Thai Dance (ATTD) is a combination of Traditional Thai dance posture and movement with aerobic exercises. They were developed specifically to enhance Cardiorespiratory Systems

METHODS: The purpose of this research was to study and compare the effects of ATTD on Cardiorespiratory System. Of 80 female students between 18-24 years old, 30 students were selected by simple random sampling . They were divided into 15 students for a control group (engaging in normal daily activities), and 15 students for an experimental group (participating in ATTD). They were tested by Cardiorespiratory system testing before and after training. The program was 6 weeks in total, 3 days a week. The test results were analyzed by means of mean, standard deviation, and an independent t-test at the statistical significance level of .05.

RESULTS indicated as follows:

After the Cardiorespiratory system test, the results of the experimental group (ATTD) were 112.67 ± 5.602 and 121.13 ± 3.226, while the results of the control group were 112.47 ± 6.885 and 106.46 ± 6.770. The test was also conducted 6 weeks after training. The results showed that the differences between the control group and the experimental group was statistically significant at the .05 level.

CONCLUSION: Aerobic exercises with Traditional Thai dance (ATTD) showed a positive effects on the Cardiorespiratory system. It could be explained that when applying traditional Thai dance into aerobic exercises activities, both involved the

participants with continuous movement at moderate intensity. As a result, it caused the positive change in the body's cardiorespiratory system.

Key words : Aerobic Exercises, Traditional Thai Dance

Physical Education and Pedagogics

DEVELOPMENT AND VALIDATION OF MEASUREMENT FOR STUDENTS' PERCEIVED CONSTRAINT SUPPORT IN PHYSICAL EDUCATION

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INTRODUCTION: Constraint-led Approach (CLA) is one of the trendy learning models in physical education. More and more researchers started to implement CLA in PE and pay attention to the outcomes of CLA-implemented PE. Nonetheless, most studies regarding CLA in PE stopped at developing CLA-based lesson plans for skill learning without trying to examine its alleged outcomes empirically. A reliable and valid measurement for students' perceived constraint support in PE would greatly benefit the examination of the effectiveness and outcomes of CLA-implemented PE. The study aimed to develop a conceptually sound and psychometrically robust measurement of perceived constraint support in physical education.

METHODS: In this three-phased study, interviews were conducted first to form initial items, and experts were then invited to further refine initial items. Exploratory factor analysis, confirmatory factor analysis, cross-validation, criterion-related validity, and test-retest reliability analysis were executed to test the validity and reliability of this measurement with samples of 866 and 792 middle and high school students respectively.

RESULTS: A psychometrically appropriate instrument titled the "Constraint Support Scale in Physical Education (CSS-PE) comprises one factor and five items. The CSS-PE passed the examinations of cross-validation, preliminary criterion-related validity, and test-retest reliability analysis, showing preliminary evidences of the reliability and validity.

CONCLUSION: This study furthered our knowledge of students' perceived constraint support and identified several constraint-supporting behavior from PE teachers, such as changing the difficulty of activities, representativeness learning design, and focusing on the movement outcomes rather than the movement itself. The study provides preliminary evidence of the reliability and validity of CSS-PE. Researchers and practitioners may use CSS-PE to evaluate students' perceived constraint support when adopting CLA teaching strategies. Furthermore, it would benefit researchers exploring the possibility of combining non-linear pedagogy or CLA with other non-skill learning models by conceptualizing constraint support and connecting it with other learning theories

EXPLORING THE EFFECT ON THE BADMINTON SKILL LEARNING IN PHYSICAL EDUCATION USING THE BADMINTON LEARNING TUTOR APP

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Introduction

It has been the goal of physical education instructors to elevate learners learning efficiency significantly in a limited time. Thus, researchers have been constantly developing a badminton teaching system, which is expected to be supportive within the learners' badminton learning progress. Consequently, this study tends to develop a Badminton Learning Tutor APP which contains automatic grading, automatic feedback, and dynamic skeleton comparison video functions. Furthermore, this study compared the APP-assisted teaching method to the real-time recording-assisted method to observe whether the proposed APP could effectively help improve learners' learning efficacy toward serve and clear skills in badminton.

Methods

This study conducted the quasi-experimental design in eight weeks (1 week for the pre-test, 6 weeks for teaching, and 1 week for the post-test). The analysis was utilized by the mixed design ANOVA in SPSS ver. 17. The assumption of sphericity was examined by the Greenhouse-Geisser correction, an alpha of .05 was used to determine statistical significance, and the post-hoc tests were presented via the Bonferroni adjustment.

Results

On the serve skill learning, the results showed that the difference between groups was significant ($p = .006$). The within-subject effects, the scores of every testing week and the interaction effect of testing week and group were also significant (p-values were all smaller than .001). After the post-hoc analysis, it indicated that the differences between the two groups from the third week to the post-test were significantly different, and the scores of the experimental group were larger than those of the control group. On the clear skill learning, the results showed that the difference between groups was not significant ($p = .093$). The within-subject effects, the scores of every testing week and the interaction effect of testing week and group were significant (p-values were all smaller than 0.001). After the post-hoc analysis, it indicated that the differences between the two groups at the second, third, and sixth weeks were significantly different, and the corresponding scores of the experimental group were larger than those of the control group.

Discussion

Due to different characteristics, hitting time could be controlled without adjusting the position for serve skill. As for clear skill, it is required to master both the hitting time and moving position. Therefore, without time and spatial disturbance, the Badminton Learning Tutor APP can elevate learning efficacy significantly in the restricted time. Nevertheless, when the conditions of time and space are being considered in clear skill, the Badminton Learning Tutor APP can perform better learning efficiency initially but improve with a rather insignificant growth in the late stage. Overall, it is suggested that the learning progress toward clear skill could be extended in the future to further observe the learning effect.

RELATIONSHIP BETWEEN ELEMENTARY SCHOOL CHILDREN'S SPORTS AND PHYSICAL ACTIVITY HABITS, SELF-ASSESSED PHYSICAL FITNESS, AND GRIT SCORE

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[Introduction] Children are less likely than adults to engage in sports or other forms of physical activity to improve their health. Most kids enjoy participating in sports itself and engaging in physical activity with their friends. Parents expect sports and other physical activities to contribute toward improving their health and physical fitness as well as the sound growth of their children. In order to promote physical activity continuously, it is essential to do so in a way that is both socially and educationally beneficial. Of late, GRIT has emerged as an important measure of social competence. In addition, it is important as an educational goal as well. We believe childrens GRIT can be improved through sports and other physical activities. In view of this, the aim of this study was to examine the relationship between childrens habits related to sports and other physical activities, self-assessed level of physical fitness, and GRIT score.

[Methods] The subjects were 5,856 elementary school students. We administered a questionnaire to get information about the average daily sports and physical activity hours, self-assessed physical fitness level, sports and physical activity preferences, and the GRIT scale. (Duckworth & Quinn, 2009). We applied factor analysis to the GRIT scale data and verified the existence of two subfactors (persistence of effort and consistency of interest). Next, scores for the overall GRIT and each subfactor were determined by simple summation of the individual items. Furthermore, two groups were created using the average of GRIT scores for each gender as the boundary value. The differences in sports and physical activity hours were examined using the t-test. The differences in GRIT scores on the basis of self-assessed physical fitness level and sports and physical activity preference were examined using t-test and one-way ANOVA.

[Results] It was observed that children with better GRIT scores engaged in significantly more hours of sports and other physical activities. However, no significant difference was observed in the score of "consistency of interest" subfactor in terms of sports and physical activity hours on weekdays. GRIT scores were significantly higher among children whose self-assessed physical fitness level was 3 or higher on a 5-point Likert scale. Moreover, kids who had higher preference for sports and physical activity had higher GRIT scores.

[Discussion] It was suggested that children who engaged in more sports and physical activity during the day had better GRIT scores. As the differences in GRIT scores were also substantiated by preference for sports and physical activity and self-assessed physical fitness level, it was concluded that encouraging sports and physical activity and boosting physical fitness can help improve GRIT.

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FACTOR STRUCTURE OF SITUATIONAL DECISION-MAKING ABILITY IN BASIC FACE-UP SITUATIONS IN BASKETBALL GAMES

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Introduction

In a basketball game, it is important to have the ability to assess the situation in order to instantly select the best play for the situation. The ability to make decision-making momentarily is naturally based on knowledge prior to games. Moreover, it is thought that not all individual situational judgments are made independently, but that there are some common situational judgment abilities underscoring these judgments that have been cultivated through experience and other factors. Therefore, this study aimed to examine the factor structure of the situational judgment ability in basic face-up situations, which is most often found in basketball games.

Methods

Eighty-one coaches were asked to answer the situational decision-making ability test in basic face-up situations, consisting of 68 questions developed by Oyama, et al. (2023). The test was conducted using an online test format (Google Forms). The scoring was based on the frequencies that the 16 coaches with advanced level S through B certifications chose as the correct answer, and the frequency as a score was given to the respondent who chose that option. Factor analysis was performed on the results of the scoring of that test to obtain the factor structure. Incomplete Principal Component analysis method was used for factor analysis, and the number of factors with a cumulative contribution of 50% or more was employed, followed by an orthogonal solution by Normal Varimax rotation.

Results

As a result, six factors were extracted showing a cumulative contribution rate of 50.52%. Factor 1 showed significant factor patterns for 13 items, including "Cognitive ability in attacking with a counter (factor pattern = 0.523)". Since these are all composed of cognitive ability, we interpreted this factor as "F1: Ability in recognizing a situation." Factor 2 showed significant factor patterns for seven items, including "Ability with prediction and decision-making when attaching the gap using driving and kicking (0.505)." Since these are composed of abilities related to drives, which are temporary numerical superiority situations, we interpreted this factor as "F2: Prediction and decision-making ability in momentary numerical superiority situations". In the same way, Factors 3 to 6 were interpreted as "F3: Prediction and decision-making ability before and after receiving a pass;" "F4: Prediction and decision-making ability in closed-out situations with the ball carrier;" "F5: Prediction and decision-making ability in facing-up and off-ball situations;" and "F6: Prediction and decision-making ability in driving situations with the ball carrier," respectively. In other words, the decision-making abilities in basic face-up situations in a basketball game consist of six factors, comprising one cognition and five prediction and decision-making abilities, with greater involvement of prediction and decision-making in the second half than cognition in the first half.

RESEARCH ON LEARNING CONTENT RELATED TO "COMPETITION" IN SCHOOL PHYSICAL EDUCATION: BASED ON EXAMPLES IN "THE COMMENTARY ON COURSES OF STUDY"

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Introduction

Previous studies provide a mixed view on "competition" in education, as some findings indicate that it may cause children to feel excessive exclusion others, and others consider it an effective means to increase the motivation to learn. (Kohn [1992], Suzuki [2005]). In Japanese school education, the word "competition" is used in "The Course of Study," indicating the learning goals and content of elementary and junior high schools. Furthermore, the only subjects that use the word "competition" are physical education and health and physical education subjects (Tai [2022]). However, it is still unclear what the description of the words related to "competition" in "The Course of Study" refers to as learning content.

In this study, we organized explanations and examples of the places where competition-related words were described in "The Commentary on Courses of Study for the Elementary School" and "The Commentary on Courses of Study for the Junior High School." We also considered the use of "competition" as teaching materials in school physical education.

It is expected that the results of this study will clarify the intention of handling "competition" in school physical education and contribute to the planning of teaching plans according to subject goals.

Methods

As a specific examination method, based on the explanations and examples using competition-related words in "The Commentary on Courses of Study," we organized each of the "subject goals," "elementary school," and "junior high school." We clarified the interpretation of "competition" and its use as teaching materials.

Result and Discussion

In junior high school physical education subject goals, "competition" was meant to be experienced with the intention of fostering "motivation" and "attitude."

In "The Commentary on Courses of Study for the Elementary School," "competition" was not only learning in itself but learning through "competition" ("acceptance of judgment," "fair play") was also shown as learning content. "Competition" in school physical education was used both as a learning objective and as a means of learning.

In "The Commentary on Courses of Study for the Junior High School," interpersonal competition by groups or individuals is recognized as a major characteristic of athletic events in the four areas where competition-related words are described. There is an understanding that enjoying "competition" means understanding the sports culture. The four areas of track and field, swimming, ball games, and budo (martial arts) are explained using phrases related to "competition." There is a characteristic of enjoying exercise in the form of games, matches, and so on, and it is important to consider this point in PE classes. At the same time, instructional examples are presented to prevent negative feelings from being competitive during exercise.

PEER VERBAL ENCOURAGEMENT ENHANCES OFFENSIVE PERFORMANCE INDICATORS IN HANDBALL SMALL-SIDED GAMES.

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QATAR UNIVERSITY

Effective teaching in physical education (PE) does not only rely on planning and implementing the best evidence-based didactic materials and pedagogical strategies to ensure students are making progress in their motor learning. There are times when PE teachers are required to address other intangible parameters in order to in-crease their students' motivation and, in turn, deeply engage them in the learning process.

This study aimed at assessing the effects of two verbal encouragement modalities on the different offensive and defensive performance indicators in handball small-sided games practiced in PE settings;

A total of 14 secondary school male students, aged 17 to 18, took part in a three-session practical intervention. Students were divided into two teams of seven players (four field players, a goalkeeper, and two substitutes). During each experimental session, each team played one 8-min period under teacher verbal encouragement (TeacherEN) and another under peer verbal encouragement (PeerEN). All sessions were videotaped for later analysis using a specific grid focusing on the balls played, balls won, balls lost, shots on goal, goals scored, as well as the ball conservation index (BCI) and the defensive efficiency index (DEI);

The findings showed no significant differences in favor of TeacherEN in all the performance indicators that were measured, while significant differences in favor of PeerEN were observed in balls played and shots on goal;

When implemented in handball small-sided games, peer verbal encouragement can produce greater positive effects than teacher verbal encouragement in terms of offensive performance.

RECEPTION OF ROGER CAILLOIS IN JAPAN

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Introduction

Since the introduction and translation of his famous work "Man, Play and Games" (1958), Roger Caillois has been frequently referenced in the field of physical education and sports studies in Japan. Of particular interest has been the category of play, which is essential to definition of sports. In other words, sports are one of the categories of play characterized by competition. However, the scope of reading Caillois in this field has stayed about this point, and it seems that the understanding of Caillois is insufficient. This study reveals the limitations of these previous studies. It also aims to clarify the issues that should be approached.

Discussion(Methodes and Results)

We reread Caillois work following his logic with its subject in mind.

As is well known, Caillois divides play into four forms according to its inner qualities: Agôn, or competition; Alea, or chance; Mimicri, or role-playing; and Ilinx, or vertigo. According to Caillois, sporting activities are indeed classified as "Agôn." The competitive nature of sports is undeniable if we consider, for example, the Olympic Games or FIFA World Cup. Sports must be competitive games.

However, what does the taxonomy of play, to which only about one-fifth of his work is dedicated, tell us about Caillois idea of sports? Upon reading "Man, Play and Games," it is immediately apparent that the above four terms do not refer simply to the divisional limbs of play but rather the internal and essential properties that drive the activity of play itself. Their properties make possible the analysis of the society, which is the subject of his work. Caillois mentions sports because they are essential requirements for that.

Following Japans modernization, educational expectations have continued to be placed on sports (perhaps as the successor to athleticism). Even now, sports are part of the regular school curriculum, from elementary school to university. Sports in Caillois work are frequently referenced in relation to the educational significance of play, but what deserves more attention is that Agôn (and play types, i.e., Paidia and Ludus) is not a division principle but an internal properties, especially the relationship between its creative function in play and sports. This is the point that has been overlooked.

Conclusion

What must be clarified first is the meanings and roles of Agôn. Only after that, the meanings and significance of sports in Caillois work should become sufficiently clear.

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ASSOCIATION BETWEEN PSYCHOLOGICAL NEED SATISFACTION, MOTIVATION FOR PHYSICAL ACTIVITY, MOTOR COMPETENCE AND PHYSICAL ACTIVITY IN YOUTH

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Introduction: Despite increased knowledge of positive health effects of physical activity, numerous studies have proclaimed a negative trend in the physical activity of youth. An important focus of research must be to identify the physical, psychological and social factors of this trends. The self-determination theory (SDT) including the sub-theory of psychological need satisfaction could give an important stimulus. To gain better understanding of the factors based on the SDT, this study explores the association between psychological need support (autonomy, competence and relatedness), their satis-

faction and motivation for physical activity. In a second step the association between motivation and motor competence as well as physical activity will be analysed.

Methods: Cross-sectional data from 332 fifth-grade children aged 9 to 11 years from four secondary schools in Germany were analysed. All subjects were measured on psychological need support, satisfaction and motivation for physical activity by questionnaire as well as tested on motor competence and physical activity. Correlation analyses using Spearman where conducted to obtain references about meaningful relationships.

Results: The results indicate statistically significant correlations between the psychological factors and physicals activity and motor competence. We found a positive correlation between psychological need support (r = .228 to .399) as well as satisfaction (r = .243 to .430) and level of intrinsic motivation. A negative relationship exists between amotivation and the support of competence (r = -.186) and relatedness (r=-.237) as well as satisfaction of autonomy (r=-.163). Extrinsic motivation shows a negative relationship with competence support (r=-.211). Furthermore, the intrinsic motivation is associated with motor competence (r=.217) and physical activity (r=.251). A negative correlation shows extrinsic motivation and amotivation with motor competence.

Discussion: To promote main forms of motor activity, the psychological factors could play an important role in youth's motor performance and activity in leisure time. The associations between intrinsic motivation, motor performance and physical activity on one hand, and the negative relationship of extrinsic motivation and amotivation on the other hand support this assumption. Moreover, the support of the psychological basic needs can influence the perceived satisfaction. These psychological factors embody potential tools for increasing motor competence and promoting physical activity. This is the basis for designing sustainable and effective countermeasures to decrease health risk factors which are associated with inactivity. Further research is needed to investigate the theoretically based assumptions.

DOSE THE BILINGUAL EDUCATION BRING NEGATIVE EFFECTS IN PHYSICAL EDUCATION?

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INTRODUCTION: In recent years, bilingual physical education has been gaining traction in Taiwan. Even if there are already many bilingual related references in various countries of the world [1], nevertheless, we have no way of knowing whether different countries and cultures have different outcomes. Based on the above, this study not only aims to explore the design of bilingual physical education activities in primary schools, but also to understand the language use of teachers and students physical activity in bilingual physical education in Taiwan.

METHODS: This study used qualitative studies. First, we design eight bilingual lessons in two teaching themes: gymnastics and dance, then we conduct public lectures and take the video. Through the observation of classroom behavior, the classroom behavior of teachers and students classroom participation were analyzed in depth. In the class observation, we use Mangold interact observation system as our tool. Furthermore, we use event recording method and Period recording method for encoding analysis. The index of this study is refer to the code list for classroom observation activities used in Coral's and Krüger's references [2].

Results and discussion:

1. In this study, we found that students physical activity in the classroom increased with the increase of teachers language use, which showed that the proportion of students physical activity was positively correlated with the proportion of teachers language use.

2. In bilingual physical education classes, the target language usage of each class is not fixed, there is no specific ratio standard, which shows that bilingual education is not taught entirely in English but should be promoted by on-site teachers who use the language flexibly according to the needs of the curriculum.

3. In terms of language use timing, the most common time for teachers to add language was during action demonstration (average use ratio was 17.48%). In the action demonstration due to the combination of body movements, even if the students do not understand what the teacher says, they still can understand the action skills that the teacher wants to convey through body language, which is the best time to join the target language.

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VALIDATION OF THE FRENCH VERSION OF THE EDMCQ-PE (EMPOWERING AND DISEMPOWERING MOTIVATIONAL CLIMATE QUESTIONNAIRE IN PHYSICAL EDUCATION, MILTON ET AL., 2018)

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Context: The importance of the motivational climate created by the teacher has been continuously emphasized in recent years, especially in its role for the quality of the students experience in Physical Education (PE) (Duda et al., 2014). The ED-

MCQ-PE (Empowering and Disempowering Motivational Climate Questionnaire in PE) initially validated by Milton et al. (2018) is a questionnaire that aims to report the students perceived motivational climate in PE. This questionnaire has the advantage of being based on two major theories of motivation: the Self Determination Theory (SDT- Deci & Ryan, 2017), and the Achievement Goal Theories (AGT - Ames, 1992) which offer possibilities for a more detailed understanding of the motivational climate in PE with the notions of empowering and disempowering behaviors (Duda, 2013). Thus, this questionnaire is a useful tool for researchers but also for physical education teachers. Unfortunately, there is no validated French version of the EDMCQ-PE.

Objectives: Our objective is to translate and validate a French version of the EDMCQ-PE (Milton & al., 2018)

Method: Based on Vallerands method (1989), we attempt to translate and validate the EDMCQ-PE through 6 steps: (1) designing a preliminary version using a traditional translation, (2) assessment and possible modifications of the preliminary version with the help of a committee of experts including Milton, (3) assessment of the experimental scale by a clarity pre-test among 29 French high school students, (4) assessment of congruent and content validity among 27 bilingual students from the French high school of Chicago ,(5) assessment of fidelity and (6) assessment of construct fidelity were tested with 337 French high school students.

Results and discussion: Following translation by the expert comity (1&2), the clarity test (3) reveals that all items are fully understood. (4) Congruent and content validity analysis show that eight items should be treated with caution because one of the two statistical score is low. (5) Cronbachs alphas show satisfactory levels of fidelity, similar to those obtained by Milton, both at the level of the 5 subscales and at the level of the higher dimensions (empowering and disempowering). (6) The assessment of construct fidelity by the confirmatory factor analysis shows that French items have a similar correlation score with their subscale and their higher dimension to those obtained by Milton (included the 8 items questioned by the assessment of fidelity). Two items could be questioned by the confirmatory factor analysis but they remain good in congruent validity and fidelity in both subscales and higher dimension. Given all these results, we make the choice to propose a version retaining the 34 items of the EDMCQ-PE in the French version in order to remain as faithful as possible to the initially validated version.

Conclusion: Many indications show that the EDMCQ-PE is satisfactory with respect to Vallerands validation method

WATER SAFETY EDUCATION FOR COLLEGE STUDENTS

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Reasons for drowning are most commonly associated with failure to stay afloat or swim to safety. Some evidence suggests that victims drown because they cannot exit the water upon reaching the water's edge.

The purpose of this paper is to explore the real and perceived capacity of young adults to safely exit the water and ascertain what safety knowledge about exiting the water is promoted.

College-aged non-sports Japanese students (N = 62) completed a pretest survey of self-estimated capacity to exit the water under varied conditions. Participants were then tested in shallow water, deep water (flush edge), and deep water with a ledge (0.30 m) when fresh, after a 5-min swim in swimwear, in clothing, and while wearing a buoyancy vest.

Participants were Japanese young adults (N = 62) with a proven swimming capacity who were enrolled in an undergraduate Bachelor of non-Sports degree programs. Of these, 40 were male (64%) and 22 were female (36%), 80% were 19–20 years of age, 17% were 21–22 years of age, and the remaining 3% were 23 years and older. Before the commencement of an aquatics education program that focused on water safety, participants completed a pretest survey that was designed to provide a measure of self-estimated water competency and estimates of their capacity to exit the water under various conditions. Practical testing of exit skills was completed during 1.5 hr aquatics sessions/1 times per week over a 3-week period during the summer term (April–July 2021) in an indoor 50 m pool (water temperature 25 °C). Appropriate lifeguard supervision and safety equipment were available at all times. Ethics clearance for the study was obtained from Keio University Ethics Committee.

All data from the completed questionnaires were double entered into Microsoft Excel and data were transferred to SPSS version 24 for statistical analysis. Descriptive statistics expressed as frequencies and percentages were used to describe or characterize all numerical variables. These included four independent variables (gender, age, ethnicity, and self-estimated swimming competency) and four dependent variables related to previous experience, knowledge, perceptions of exiting task difficulty, and actual exiting competency. Chi-square tests of independence were used to test associations between the frequencies of the influences of age, gender, and ethnicity against the perceived and actual exertion required to perform the exiting tasks.

All participants were able to exit shallow and deep water when not fatigued, after a swim when wearing clothing or a buoyancy vest, but many failed to exit deep water over a 0.30 m ledge after swimming in clothing or in a buoyancy vest. Significantly more females than males found exiting deep water difficult. Most participants (especially males) underestimated the demands of exiting deep water. The value of situational learning via exposure to exiting difficulties in simulated

pool practices is discussed.

THE INFLUENCE OF

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[Background]

In recent years, attention has focused on extending healthy life expectancy in Japan, where the ageing population is advancing. The emphasis on primary prevention and improvement of the quality of life are fundamental concepts in the second phase of Healthy Japan 21 (Ministry of Health, Labour and Welfare, 2012). Moreover, recent social changes also involve youth life in disorder. Therefore, efforts for health and safety in school education are essential (Japan School Health Association, 2020). Especially health education, which plays a central role, aims to develop students' competency in making appropriate decisions and behavioural choices and implementing exercises actively (Ministry of Education, Culture, Sports, Science and Technology, 2020). However, due to teaching methods that lay emphasis on knowledge infusion, classes that approach the goal of health education have not been formed yet (Sugiyama, 2017). Thus, it is necessary to improve teaching methods. "Hands-on health learning", an innovative method, has shown various effects. However, introducing it to schools is complex due to the limitation of class periods. Considering this, "Hands-on Home Study Materials: My Body Record" is significant in achieving better health education and independent learning, enhancing students health awareness, cultivating competency of active practice and appropriate decision-making and behaviour choice. Accordingly, this study aims to clarify the effects of "My Body Record" on students health, lifestyle, and motivation for health learning.

[Methods]

This study was conducted among junior and senior high school students. Students did homework which included reflecting on their own lives, considering health issues and solutions, and filling in the handouts provided in advance. Each teacher collects the pre-prints and returns the pre-prints to students after checking the safety of the solutions. The students practised the solution for two weeks and recorded their work using practical prints and Google forms. Before and after the home study, a questionnaire survey was conducted using Google forms. The questionnaire items for the health and lifestyle survey were developed based on the previous study by Tokunaga (2005). The content of health learning was based on Sato (2015) and the report of the Health Learning Promotion Committee of the Japan School Health Association (2017).

[Results and Discussion]

Looking at the daily habits of the students, various problems can be seen, such as late bedtimes, shortened sleeping hours, and prolonged use of smartphones. By using the "Hands-on Home Study Materials: My Body Record" to practice what they have learned in health class, it is expected that these lifestyle habits will be improved. The details will be presented on the day.

COOKING PRACTICE FOR PARENTS OF HIGH SCHOOL ATHLETES: EFFECTS ON UNDERSTANDING THE QUANTITY OF RICE SERVED ON A PLATE

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Introduction

Female students who play sports need to eat grain dishes in order to consume the appropriate amount of carbohydrates in their diet. For example, they require approximately 200 g of rice per meal. Some students who are part of the cheerleading club and do not want to gain weight in positions that require them to be lightweight, or who want to maintain a slender appearance, make the mistake of losing weight by eating less. By choosing an appropriately sized bento and filling it with rice, main dishes, and side dishes, the bento can be cooked to provide appropriate levels of energy and nutrients. Therefore, in this study, we conducted cooking training using bento for parents of athletes to determine if it would affect their estimation of the amount of rice required.

Method

The participants were parents of students who were part of a high school cheerleading club (n=15). Parents first attended a brief lecture on food quantities, menus, and nutrients during cooking practice. Thereafter, in groups of four, they cooked the prepared ingredients as per the bento recipe. Next, they measured the portion size of their childs bento and served the rice, the main dish, and the side dish. A Google Forms questionnaire was then used to estimate the quantity of rice by looking at a picture of a bowl and a plate with 300 g of rice before and after cooking. Two groups were formed based on their ease of estimation; the D group (n = 4) found it difficult to estimate the amount of rice, main dishes, and side dishes before the cooking practice, while the ND group (n = 11) did not find it difficult. Statistical differences were determined using a two-way factorial analysis of variance. Differences were considered statistically significant at $p < 0.05$.

Results

Eight parents chose the appropriate bento size for the athletes, whereas seven parents chose a smaller bento than the appropriate amount. In the D group, 75% said they were not good at cooking, while 50% disliked cooking altogether. The amount of rice estimated for both plates and bowls were the same. There were no significant differences between the groups before and after the cooking practice. However, there was a significant difference between the two groups (dish

p=0.049, bowl p=0.012); the ND group estimated the dish and bowl to be approximately 200 g, while the D group estimated the dish to be approximately 150 g and the bowl to be approximately 120 g. Post-cooking practice, both groups answered that they could understand the guidelines for the amount of rice, main dish, and side dish.

Conclusion and discussion

Parents of students who are part of the cheerleading club were able to understand the amount of rice, main dishes, and side dishes in bento through cooking practices and lectures. However, when testing the ability to estimate the amount of rice, there was no change in either group; the estimated amount in the D group was less than the required measurement and lower than that in the ND group.

THE IMPACT OF CLASSROOM BASED PHYSICALLY ACTIVITY PROGRAM ON MATHEMATICS AND SUBJECT PREFERENCES ON 3TH GRADE PRIMARY SCHOOL PUPILS

TAMÁS, K.

ESZTERHÁZY KÁROLY CATHOLIC UNIVERSITY,

The impact of classroom based physically activity program on mathematics and subject preferences on 3th grade primary school pupils

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There is a growing body of literature on the impact of physical activity learning (PAL) on cognitive and psychological development. Research suggests that innovative classroom based PAL interventions have beneficial effects on academic performance. The introduction of coordination skills-based tasks in mathematics lessons demonstrates positive changes in task mastery and subject engagement. The purpose of this study was to demonstrate the effectiveness of an innovative sport tool and associated coordination-based methods on the learning of mathematics and subject preferences.The sample consisted of 3rd grade students (N=104) from two primary schools. Based on the PAL intervention, there were three experimental groups (1x a week; n=12), (2x a week; n=21), (3x a week; n=24), and also a control group (n=51). In addition, teacher interviews (n=2) were conducted to gain a deeper understanding of the experiences. An innovative coordination tool was utilized to support learning and during the 6-week program.

According to our results, significant improvements were observed between the pre- and post-measurements of the experimental group algebra and geometry variables and also in subject preferences ($p<0,05$). Repeated ANOVA analysis yielded significant differences for group, time and variables ($F=3.965$; $p=0.00066$). The interviews confirmed the positive impact of the innovations used in this study, not only in terms of students cognitive and emotional development, but also in terms of their adaptability to support the teaching-learning process. The results of this study suggests that it is a successful program and so it is worth extending in different classroom based physical activity programs.

STUDY PROTOCOL OF A PHYSICAL LITERACY BASED LONG-TERM ATHLETE DEVELOPMENT IN PHYSICAL EDUCATION CURRICULA FOR SECONDARY SCHOOL IN HONG KONG: A RANDOMIZED CONTROLLED TRIAL

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THE CHINESE UNIVERSITY OF HONG KONG

Background

Health and education-related organizations such as the United Nations and the Hong Kong Education Bureau continue to cultivate high expectations on quality physical education (QPE) curriculum and vast number of diversity strategies to ensure students develop physical literacy (PL) from an early age and build a solid foundation of movement from adequate physical activity (PA) guidelines. Barriers to meet this expectation such as lack of unique PE curriculum and long-term development programme for students, lack of time and greater emphasis on academic achievement are ongoing challenges to schools. Physical literacy based long-term athlete development (PLB-LTAD) curriculum for secondary school students, as a key intervention of this proposed project, is considered to be a pivotal role to enhance and support the quality of secondary schools PE in Hong Kong. The purpose of this study is to evaluate the effect of a PLB-LTAD programme in physical education curricula and how its routines can be associated with QPE at Hong Kong secondary schools.

Method

A randomized controlled trial (RCT) design was performed. One hundred twenty students aged 11 to 16 years participated in an eight-months of PLB-LTAD training programme (2 days a week, 45 minutes training per day). A total of 45-hours of PLB-LTAD training was conducted to students during this period. Qualified PE teachers implemented the PL intervention across two classes, and another two classes formed a control group as part of a RCT. Video recordings of PE lessons were used to check fidelity of the PLB-LTAD programme. Charting Physical Literacy Journey (CPLJ) Matrix, seven days of wearing accelerometers, and the LTAD stage four -"Training to Train" (endurance, strength, and speed) were used to collect self-report and objective data measures from baseline, post-intervention and follow-up phases. Repeated meas-

ure ANOVAs and MANCOVA, with time (baseline, after intervention, and follow-up) as within-subjects factor and intervention group (PLB-LTAD and CG) as between-subjects factors were used to evaluate the change of interventions on the students' PL, PA, and fitness levels.

Discussion

The study presents as an experimental study in Hong Kong to investigate the effect of a PLB-LTAD programme at the secondary school PE curriculum. Upon its completion, the study protocol may contribute to the field by providing evidence for the effectiveness of training programmes, for the manageability of students' PA levels and PL awareness in school settings. While it may affect students' athletics career and motivation to participate in various sports.

Physiology

MUSCLE OXYGENATION DURING THE MAXIMUM AEROBIC METABOLISM WORKOUTS IN WORLD CLASS KAYAKERS: A CASE STUDY

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INTRODUCTION: In 1000-meter sprint kayaking events some muscle energy is generated through aerobic reactions and the other part of the energy comes from anaerobic reactions. Near Infrared Spectroscopy (NIRS) is one of the most informative methods for the analysis of aerobic metabolism in muscles. Although some researchers have analyzed the muscle oxygenation in different age kayakers by the NIRS method, there is little research evidence about the muscle oxygenation in world-class kayakers getting ready for 1000-meter sprint events.

The aim of this research work is to investigate muscle oxygenation of the world-class kayaker during workouts with different intensity efforts.

METHODS: A single case study was conducted with the kayaker who is the winner of Europe and World championships and who was the fifth at the Olympic Games. Athlete's data: height 184.5 cm, weight 89.4 kg, lean body mass 50,2 kg, vital capacity 7.7 l, grip strength 74 kg, VO2 max 5.24 l/min, maximum aerobic power on kayak ergometer 340 W, with VO2 at the anaerobic threshold of 3,90 l/min, capacity 220 W. NIRS monitors were fixed on the following muscles: Lateralis Dorsi (LD), Pectorlis Major (PM) and Vastus Lateralis (VL). The athlete performed two special workouts with explosive and high-intensity efforts. One workout was used to determine the VO2 max using a kayak ergometer. The other workout was rowing in water in a 1000-meter race (average 310 W, 3 min 38 sec.).

RESULTS: The VO2 max test revealed different oxygenation processes. Oxygen saturation reduced the most in VL muscle, whereas in LD and PM muscles the SmO2 dropped down to 20–30 %. During the racing workout, the SmO2 gradually reduced and reached the 0–10 % limit at the end of the distance. The heart rate was 184 bpm during both workouts.

CONCLUSION: Our study revealed that aerobic processes were very intensive in all world-class kayaker's muscles during both workouts involving high-intensity efforts. The greatest oxygenation changes were observed in VL muscle. These findings prompt the need for further research into aerobic metabolism in the muscles of world-class athletes.

EXERCISE TRAINING IMPROVES ERYTHROCYTE OSMOTIC DEFORMABILITY IN PATIENT WITH END STAGE RENAL DISEASE

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INTRODUCTION: Erythrocyte injury and early senescence resulted in impaired deformability are important pathogenic features in end stage renal disease (ESRD), and which further disturb microcirculation. Moreover, the drastic changes in osmotic pressure also crucially affected osmotic deformability. This study investigated whether moderate intensity exercise training affect erythrocyte membrane and osmotic deformability in ESRD.

METHODS: Ten patients suffering from ESRD underwent moderate intensity exercise training for 30 min a day, 3 days a week for 12 weeks. The blood sample collection and graded exercise test (GXT) were performed 3 times at intervals of 12-weeks: baseline (T1), start training (T2), and after training (T3). All subjects were analyzed with osmotic gradient ektacytometry for assessing erythrocyte membrane stability and osmotic deformability before the GXT test.

RESULTS: The patients significantly improved their aerobic capacity, achieved a more symmetric erythrocyte shape, and heighten the levels of CD47 and CD147 after training. Furthermore, the osmolarity at EIhyper (Ohyper), elongation index values at low osmolar conditions (EImin) and the area under the osmolarity-elongation index curves were significantly higher after training compared to the baseline. Although no change was observed in the maximum elongation index (EImax), training for 12 weeks augmented the erythrocyte membrane deformability, represented by decreased SS1/2 and SS1/2/EImax. The erythrocyte count and hemoglobin were unchanged among three test timepoints.

CONCLUSION: A 12-week moderate intensity exercise training significantly improves erythrocyte membrane and osmotic deformability, and further enhanced aerobic capacity.

THE HIGH CARBOHYDRATE-INDUCED IMPAIRMENT OF ENDOTHELIAL FUNCTION IS SUPPRESSED BY THE FOLLOWING INTERMITTENT EXERCISE

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INTRODUCTION: Aerobic exercise for the lower legs induces endothelial adaptation of the conduit artery in the inactive upper limbs, such as the brachial artery (BA). This favorable effect on the endothelium is derived from nitric oxide (NO) production, which is a strong endothelial mediator of vasodilation. NO production is mainly caused by the exercise-induced elevation of shear stress (SS) because of increased blood flow in the BA. However, ingestion of a carbohydrate-rich meal impairs endothelial function temporally. This damaging effect is caused by postprandial hyperglycemia, which increases oxidative stress and reduces endothelial NO bioavailability. Subsequently, repeated daily hyperglycemia would be associated with atherosclerosis development along with type II diabetes. However, the effect of exercise and its timing (e.g., pre- or postprandial exercise) on impaired endothelial function caused by high carbohydrate ingestion has not been extensively studied. Therefore, we evaluated flow-mediated dilation (FMD) of BA as a noninvasive standard measure of endothelial function after oral glucose ingestion. FMD was evaluated immediately before or after high-intensity intermittent exercise (HIIE), which is more effective than moderate-intensity constant exercise.

METHODS: Healthy young volunteers (n=11) participated in three protocols in random order. In the preprandial exercise protocol (preprandial Ex), 30 min HIIE was performed for 60–30 min before the ingestion of a 500 mL drink containing 75 g of glucose. In the postprandial exercise protocol (postprandial Ex), HIIE was performed for 15–45 min after ingestion of the drink. In the control protocol (Con), the subjects ingested the same drink without exercise. The leg cycling HIIE comprised a 2-min warm-up of 20 W and 28 min of main exercise. The main exercise consisted of 4 HIIE set repetitions: one 7 min set, approximately 80% of maximal heart rate (HRmax) corresponding to a work rate of 158 ± 41 W for 4 min, followed by a work rate of 20 W for 3 min. Before and at 60 and 120 min after glucose drink ingestion, FMD (%FMD = ([peak diameter−baseline diameter]/baseline diameter) × 100) and SS profiles (ante- and retrograde shear rates (SR) [an estimate of SS] = blood velocity/diameter) were evaluated by Doppler ultrasonography. Blood glucose (BG) and plasma insulin (PI) concentrations were measured at the same time schedule.

RESULTS: At 60 min after ingestion, postprandial Ex showed significantly higher % FMD compared with Con and preprandial Ex. The changes of antegrade SRs with time in three protocols were very similar to those in %FMD. The BG and PI responses with time in three protocols were mirror images of those in %FMD.

CONCLUSION: The postprandial high-intensity intermittent exercise effectively suppresses subsequent endothelial dysfunction via postprandial hyperglycemia suppression and antegrade shear stress elevation in the brachial artery.

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EFFECT OF TRAINING ON URINARY N-TELOPEPTIDES OF TYPE I BONE COLLAGEN LEVELS IN MALE COLLEGE LONG-DISTANCE RUNNERS

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INTRODUCTION: A stress fracture is a bone injury tissue caused by chronic low-level stress activities such as running and eventually may lead to a complete fracture. This type of fracture is a serious complication with a long-term impact and affects athlete training status. The incidence of stress fracture has been shown to be high in long-distance runners, who may have two different types of training techniques: 1) long-running distances at a slow speed, and 2) short-running distances at a high speed. However, the effects of these types of training techniques on stress fracture are unknown. This study aims to determine the effects of these training methods on the levels of urinary N-telopeptides of type I bone collagen (u-NTX), a well-known biomarker for bone resorption, and Creatine Kinase (CK) enzyme in male college runners.

METHODS: In this study, we investigated the effects of different training contents on bone metabolism in long-distance runners. The participants were six male college students (mean age 19.5 ± 1.3 yr, mean body fat 12% ± 2.3%) of a university track team. The levels of u-NTX and CK were quantified during three different running periods: the "off" (at rest), the long-distance (LD), and the high speed (HS). The LD period involved high-training volumes and long distances, while the HS period involved high-quality training and short distances at faster speeds. The running speed and distance training were recorded each week using a smartwatch (ForeAthlete935, Garmin Corporation). The level of CK enzyme was assessed once each day after the finalization of the training period while u-NTX concentration

was continuously measured for seven days after each period.

The level of u-NTX is well-known to exhibit a large daily variation, and therefore the normal value was based on an average for seven consecutive days during the "off" period. Average values and fluctuations in the concentrations of u-NTX after LD and HS periods were compared to the normal value.

RESULTS: Results showed that the LD period (786.3 ± 218.4 U/L) had higher levels of CK than the "off" period (280.6 ± 73.5 U/L), $p < 0.05$). There was no change in the level of u-NTX after the HS period. After the LD period, the u-NTX values were lower on the 1st day (39.7 ± 9.5 nmolBCE/mmolCRE) and 5th day (37.2 ± 7.9 nmolBCE/mmolCRE) than the normal average value (47.6 ± 8.0nmolBCE/mmolCRE, $p < 0.05$). The average value 7 days after the LD period (40.2 ± 9.5 nmolBCE/mmolCRE) was also lower than the "off" period average ($p < 0.05$).

CONCLUSION: Our results support the idea that high-training volumes and long distances are associated with higher muscle damage than high-quality training and may also lead to the suppression of bone resorption.

COMBINED EFFECTS OF HYPERTHERMIA AND MENTAL FATIGUE IMPAIRS AEROBIC EXERCISE CAPACITY IN HIGHLY TRAINED ATHLETES IN THE HEAT.

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INTRODUCTION: Combined effects of mental fatigue by a prolonged cognitive task and exposure to heat stress would impair exercise capacity in the heat. However, in the focus of thermoregulatory responses, it is not unclear whether the effects of elevation in core temperature (hyperthermia) or heat exposure without elevation in core temperature during performed cognitive task induce to impair exercise capacity. The purpose of this study was to investigate the effects of differences in core temperature by exposure to heat stress in addition to a mental fatigue on aerobic exercise capacity in the heat.

METHODS: Seven highly trained athletes (age: 22 ± 1 years, height: 173.2 ± 2.4 cm, body mass: 67.11 ± 5.2 kg, maximal oxygen uptake: 63.7 ± 7.1 mL/kg/min) completed two experimental conditions: hyperthermia (HYP) and control (CON). Participants were conducted AX-Continuous Performance Task (AX-CPT) and Stroop tasks to induce mental fatigue during a warm water immersion at 40°C (HYP) or a seated in chamber at 35°C and 60% relative humidity (CON) for 45 min before exercise. Thereafter, participants performed running trial at 80% maximal oxygen uptake until voluntary exhaustion in the same chamber as the CON.

RESULTS: Exercise time to exhaustion was significantly lower in the HYP trial (8.9 ± 3.3 min) than that of the CON trial (12.6 ± 3.3 min; $p = 0.028$). Rectal temperature at the end of tasks in the HYP trial increased by 0.86 ± 0.26°C ($p = 0.001$) and was significantly higher (37.69 ± 0.18°C) than that of the CON trial (36.96 ± 0.13°C; $p = 0.001$), albeit no significantly differences in mean skin temperature ($p = 0.610$). Heart rate at the end of tasks in the HYP trial was significantly higher (98 ± 18 bpm) than that of the CON trial (76 ± 11 bpm; $p = 0.021$). Self-reported mental fatigue using visual analog scale was significantly higher after tasks in both trials ($p < 0.001$), but no significantly differences between trials (HYP: 5.3 ± 2.5, CON: 6.1 ± 2.2, $p = 0.349$). Throughout trial, salivary cortisol concentration and perceptual responses (perception of effort and thermal sensation) were not affected by hyperthermia.

CONCLUSION: This study demonstrated that combined effects of elevation in core temperature (hyperthermia) and mental fatigue in highly trained athletes causes to impair exercise capacity in hot environments compared to mental fatigue during heat exposure without elevation in core temperature. This observation suggests that athletes with mental fatigue should avoid elevation in core temperature equivalent to hyperthermia before exercise to attenuate impairment in subsequent endurance exercise performance in hot environments.

ESTIMATION OF LACTATE THRESHOLDS FOR MUSCLE OXYGENATION IN HEALTHY, NON-TRAINING INDIVIDUALS AND HIGH-TRAINED SPEED SKATERS

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INTRODUCTION: In the last few years, the introduction of mobile oximeters to measure the oxygenation level of myoglobin in the muscle cytoplasm and hemoglobin in the blood vessels of the muscle microcirculation (muscle oxygen saturation, SmO2) has been particularly relevant to training practice [1]. SmO2 measurements provide valuable information about oxygen transport and utilization in muscles [2]. The main objective of the study was to determine lactated thresholds (aerobic and anaerobic) for near-infrared spectroscopy (NIRS) measurements in healthy, non-training individuals and highly trained athletes. It was important to answer the question to what extent muscle oxygenation at the anaerobic threshold level and after maximal exercise is dependent on the level of physical capacity.

METHODS: The study involved 29 untrained students (Female students n=13, 23.1 ± 1.0yrs, body mass index (BMI) 22.3 ± 3.7, Male students n=16, 23.8 ± 1.1yrs, BMI 25.6 ± 3.4) and 27 leading Polish speed skaters, members of the National Team of juniors and seniors, men and women (Female speed skaters n=13, 18.5 ± 2.0yrs, BMI 21.3 ± 1.0, Male speed skaters n=14, 17.9 ± 2.2yrs, BMI 22.3 ± 1.2). A graded-intensity exercise test on a bicycle ergometer was performed. The test consisted of 3-minute stages with graded load performed continuously. Based on blood lactate concentrations, the aerobic and 3 anaerobic thresholds (AT4 mmol, Dmax modf. and LT) were determined. During GXT test, a NIRS device (Moxy monitors; Fortiori Design LLC, Hutchinson, MN, USA) was placed on the vastus lateralis (VL) muscle that is active during cycling. The normal distribution of variables was examined using the Shapiro-Wilk test. The significance of differences was assessed using the Student test and Mann-Whitney U-test for variables with a distribution different from the normal distribution. The power of relationships between the variables was determined based on Pearson's correlation coefficients (r). The coefficient intervals for correlations were also presented. The level of statistical significance was set at $p \leq 0.05$.

RESULTS: Power values determined for all thresholds were significantly higher in female and male speed skaters compared to male and female college students. Muscle oxygenation (SmO2) at anaerobic thresholds was significantly lower in female speed skaters than in female students. In male speed skaters, the differences discussed were not statistically

significant. Both female and male skaters additionally showed greater decreases in SmO2 after the maximal test compared to students. The dependence of SmO2 on exercise load for all groups combined was polynomial. Although the time to achieve 50% SmO2 during recovery did not differentiate between the male and female groups studied, a higher rate of muscle reoxygenation (% / s) was found in female speed skaters compared to female students. This was also confirmed by a significant correlation in women between the rate of muscle reoxygenation and Peak Power. In speed skaters, although the mentioned rate of muscle reoxygenation was not significantly higher compared to students it showed a significant positive correlation with VO2max.

CONCLUSION: High diagnostic value characterized the assessment of differences in muscle oxygenation relative to resting value (ΔSmO2) both at anaerobic threshold (in females) and after maximal exercise (in females and males), with greater decreases in SmO2 observed in subjects with higher physical capacity. There was also a significant positive correlation between the rate of muscle reoxygenation after the maximal test and the level of physical capacity.

1. Perrey & Ferrari (2018) 2. McCully & Hamaoka (2000)

EFFECTS OF EQUOL SUPPLEMENTATION ON EXERCISE-INDUCED MUSCLE DAMAGE AND DELAYED-ONSET MUSCLE SORENESS IN YOUNG MEN: A RANDOMIZED, DOUBLE-BLINDED, PLACEBO-CONTROLLED CROSS-OVER STUDY

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INTRODUCTION: Estrogen has a protective effect on exercise-induced damage (EIMD) of skeletal muscle. Equol is a metabolite of dietary soy isoflavone daidzein by gut microbiome and has an anti-inflammatory and antioxidant effect like estrogen (Kim, 2021). Equol may be effective for attenuating the EIMD since inflammatory cytokines and reactive oxygen spaces are involved in the process of the EIMD. The purpose of the present study was to determine the positive and protective effects of equol supplementation on eccentric exercise-induced muscle damage and delayed onset muscle soreness in young men.

METHODS: Healthy young sedentary and recreational active men (n=12, 22±2 years, mean±SD) participated in the double-blind placebo-control cross-over designed study. All participants were tested for the equol producing status, and only the non-equol producers participated in the trial. Participants took the equol supplements (10mg/day) or placebo for 7 days before and 2 days after the 150 maximal eccentric actions of the quadriceps femoris muscle of one-leg on an isokinetic dynamometer (Cybex). At least 3 weeks later, participants performed an equivalent bout of eccentric exercise on the contralateral leg with consuming the other supplements. Maximum isometric torque and peak concentric torque during isokinetic knee extension (60 degree/sec), muscular stiffness of rectus femoris (handheld tissue hardness meter), range of motion of knee joints of the exercised leg, and pain scale of quadriceps (visual analog scale) were measured before and after 24h, 48h, and 72h the eccentric exercise.

RESULTS: Maximum isometric torque (-16.1%) and peak concentric torque (-22.9%) during isokinetic knee extension decreased at 24h after the eccentric exercise in the placebo condition ($p<0.05$) but apparent declines were not observed in the equol condition (isometric torque: -2.6%, peak concentric torque: -3.7%, interaction effect: $p<0.05$). The muscular pain scale of quadriceps increased at 24h following the eccentric exercise and returned to baseline at 48h in both conditions but no differences of trend were observed between the two conditions. Muscular stiffness of the rectus femoris and range of motion of knee joints of the exercised leg did not change in both conditions.

CONCLUSION: These results suggest that equol has a protective effect on the eccentric exercise-induced decline of muscular performance but not on delayed-onset muscle soreness in young men. Equol supplementation may be useful in maintaining muscular conditioning during the training and competitive periods.

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EFFECTS OF EXERCISE INTENSITY IN HYPOXIA OR NORMOXIA ON EXPRESSION OF GENES INVOLVED IN MICE SKELETAL MUSCLE METABOLIC PATHWAYS

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INTRODUCTION: Exercise training performed in hypoxia may improve oxygen transport and skeletal muscle metabolism, and lead to greater benefits on physical performance, than similar training in normoxia. However, there are few studies comparing the molecular responses of skeletal muscle to different exercise intensities, superimposed to hypoxia. The aim of the present study was therefore to investigate the effects of low and supramaximal exercise intensities in hypoxia and normoxia on expression of genes associated with muscle energy metabolic pathways in healthy mice.

METHODS: A total of 36 8-week-old male C57BL/6J mice were randomly divided into six groups (n=6 mice/group): sedentary (SED) in normoxia and hypoxia, low-intensity training normoxia (LIT) in normoxia and hypoxia, supramaximal intensity normoxia (SIT) in normoxia and hypoxia. Exercise consisted in running on a mouse treadmill 3 times/week for 4 weeks, in a chamber with a fraction of inspired O2 (FiO2) of either 0.13 (hypoxia) or 0.21 (normoxia). Mice assigned to LIT groups ran continuously for 40 min at 40% of maximal aerobic speed, while mice in the SIT groups ran 4 sets of 5 × 10 s sprints at 150% of maximal aerobic speed, with 20s and 5 min of passive recovery between each sprint and each set, respectively.

At end of the study, maximal running distance was assessed with an incremental running test to exhaustion. Expression of genes involved in glucose, lipid and lactate metabolism, as well as mitochondrial biogenesis, was determined in the gastrocnemius muscle using real-time PCR.

RESULTS: Maximal running distance was not significantly different between the 6 groups of mice. HK2, PFK, LDHA, TFAM and HSL mRNA levels were significantly increased in SED in hypoxia compared to SED in normoxia, while no significant difference was reported in LIT and SIT in hypoxia in comparison with respective groups in normoxia. GLUT4 mRNA level significantly decreased in SIT in hypoxia versus SIT in normoxia. In normoxia, GLUT4, MCT1, MCT4 and NRF1 mRNA expression was significantly higher in SIT than in SED and LIT, when in hypoxia only MCT1 and MCT4 expression was upregulated in SIT compared to SED and LIT. Expression of PKm1, PDH, PDK4, PGC-1α, PGC-1β, mtDN1, mtND6, CytC, CytB, CD36 and UCP2 did not significantly differ between hypoxic and respective normoxic groups, and with exercise in any group.

CONCLUSION: The present study showed that 4 weeks of exercise training at low and supramaximal exercise intensities in normoxia and hypoxia have moderate effect on muscular transcriptional regulation of genes related to metabolic pathways in healthy mice. Despite previous reports that hypoxia induces a potent physiological stimulus and increases physical performance, due to the heterogeneity in response of LIT and SIT in hypoxia observed in the present study, we showed that the exercise intensity per se is paramount and induces different adaptations to hypoxic exercise.

IMPACT OF PHYSICAL ACTIVITY AND METABOLIC SYNDROME PARAMETERS ON THE RISK OF CAROTID PLAQUE INSTABILITY ASSESSED BY MRI.

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INTRODUCTION: Atherosclerotic disease is a complex multifactorial and systemic condition that affects coronary arteries, carotid arteries, and arteries of the lower limbs. Atherosclerotic plaque instability can lead to death, ischemic stroke, myocardial infarction, or acute lower limb ischemia and amputation. The pro-inflammatory and hypoxic environment of the atherosclerotic plaque promote the development of intraplaque neo-vessels that cause intraplaque hemorrhage (IPH). The most reliable in-vivo criterion for carotid plaque instability detection is presence of IPH, detected by magnetic resonance imaging (MRI) with gadolinium injection. Physical Activity (PA) decreases stroke's incidence and coronary arteries calcification. More precisely, PA has an impact on arterial stiffness and stenosis, but also on volume and instability of atheroma plaque.

The objective of the present study is to evaluate the impact of PA and sedentary behavior on IPH by MRI.

METHODS: This cross-sectional cohort study involves 57 patients with carotid atherosclerotic plaque with more than 50% stenosis, asymptomatic for more than 6 months, with no surgical indication for endarterectomy and no recent inflammatory intercurrent diseases. Characterization of carotid plaque instability was evaluated by magnetic resonance imaging (MRI). A score was defined for IPH (from 0: non hemorrhage to 3: large hemorrhage). PA and sedentary behavior were assessed by questionnaires (GPAQ) and physical fitness by 6-minutes Walking Test (6-MWT). The parameters of the metabolic syndrome (BMI, fat mass, hypertension, fasting blood glucose, dyslipidemia) known to promote atherogenesis have been analyzed as covariates.

RESULTS: We showed that the score of IPH quantified by MRI was increased in the glucose intolerant subgroup of patients (0.39 vs 0.84, p=0.04). This result was confirmed by a higher prevalence of hemorrhagic plaque in the glucose intolerant group (73 vs 41%, p< 0.05). Interestingly, the fasting blood glucose level is higher in patients with a hemorrhagic plaque than non-hemorrhagic plaque (5.6 vs 6.9 mM, p=0.04). Moreover, neither other known pro-atherogenic markers (LDL, cholesterol, TG) nor obesity seem to increase the degree of IPH. We also observed that the score of intraplaque hemorrhage quantified by MRI was increased in the sedentary non-physically active subgroup of patients (1.6 vs 0.8, p=0.08). This result confirms our previous observation3 showing a higher prevalence of hemorrhagic plaque in the sedentary non-active group compared to the physically active non-sedentary group (69 vs 31%, p< 0.01).

CONCLUSION: In conclusion, we demonstrated the major role of PA on the risk of plaque instability. Moreover, as we were able to reproduce by MRI imaging a result obtained by histology, we highlighted the importance of plaque MRI to detect unstable plaque in at-risk populations and to evaluate in-vivo beneficial interventional treatment including both PA and pharmacological treatment.

THE BILATERAL DIFFERENCE OF THE DEVELOPMENT ON LOWER LIMBS MUSCLE THICKNESSES IN MALE JUNIOR SPEED SKATERS.

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INTRODUCTION: The force and power generation capacities of the lower limb muscles are improved by speed skating training in speed skaters (Nemoto et al. 1990). Speed skating runs around a 400m ice rink. In curve skating, the body is tilted to the inside of the rink and the body is always pushed off to the right, so the kinetics of the left and right legs are different during curve skating. From these facts, it is expected that the load on the left and right legs is different during speed skating, and it is possible that there is a difference in the development of muscle morphology between the left and right legs. However, it is not clear whether the same specific hypertrophy in each site of lower limbs muscles occurs with competitive speed skating training in junior skaters. Therefore, in this study, we investigated that the effects of growth and

development on the bilateral difference of the development on lower limbs muscle thicknesses in male junior speed skaters.

METHODS: The subjects were 10 to 18 years old male speed skaters. They were divided into 9 groups according to chronological age every 1 year. All subjects had belonged to speed skating clubs and they performed training of speed skating all through the year. Body compositional parameters for body height, body mass, fat mass and fat-free mass of the whole body were measured using the body impedance analysis method. The muscle thicknesses on the thigh anterior, lateral and posterior, lower legs anterior and posterior in both legs were measured using the B-mode ultrasonic method.

RESULTS: As a result of two-way analysis of variance of age x left and right legs for muscle thickness, no significant difference or interaction between left and right legs was observed at all sites. The ratio of muscle thickness values in each age group to the 10-year-old group showed a greater rate of change in the thigh than in the lower leg. As a result of comparing the slope of the liner regression line in relationships between the left and right muscle thicknesses, the regression lines for the anterior and lateral thighs were gentler than those for the other regions. In other words, skaters with larger muscle size had greater muscle thickness on the left side.

CONCLUSION: From these results, the muscle thickness of the lower extremities in junior speed skaters is thought to be more remarkable in the thigh than in the lower leg. Furthermore, it was suggested that the muscle thickness on the left side is more developed than the muscle thickness on the right side in skaters with higher muscle thickness values.

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EFFECTS OF DIFFERENT ENVIRONMENTAL ENRICHMENT ON SPONTANEOUS PHYSICAL ACTIVITY AND SPATIAL LEARNING.

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PHYSICAL FITNESS RESEARCH

INTRODUCTION: Environmental enrichment (EE) promotes a variety of positive effects on brain function. However, it is controversial whether EE remains beneficial in the absence of wheel running. The controversy may be the result of differences in spontaneous physical activity level. Nevertheless, in EE experiments where multiple rodents were housed in a cage, individual spontaneous physical activity level has not been measured due to the technical difficulties. PURPOSE: We tested the hypothesis that cognitive benefits arising from EE are associated with spontaneous physical activity level (wheel running and/or other locomotor activity). The purpose of the present study was to examine whether EE that enables facilitation of wheel running activity and physical activity (PA) changes spatial learning and memory and stress hormone.

METHODS: Wistar rats were divided into four different housing groups: EE (running wheel and objects: slope, tunnel, and hut), running wheel only (EE-R), objects only (EE-O), and standard environment (SE) (N=7-8/group). Physical activity level of each rat was continuously recorded using an embedded three-axis accelerometer. After exposure to each condition for 4 weeks, the animals were submitted to the Morris water maze (MWM) test. The MWM test was carried out on 4 consecutive days, and spatial learning and memory was assessed using time to find the platform. The concentration of serum corticosterone was analyzed using an electrochemiluminescence immunoassay method.

RESULTS: Physical activity level was higher in the EE (260,350 ± 9,203 a.u./week) and EE-R (205,018 ± 8562 a.u./week) compared with the SE (13,745 ± 945 a.u./week, Ps < 0.05). There was no difference in physical activity level between the EE-O (16,770 ± 1,200 a.u./week) and the SE. In the MWM, the time to find the platform was shorter in the EE groups (EE: 15.5 ± 3.0, EE-R: 11.4 ± 3.5, EE-O: 11.6 ± 4.5 sec) than the SE group (29.9 ± 3.0 sec, Ps < 0.05) on day 3. Physical activity level among the groups was not correlated with the time to find the platform (R2 = 0.22). The serum corticosterone concentration in the EE groups (EE: 399 ± 29.5, EE-R: 409 ± 46.5, EE-O: 420 ± 36.2 ng/mL) was significantly lower than that in the SE group (574 ± 33.1 ng/mL, Ps< 0.05).

CONCLUSION: The EE-O enhanced cognitive function despite lower physical activity level without increasing physiological stress. The present investigation suggests that spontaneous physical activity level alone does not determine hippocampus-dependent cognition in the environmental enrichment conditions.

COMBINED AEROBIC AND LOW-INTENSITY RESISTANCE EXERCISE TRAINING INCREASES BASAL NITRIC OXIDE PRODUCTION AND DECREASES ARTERIAL STIFFNESS IN HEALTHY OLDER ADULTS

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INTRODUCTION: Meta-analyses have concluded that combined aerobic and high-intensity or moderate-intensity resistance exercise training has no effects on arterial stiffness (1). However, a recent study demonstrated that combined aerobic training and low-intensity resistance training using rubber bands increases basal nitric oxide (NO) production and decreases arterial stiffness with marked reduction of body weight in obese adolescent girls (2).

METHODS: To investigate whether combined aerobic and low-intensity resistance training increases basal NO production and decreases arterial stiffness without body weight reduction in older adults, 27 healthy older individuals participated in a 6-week program as a part of the training group (mean body mass index, 21 kg/m2; walking and resistance training using one's body weight) or the control group (22 kg/m2, asked not to modify their lifestyle) (UMIN000034111).

RESULTS: The exercise intervention increased maximal oxygen uptake (aerobic capacity), score of the 10-time sit-to-stand test (muscle strength and endurance), and plasma concentrations of nitrite/nitrate (end products of NO) and decreased brachial-ankle pulse wave velocity (an index of arterial stiffness) without changes in body weight. In the control group, there were no differences in these measures before and after the study period.

CONCLUSION: These results suggest that combined aerobic and low-intensity resistance exercise training increases basal NO production and decreases arterial stiffness in healthy older adults.

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THE BLOOD PRESSURE REGULATION AGAINST ACUTE CENTRAL BLOOD VOLUME REDUCTION IN ENDURANCE ATHLETES

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INTRODUCTION: The blood pressure is determined by the triple product of stroke volume (SV), heart rate (HR), and total peripheral vascular resistance (TPR), and thus maintained by adjusting these variables. It is necessary to increase HR and/or TPR to maintain blood pressure in response to SV reduction due to the decrease in central blood volume caused by a standing posture. It is known that orthostatic intolerance is lower in endurance athletes (Fit) as compared with non-athletes (UnFit). Therefore, Fit may have lower responses in HR or TPR than UnFit. We hypothesized that an increase in HR and/or TPR in response to the decrease in SV would be more impaired in Fit than UnFit. The purpose of this study was to test our hypothesis by comparing the SV, HR, and TPR changes during severe orthostatic stress by low body negative pressure (LBNP) between Fit and UnFit.

METHODS: Eleven male endurance athletes (Fit; 21±3 years old, VO2max 59.2±4.6 ml/kg/min) and 11 male non-athletes (UnFit; 25±7 years old, VO2max 35.6±8.1 ml/kg/min) underwent severe orthostatic stress test using gradient increase of LBNP. LBNP was gradually increased at -15 mmHg, -30 mmHg, and -40 mmHg for 5 minutes, and then incremented -10 mmHg every 3 minutes until pre-syncope (LBNPmax). HR (ECG), SV (3D echocardiography) and mean arterial pressure (MAP; Finometer) were assessed. TPR was calculated by MAP/(SV×HR). Changes in HR, SV, TPR, and MAP from baseline to the load of 85% LBNPmax (85% LBNPmax) were compared between Fit and UnFit.

RESULTS: There was no difference in delta decrease in SV between Fit and UnFit (P=0.277), while SV decreased at the 85% LBNPmax in both groups. However, delta increase in HR and TPR at 85% LBNPmax were smaller in Fit than UnFit (P=0.045 and P=0.024). As a result, delta decrease in MAP at 85% LBNPmax was larger in Fit than with UnFit (P=0.005).

CONCLUSION: The findings indicate that the responses of HR and TPR to an acute severe reduction in SV due to orthostatic stress was blunted in Fit as compared with UnFit, proposing one possible explanation for lower orthostatic intolerance in Fit.

EFFECTS OF SCIATIC NERVE AND CAPSAICIN-INDUCED SENSORY DENERVATION ON TRABECULAR BONE IN YOUNG RATS

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INTRODUCTION: Bone metabolism is regulated by neurogenic as well as mechanical and humoral factors. Both limb disuse induced by sciatic nerve denervation and capsaicin-induced sensory denervation cause bone loss in rat tibiae. In the present study we investigated the effects of the sciatic nerve and capsaicin-sensitive sensory neurons on the trabecular microstructure of tibial bone.

METHODS: We divided 32 twelve-week-old male Fischer 344 rats into four groups: control (C), capsaicin-administered (Cap), sciatic denervation (DN), and DN+Cap. The subcutaneous capsaicin injection was administered dorsally on three consecutive days. The sciatic denervation surgery was performed at the age of 12 weeks. At the age of 16 weeks, the tibiae were collected and subjected to three-dimensional micro computed tomography . The following parameters were measured: trabecular bone volume fraction , trabecular number, trabecular thickness, connection density, trabecular bone pattern factor, and structure model index (SMI). The SMI quantifies the plate versus rod characteristics of trabecular bone.

RESULTS: The connection density and the trabecular bone volume, number, and thickness were lower, by 25–70%, in the Cap, DN, and DN+Cap groups than in the C group. They were significantly lower in both the DN and DN+Cap groups than in the Cap group, but there was no significant difference between the DN and DN+Cap groups. In contrast, the SMI and trabecular bone pattern factor were significantly higher in the Cap, DN, and DN+Cap groups than in the C group.

CONCLUSION: These results suggest that in addition to reducing bone mass, selective sensory denervation through capsaicin treatment has negative effects on the maintenance of trabecular structure. This results in a shift toward the formation of a rod-like trabecular structure, although this effect is weaker than it is under sciatic denervation. These data also

suggest that capsaicin-sensitive sensory neurons have positive functions in the maintenance of bone mass and trabecular microstructure.

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FUNCTIONAL, MOLECULAR AND STRUCTURAL EVENTS ARE NOT SYNCHRONIZED AFTER A PROTOCOL OF INTERMITTENT COLD EXPOSURE FOR MUSCULAR INJURY RECOVERY

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INTRODUCTION: Musculoskeletal disorders are one of the main causes of requirement for functional rehabilitation in the world. In sports, musculoskeletal system injuries represent between 10-55% of all sustained injuries. Because of its high incidence and impact on health, skeletal muscle regeneration process has been extensively studied and characterized. However, still new therapeutic strategies need to be studied in order to accelerate the muscle regeneration process and ameliorate muscle tissue after injury. Due to its high plasticity, skeletal muscle can adapt and respond to different stimuli in order to maintain the homeostasis and improve its functionality. The main objective of our work was to study the effects of an intermittent cold exposure (ICE) protocol on the process of muscle regeneration in an animal model.

METHODS: Eighteen adult-male rats were surgically injured in the right gastrocnemius muscle (GM) and randomly divided into two groups: 1) Control (CON), that recovered at T=24ºC; 2) Intermittent cold exposure (ICE), that recovered for 4h/day at T=4ºC. Several parameters indicators of muscle recovery were measured in both GM (injured and contralateral non-injured) at two different time points after injury (9 and 21 days). Tetanic force (TF) was measured as a functional indicator. Capillary-to-fibre ratio (C/F), after muscle capillaries histochemical staining for eATPase, and VEGF expression, analysed by Western blot, were used as angiogenic indicators. Finally, expression of developmental myosin heavy chain (dMHC), quantification of central nuclei, and collagen I deposition at the injury site, assessed in histological slides, were used as markers of muscle regeneration.

RESULTS: Complete functional muscle recovery (TF) was achieved after 21 days of ICE (injured GM vs non-injured contralateral GM: $p=0.318$) but not after 9 days ($p<0.001$). Conversely, CON did not present any sign of recovery neither after 9 nor after 21 days ($p<0.05$). However, ICE increased VEGF expression after 9 days ($p=0.038$), which translated into angiogenesis at 21 days (C/F CON=2.6 vs ICE=2.9). After 21 days, ICE did not improve collagen I deposition ($p=0.243$) nor dMHC expression ($p=0.967$) and presented higher number of fibres centrally nucleated ($p<0.05$) at the injury site.

CONCLUSION: Our results indicate that ICE did not show a total muscle recovery, at the histological level, after 21 days from injury since fibrosis and molecular and cellular clues are still present after this period of time. However, total functional force recovery was evident from TF recordings which could be explained after an improvement in muscle angiogenesis leading to a good supply of nutrients and growth factors. These findings must be considered when taking decisions regarding the timing of return to play. A total functional recovery is not matched to histological structure repair, which could increase the risk of relapse after muscle injury recovery.

ACUTE EFFECTS OF MAXIMAL GRADED EXERCISE TEST ON CARDIAC AUTONOMIC NERVOUS ACTIVITY AND ARTERIAL BARORECEPTOR REFLEX FUNCTION IN ENDURANCE ATHLETES

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INTRODUCTION: It is known that endurance athletes (Fit) have a lower tolerance for orthostatic stress than sedentary adults (Sed). Autonomic nervous activity and arterial baroreflex function (BRS) play an important role for maintaining blood pressure during orthostatic stress. It has been reported that autonomic nervous activity and BRS are more functioning in Fit than in Sed in the resting condition. However, it is still unknown how the maximal graded exercise test (GXT) would acutely affect these functions in endurance athletes as compared with sedentary individuals. The purpose of this study was to examine whether the effects of GXT on cardiac autonomic nerve activity and BRS would be different based on a physical fitness level.

METHODS: Eight Sed and eleven Fit subjects underwent GXT. The resting RR interval (RR) and systolic blood pressure (SBP) were measured every heartbeat for 5 minutes before and after GXT. Power spectral analysis was applied for SBP and RR variabilities, and transfer functional analysis was applied between these variable. The speed of fluctuations in RR and SBP variabilities were divided into low frequency band (LF: 0.05~0.15Hz) and high frequency band (HF: 0.15~0.35Hz), and the power in each band was calculated. All parameters were compared before and after GXT between Sed and Fit using two way repeated ANOVA with post hoc test of Holm-Sidak.

RESULTS: SBP decreased only in Sed ($P<0.05$) and HR increased in both groups ($P<0.05$) after GXT as compared with before. HF-RR (a measure of parasympathetic activity) decreased only in Sed ($P<0.05$) and LF/HF (a measure of sympathetic activity) increased only in Sed ($P<0.05$) after GXT. LF-Gain (a measure of BRS) tended to decrease in both groups after GXT. LF-Gain was higher in Fit than in Sed after GXT ($P<0.05$).

CONCLUSION: Vagal withdrawal and sympathetic activation were observed in Sed but not in Fit after GXT. BRS was similarly attenuated in Sed and Fit after GXT even though different autonomic responses to GXT were observed between Sed and Fit.

ACUTE EFFECTS OF BLOOD FLOW RESTRICTION ON SPRINT INTERVAL EXERCISE IN COLLEGIATE ATHLETES

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INTRODUCTION: Blood-flow restriction (BFR) training combined with low-intensity aerobic or resistance exercise could increase aerobic capacity and muscle mass [1]. Preview studies [2, 3] reported that 4-wk of sprint interval training (SIT) combined with BFR might be a potent stimulus to enhance maximal oxygen uptake (VO2max) in well-trained individuals. This study examined the acute effects of BFR with different arterial occlusion pressures (AOP) on the 6 sets of Wingate-based cycling sprint exercise (SIE) performance and physiological responses in athletes.

METHODS: Twelve male collegiate basketball players familiar with SIT program were recruited in this randomized crossover-designed study. After performing the incremental cycling test, participants were asked to respectively perform three treatments, including BFR40 (40% AOP), BFR80 (80%AOP), and CON (passive rest), at rest intervals during SIE. The performance, i.e., peak and mean power, and percentage decrement score, were recorded during SIE test. The muscular deoxygenation and pulmonary oxygen uptake during SIE were measured by near infrared spectroscopy and gas analysis system, respectively. The blood lactate and pH levels were measured before and after SIE. The norepinephrine (NE), growth hormone (GH), insulin-like growth factor-1 (IGF-1), testosterone, nitric oxide (NO) and vascular endothelial growth factor (VEGF), were evaluated before, and immediately, 5, 15, 30, and 60 min after SIE.

RESULTS: No significant differences were found on the peak and mean power outputs among treatments during SIE test. There were also no significant differences on the percentage decrement scores of peak (BFR80 vs. BFR40 vs. CON, 7.8 ± 6.7% vs. 6.4 ± 2.8% vs. 6.7 ± 4.8%, $p > 0.05$) and mean (BFR80 vs. BFR40 vs. CON, 15.1 ± 5.9% vs. 13.7 ± 6.1% vs. 15.9 ± 6.9%, $p > 0.05$) power during SIE among treatments. No significant differences were found in the accumulated exercise time at ≥ 80%, 90%, and 100%VO2max during SIE among treatments. There were non-significant interaction effects on tissue saturation index, total hemoglobin, and deoxyhemoglobin (△HHb) during sprints. However, the △HHb at rest intervals in BFR40 (from the third to fifth rest interval) and BFR80 (from the second to fifth rest interval) were significantly higher than those in CON. No significant differences on blood lactate levels and pH after SIE among treatments. There were no significant interaction effects on the NE, GH, IGF-1, testosterone, NO and VEGF levels among treatments.

CONCLUSION: The BFR administrated at rest intervals might increase the oxygen extraction of muscles, however, different pressures of BFR might neither increase the SIE performance nor improve the muscle hypertrophic and angiogenic responses to SIE in collegiate athletes. Supported by grants from Ministry of Science and Technology, Taiwan (MOST 110-2410-H-003-126). References: [1] Patterson, S. D., et al. (2019) [2] Mitchell, E. A., et al. (2019) [3] Taylor, C. W., et al. (2016). Contact: andescheng@ntnu.edu.tw

VALIDATION OF A DOWNHILL RUNNING PROTOCOL TO STUDY THE EXERCISE-INDUCED MUSCLE DAMAGE (EIMD) AND DELAYED-ONSET MUSCLE SORENESS IN TRAINED ATHLETES.

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INTRODUCTION: Exercise-induced muscle damage (EIMD) has largely been studied in sedentary subjects and/or in the days following maximal eccentric exercise on isolated muscle. However, a better understanding of the EIMD occurrence, prevention or intersubject variability resulting from a functional exercise as downhill running (DR) appears necessary to address this problem in endurance athletes. The purpose of this study was to investigate whether a 30min downhill running (DR) bout cause significant changes in EIMD indirect markers in trained athletes.

METHODS: Healthy well-trained males (n=12, 25±4.89yrs) underwent a VO2max test on a treadmill to determine their maximal aerobic speed (MAS). Then, they were submitted to a 30min DR protocol at 90% MAS (-15% gradient). The rate of perceived exertion (RPE) was assessed using a Borg scale. Indirect markers of muscle damage (plasma creatine kinase, muscle function, muscle extensibility and DOMS in lower limbs) were assessed pre, 24h and 48h after the DR. We also compared the stride parameters (using a 3D motion system) during level and downhill running at the same speed.

RESULTS: The athletes (VO2max: 51.84 ± 6.77 mlO2.min-1.kg-1) completed 30min DR at a speed of 15.53 ± 0.97km/h. Blood lactate increased from the start (2.58 ± 0.59mmol/l) to the end of the DR (5.06 ± 1.76mmol/l). A higher RPE score was found for the cardiovascular demand (13 ± 1.41) than for the muscular effort (14.92 ± 2.81). Plasma CK activity significantly increased from pre (226.08 ± 84.34UI/l) to 24h (1412.25 ± 579.16UI/l) and 48h (869.17 ± 573.11 UI/l) post-exercise ($p<0.01$). A significant decrease in maximal isometric strength of the knee extensors was observed at 24h (-16.12 ± 9.37%) and 48h (-11.61 ± 8.67%) post-DR compared to pre ($p<0.05$). Countermovement jump performance was also decreased at 24h (-5.28 ± 4.30%) and at 48h post (-3.18 ± 5.15%) compared to pre ($p<0.05$). Significant DOMS was observed ensuing the DR with the highest values found for the quadriceps (5.36 ± 2.27 a.u) and the gluteal muscles (4.63 ± 2.49 a.u) 24h post-exercise ($p<0.01$). The knee extensors' extensibility was decreased at 24h (-3.13 ± 4.03cm) and at 48h (-2.75 ± 2.39cm) post-exercise. A Pearson correlation analysis demonstrated a significant correlation between muscle strength loss and plasma CK activity measured 24h post-exercise ($r=0.71$; $p<0.01$). A lower stride frequency and a higher ground contact time was found during DR (-2.8%, $p<0.05$; -2.66% $p<0.001$, respectively) compared to level running.

CONCLUSION: Our data demonstrated that completing 30min downhill running (-15% gradient) at a speed corresponding to 90%MAS was effective to induce significant changes in EIMD markers in trained men, with higher changes observed at 24h post-exercise. This protocol represents an attractive model to deeper study the mechanisms underlying EIMD or its adaptation following DR in trained populations.

SEX DIFFERENCES IN MAXIMAL OXYGEN UPTAKE ADJUSTED FOR SKELETAL MUSCLE MASS IN ENDURANCE ATHLETES: A PRELIMINARY STUDY.

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INTRODUCTION: It is well known that male athletes perform better than the female athletes in several endurance sports. One of the main reasons for this sex difference in performance has been attributed to VO2max, more specifically to weight-adjusted VO2max, which is limited by the maximum cardiac output. It is estimated that male athletes presented VO2max about 20% higher than the women. However, the sex difference in aerobic performance in lower than 20%. For example, the sex difference in triathlon performance is about 10-12%. Therefore, other variables, apart to VO2max, also affect aerobic performance. Beside VO2max, the performance in long distance events also can be affected by muscle oxidative capacity. The latter can be estimated by lean mass adjusted VO2max. However, there are very little data in the literature on this variable, and little data about sex differences according to muscle oxidative capacity. Therefore, the aim of this study was to compare the aerobic muscle quality, accessed by VO2max adjusted by lower limbs lean mass, between male and female amateur triathletes.

METHODS: Thirty triathletes (15 men and 15 women) that are involved with triathlon training for at least 2 years underwent a cardiorespiratory maximal treadmill test to assess their VO2max (L.m-1), and a body composition test (dual-energy X-ray absorptiometry - DXA) to assess lower limbs lean mass. VO2 max was determined as the stabilization of O2 consumption (increase lower than 2.1 ml. kg-1. min-1), even after increasing treadmill speed. Body mass-adjusted VO2max (mL.kgBM-1.m-1) and lean mass-adjusted VO2max (mL.kgLM-1.m-1) were calculated.

RESULTS: The absolute VO2 max (4.9±0.2 vs. 2.9±0.2 L.m-1, $p < 0.001$, d = 10, 95% CI = 3.4 to 29) and body mass-adjusted VO2 max (61.9±7.1 vs. 52.6±7.1 ml. kg-1. min-1, $p = 0.001$, d = 1.3, 95% CI = 1.2 to 1.5) were significantly higher in male athletes than in female athletes. Conversely, the lean mass-adjusted VO2 max (186.5±14.5 vs. 199.0±23.5 mL.kgBM-1.m-1, $p = 0.092$, d = 0.6, 95%CI = 0.3 to 0.9) were not significantly different between sexes, but the effect size of the difference can be classified as moderate (higher values for the female athletes).

CONCLUSION: Although the sex difference in weight-adjusted VO2max values may explain, at least in part, the difference in performance, muscle oxidative capacity can attenuate the sex difference in performance, once the effect size of sex on lean mass-adjusted VO2max was moderate.

EFFECT OF HYPERCAPNIA ON OXYGEN UPTAKE KINETICS DURING MODERATE CONSTANT INTENSITY EXERCISE

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INTRODUCTION: Hypoxic gas (HP) inhalation increases the time constant of oxygen uptake (tVO2) in phase II during constant work-rate exercise (CWE) at moderate intensity [1]. Hypercapnic gas (HC) inhalation leads to increased pulmonary ventilation and decreased respiratory exchange ratio (RER) during CWE at moderate and heavy intensities [2]. Thus, it is hypothesized that HC inhalation alters VO2 kinetics during CWE. This study aimed to test the hypothesis that HC inhalation would alter tVO2 during CWE at moderate intensity.

METHODS: Six healthy males volunteered to participate in the present study. To set up the exercise intensity, the subjects performed incremental maximum exercise tests on three occasions; 1) breathing ambient air (Air); 2) breathing HC (21% O2, 3% CO2, N2=balance); 3) breathing HP (16% O2, N2=balance). Thereafter, each subject performed CWE at 45%VO2max intensity for 6 min on three occasions. Subjects breathed Air or HC or HP from 10 min before the start of exercise until the end of the exercise. The respiratory data were sampled by the automatic gas analyzer by the breath-by-breath system, and tVO2 in phase II was estimated with a nonlinear least-squares fitting procedure. Statistics analysis was performed by one-way ANOVA with a post hoc test.

RESULTS: The average value (baseline) of VO2 before the start of exercise for HC was significantly higher than in Air and HP (306±31 vs 265±35 vs 253±44 ml/min, respectively, $p<0.05$). The baseline VO2 was not different between Air and HP. The amplitude value (Amp) of VO2 for exponential fits for HP was lower than in Air and HC but not significantly statistically (1112±112 vs 1268±325 vs 1275±213 ml/min, respectively). Amp for VO2 was not different between Air and HC. There was no significant difference in the time delay (TD) of VO2 for the three conditions (HC:17.0±3.9, Air:13.3±4.3, HP:13.8±5.0 sec). tVO2 for HC was significantly less than in HP ($p<0.05$) and less than in Air but not significantly (20.6±6.2 vs 25.2±6.1 vs 23.3±8.0 sec, respectively). tVO2 for HP was higher than in Air but not significantly.

CONCLUSION: Our results showed that the increased pulmonary ventilation with HC led to an increase in the baseline VO2 at the resting period, but not in Amp VO2 during CWE at moderate intensity. Although not significantly different, tVO2 was less for HC than for Air, suggesting that HC may alter the dynamics of VO2 to saturation. However, this was for a small number of cases, and further experimentation is needed. In conclusion, VO2 kinetics during CWE at moderate inten-

sity change with HC inhalation, and while tVO2 during CWE at moderate intensity increases with HP inhalation, it may decrease with HC inhalation.

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SEX DIFFERENCES IN INFLAMMATORY RESPONSES FOLLOWING ECCENTRIC EXERCISE

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INTRODUCTION: Estradiol is a female hormone that inhibits inflammation following exercise. Increased blood neutrophil counts have been especially reported following eccentric exercise in males, but whether the same phenomenon occurs in females remained unclear. Furthermore, no studies have investigated the relationship between estradiol concentrations and inflammatory markers. Thus, this study aimed to investigate sex differences in the changes in blood inflammatory markers following eccentric exercise, including the relationship to estradiol concentration.

METHODS: This study included untrained 12 males (age: 22.3 ± 2.1 years; height: 175.1 ± 4.4 cm; weight: 65.4 ± 6.8 kg; and lean body mass: 57.4 ± 5.4 kg) and 12 females (age: 26.7 ± 6.7 years; height: 160.0 ± 3.4 cm; weight: 56.7 ± 3.4 kg; and lean body mass: 40.3 ± 1.9 kg). Participants performed 10 sets of 6 repetitions of eccentric exercises of elbow flexors with their nondominant. Blood samples were collected pre-exercise (PRE) and 4, 48, and 96 h postexercise (POST) to analyze serum estradiol concentration, serum creatine kinase (CK) activity, leukocyte count, leukocyte fractionation (neutrophils, lymphocyte, monocyte, and other leukocytes), and interleukin-6 concentration. The serum estradiol concentration was analyzed only PRE.

RESULTS: The serum estradiol concentration was significantly higher in females than in males (males: 27.0 [16.3–33.8] vs. females: 37.5 [30.8–50.8] pg/mL; $p < 0.01$). Significant time effects were observed for serum CK activity at PRE to 96 h POST ($p < 0.01$). PRE and 4 h POST CK activity were significantly lower in females compared to males, but the difference disappeared when normalized for lean body mass. Lymphocyte counts increased in 4 h POST compared to PRE only in females ($p < 0.01$), and the percent change in lymphocyte counts from PRE to 4 h POST was significantly higher in females than in males ($p < 0.05$). A significant negative correlation was observed between serum estradiol concentration and the percent change in lymphocyte counts from PRE to 48 h ($r = -0.640$, $p < 0.05$) and 96 h ($r = -0.735$, $p < 0.01$) POST in females. No sex differences were found in changes between neutrophil, monocyte, other leukocyte counts, and interleukin-6 concentrations.

CONCLUSION: These results suggest that the percent changes in lymphocyte counts from PRE to 4 h POST following eccentric exercise are higher in females than in males. Additionally, serum estradiol concentrations were negatively correlated with the percent change in lymphocyte counts following eccentric exercise in females. Therefore, females experience an increase in lymphocyte counts following eccentric exercise, which may be suppressed by estradiol.

INFLUENCES OF TRAINING IN THE COLD ON SKELETAL MUSCLE METABOLISM AND STRUCTURAL GENE EXPRESSION

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INTRODUCTION: Exercising under cold stress regulates muscle metabolism by increasing lipid utilization (1). Interestingly, lower muscle temperature may also impede post-exercise muscle protein synthesis following exercise (2). Whether acute metabolic and structural responses observed under cold stress regulate chronic adaptations to exercise in skeletal muscle during training in a cold environment remains unknown. This study investigated the effect of seven weeks of interval cycling training in thermoneutral or cold environment on the expression of selected metabolic and structural genes in skeletal muscles of healthy previously untrained volunteers.

METHODS: Thirty-four participants (age 24.7 ± 3.2 yrs, height 177 ± 12 cm, body mass 80.3 ± 17.9 kg, fat 27 ± 3%) with no training history took part in seven weeks of cycling interval training consisting of a short (100-130% of Watt max), a medium (90-95%), and a long (80-85%) session every week in either a thermoneutral (22°C [TN], n=19; 10F and 9M) or cold (0°C [CO], n=15; 8F and 7M) environment, wearing shorts and a t-shirt. Training sessions ranged from 10 - 45 min. Incremental VO2max testing was conducted before the training intervention and 72 hrs. post intervention, combined with muscle biopsies from the vastus lateralis muscle at both time points (6G Bergström needle). Real-time PCR was used to quantify metabolic and structural changes in muscle tissue. Two-way analyses of variance were used (temperature and time) to assess differences with a level of significance set at $p<0.05$.

RESULTS: Both groups exhibited increases in VO2max from 40.5±8.3 to 43.3±8.3 ml/kg/min in TN ($p<0.001$) and from 42.0±9.5 to 46±7.9 ml/kg/min in CO ($p<0.01$). In both groups, post training muscle analyses revealed an upregulation of peroxisome proliferator-activated receptor-gamma coactivator 1 alpha, glyceraldehyde 3-phosphate dehydrogenase, beta actin, and growth differentiation factor 11 (fold changes of 1.3, 1.3, 1.2, and 1.4, respectively, $p<0.05$), whereas myo-

statin was downregulated (fold change 0.6, p<0.01). Importantly, the effects of training in the cold did not lead to noticeable changes in gene expression compared to the TN group.

CONCLUSION: The present study explored the effects of training in a cold environment on metabolic and structural skeletal muscle gene expression. While acute exercise in the cold may alter energy metabolism and muscle remodelling pathways, these results suggest no meaningful impact of lower ambient temperature on key metabolic and structural gene expression in untrained young individuals following a 7-week training protocol.

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EFFECTS OF SOLE CRYOSTIMULATION BETWEEN RESTING PERIODS ON PHYSIOLOGICAL RESPONSES AND EXERCISE PERFORMANCE IN A HOT ENVIRONMENT.

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INTRODUCTION: Exercising in a hot environment causes hyperthermia, which reduce exercise performance(Gonzälez-Alonso et al.,1999, Parkin et al.,1999). It is important to maintain a low core temperature to maintain high exercise performance. Cooling mainly through arteriovenous anastomoses, such as palms and soles, is more efficient in lowering core temperature (Hirata,2016). The present study examined the effects of cryostimulation of sole after constant load exercise in a hot environment on subsequent endurance exercise performance tests and physical responses.

METHODS: Five trained subjects (age: 26 ± 2 years, height: 177.5 ± 4 cm, weight: 76.3 ± 5.8 kg) completed a submaximal (70% Vo_2max) constant load exercise test for 30 minutes (EX1) in a hot environment (Ta 35°C, RH 60%). The subjects After 10minutes rest completed a submaximal (70%vo2max) exercise (EX2) until it became impossible to continue exercise. Between EX1 and EX2, the subjects were at rest and the sole was cooled in an ice pack at -50°C for 2 minutes. Measurements were taken for esophageal temperature (Tes), skin temperature, heart rate (HR), cardio output (CO), stork volume (SV), forearm blood flow (FBF), muscle temperature. Every 2 minutes during the exercise, rate of perceived exertion (RPE) and thermosensory scale measurements were taken.

RESULTS: EX2 increased exercise time during cryostimulation of the sole. There was a decrease in Tes, HR, and FBF in rest cooling conditions between EX1 and EX2 compared to rest. SV increase was observed in cooling of the sole at rest. Cooling of the sole, there was a decrease in the thermosensory scale and RPE at the start of EX2.

CONCLUSION: Sole cooling decreased Tes and decreased the thermosensory scale and RPE from the start of exercise at EX2. Thermal discomfort and RPE may have influenced the duration of exercise. FBF decreased during sole cooling, which delayed the increase at the onset of EX2. Sole cooling also increased CO and SV at the start of EX2. These results suggest that the blood that should have been supplied to the skin from the start of EX2 was able to supply the active muscle blood flow. A 2-minute exposure to cryostimulation of sole improved thermoregulatory and cardiovascular function and prolonged the duration of EX2 exercise.

INFLUENCE OF EXPOSURE PERIODIC HYPOBARIC NORMOXIA ENVIRONMENT ON NIGHT SLEEP

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INTRODUCTION: Sleeping in low-pressure environments at altitudes of 1,500 m and 2,000 m has been shown to shorten slow-wave sleep time and reduce sleep quality. A decrease in periodic respiration and slow-wave sleep was also observed in a low-pressure environment equivalent to an altitude of 2000m. It was clarified that there is a risk of inducing sleep disorders and lowering the quality of sleep while staying at high altitude. In addition, exposure to periodic hypobaric normoxia environment (PHNE) increases post-exercise VO2 and respiratory quotient (R), and has been shown to improve ventilation efficiency and promote lipid metabolism. The purpose of this study was to investigate how this PHNE affects sleep.

METHODS: Eighteen healthy university students participated in this study. Before the experiment, the content was fully explained and consent was obtained from the subjects. Subjects were exposed to PHNE room (NR-100E-3, Shinmei-room Inc., Japan) for 50 minutes (PHNE). As a control experiment, measurements were carried out in an environment (normobaric pressure) without changes in air pressure using the same equipment. After that, EEG measurement (EEG sensor ZA-X, Proassist, Japan) was performed during night sleep, and the sleeping state was analyzed. In addition, a sleep monitor (MTN-221, Acos, Japan) was attached to the waist to measure physical activity and body movement during sleep. Body temperature, SpO2, Visual Analog Scale (VAS), and POMS were measured before and after PHNE exposure. Statistical evaluation of the data was done by paired student's t-test. Significance level was set at the $p < 0.05$.

RESULTS: A decrease in heart rate was observed after the experiment both during PHNE and during normobaric pressure. The body temperature before the experiment and the body temperature after 30 minutes in the room tended to temporal increase in body temperature from the same level during both PHNE and normobaric pressure (36.7°C vs. 36.7°C: ns, 36.6°C vs. 37.0°C: p< 0.05). This suggests that the time zone after 30 minutes has passed is an environment that is likely to induce sleep like after bathing. There is a decrease in body temperature at the end of PHNE (37.0°C vs. 36.6°C, p<0.05).

Since some subjects were drowsy and asleep around this time, it was thought that the core body temperature decreased due to heat dissipation. Total sleep time did not differ between the two environments. EEG-measured sleep efficiency was increased in PHNE (73.4 vs. 90.6: p<0.05), and nocturnal awakening was shortened (21.3 min vs 5.7 min: p<0.05). In PHNE, both REM sleep (27.2 min vs. 66.5 min: ns) and NREM sleep (161.0 min vs. 219.1 min: ns) tended to increase.

CONCLUSION: Exposure to PHNE was associated with an increase in body temperature, suggesting the possibility of promoting sleep latency. In addition, EEG measurements suggest that sleep efficiency is improved, nocturnal awakening are reduced, and REM sleep and NREM sleep are increased.

ACUTE PHYSIOLOGICAL AND PERCEPTUAL RESPONSES TO WHOLE-BODY HIGH-INTENSITY INTERVAL TRAINING COMPARED WITH ERGOMETER-BASED INTERVAL AND CONTINUOUS TRAINING

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INTRODUCTION: Time-efficient, whole-body calisthenics exercise has gained worldwide popularity in recent years, especially during the COVID-19 pandemic. Previous studies have compared the physiological and perceptual responses of specialized, equipment-based high-intensity interval training (HIIT) with conventional, high-volume moderate-intensity continuous training (MICT), but relatively little is known about the impact of other more easily accessible forms of HIIT. This study aimed to compare the acute response to a single session of low-volume, whole-body HIIT (WB-HIIT), ergometer-based HIIT (ERG-HIIT), and MICT.

METHODS: Fourteen physically inactive adults (age = 28.4 ± 6.5 yr, VO2peak = 31.5 ± 6.3 ml· kg-1· min-1) underwent three exercise trials in a randomized order with 3-7days apart. During exercise, heart rate (HR), blood lactate (BLa) and rating of perceived exertion were measured. Level of enjoyment and task-specific self-efficacy were assessed after each trial.

RESULTS: The peak HR of WB-HIIT was significantly greater than MICT (p = 0.001). WB-HIIT induced significantly higher BLa concentration than ERG-HIIT (p < 0.05) and MICT (p < 0.001). WB-HIIT displayed the highest self-efficacy and elicited greater enjoyment than MICT (p < 0.05). Half of the participants prefer WB-HIIT to ERG-HIIT and MICT.

CONCLUSION: In conclusion, WB-HIIT appears to induce similar physiological and perceptual responses to ERG-HIIT but different from MICT. Our results indicated that low-volume, high-intensity whole-body calisthenics workout can be a viable, alternative exercise strategy when lacking time and accessibility of equipment, but further studies should address its safety concerns and long-term benefits for the general population.

WATER INTAKE INFLUENCE IN SWIMMING PERFORMANCE IN 100-M FRONT CRAWL IN WELL-TRAINED SWIMMERS

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INTRODUCTION: Swimming training can induce significant stress on various physiological systems and is distinctive since it is the only sport conducted entirely in a body weight–supported prone or supine position in water, featuring simultaneous use of arms and legs for propulsion with low eccentric and central nervous system demands [1]. Since many athletes experience fluid imbalances that can sabotage performance and even health [2], the purpose of this study was to evaluate hydration status and water intake during a simulated swimming competition influence on body mass (BM), sweat rate (SR), sweat loss (SL), % of body mass loss (%BML), heart rate (HR), urine pH and 100-m front crawl performance in well-trained swimmers.

METHODS: Twelve male competitive swimmers participated in the study (mean ± SD; 16.25 ± 1.66 years of age, 176.50 ± 6.35 cm of height, 66.13 ± 8.30 kg of BM. After a pretraining urine sample was collected for initial pH evaluation (pHi), each participant completed a validated food frequency questionnaire regarding the assessment of fluid intake during the day [3]. Afterward, BM was measured and considered initial BM (BMi), and later, athletes were provided with a 50 cl bottle of water. The first group (G1) were the swimmers with a water intake ≤ 340 mL, and the second group (G2), with a water intake ≥ 350 mL and ≤ 500 mL, in both cases immediately ingested before the 800-m aerobic swim of low to moderate intensity in-water warm-up. Then, in the middle of a 6-min rest period, initial heart rate (HRi) was measured, and after, 4 x 25 m maximal front crawl swimming were performed with 1-min rest in between, followed by another 6-min rest period before the 100-m maximal front crawl swimming trial (T100). Immediately after, end HR (HRend) was measured, and the same procedure was completed after a 5-min rest period for recovery HR assessment (HRr).

RESULTS: A total of six swimmers lost BM during the 45 minutes swimming training session, three integrated G1 (water intake ≤ 340 mL) and the other three G2 (water intake ≥ 350 mL and ≤ 500 mL). Five swimmers increased their BM (two in G1 and three in G2), and one swimmer presented no change in BM (G1). Correlations were observed in both groups between HR and urine pH data, water intake, and SL, but only in G1 was the HRend correlated to body mass loss (BML) and %BML (respectively, r=-0.81 and r=-0.82, in both cases p <0.05). Furthermore, also only in G1, T100 was strongly correlated to water intake and SL (in both cases, r=-0.85, p <0.05).

CONCLUSION: Our results suggest the measurement of individual needs to optimize fluid intake strategies and having an adequate hydration plan in place before, during, and after training can help not only swimming performance enhancement, but also aid in recovery of swimmers.

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ASSESSMENT OF LEFT VENTRICULAR MASS USING DIFFERENT ECHOCARDIOGRAPHIC TECHNIQUES IN HEALTHY FEMALE ATHLETES

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INTRODUCTION: The application of three-dimensional (3D) echocardiography for the measurement of left ventricular mass (LVM) is considered to provide LVM quantification results similar to that of cardiac magnetic resonance imaging (gold standard) compared to two-dimensional (2D) echocardiographic techniques. We sought to assess the effects of two echocardiography techniques and training status on LVM in healthy female university students.

METHODS: LVM was assessed using the 2D American Society of Echocardiography linear method technique and 3D echocardiography was assessed using the volumetric technique. Training status was assessed through the comparison of LVM from female athletes (team sports and cross-country) (n=22) and normally active females (n=20).

RESULTS: Forty-three females (21.2±1.9) underwent echocardiography. There was no significant difference for age, heart rate or blood pressure ($p>0.05$) between the groups. Stroke volume did not differ between the groups using assessed by 2D or 3D echo. The relative wall thickness assessed by 2D echo was not significantly different between athletes and normally active (0.37±0.08 vs. 0.36±0.06; $p=0.536$). There was a significant difference in indexed LVM between the athletes (67.5 g/m2±14.9 vs. 56.8 g/m2±8.5; $p=0.005$) but not in the normally active females (56.9 g/m2±11.2 vs. 56.3 g/m2±9.6; $p=0.844$), for 2D echocardiography and 3D echocardiography methods, respectively. The distribution of relative wall thickness and indexed LVM using concentric and eccentric remodeling and hypertrophy cut-offs resulted in two athletes being identified to have concentric hypertrophy and one athlete having eccentric hypertrophy using 2D but not 3D echocardiography.

CONCLUSION: In female university students, indexed LVM assessed by 2D echo in female athletes may be overestimated, however, further analysis using these methods, including in male athletes and normally active males needs to be conducted.

EFFECT OF AN ACCLIMATION PROTOCOL TO ENVIRONMENTAL HEAT AND HUMIDITY STRESS ON PHYSIOLOGICAL AND INFLAMMATORY MARKERS.

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INTRODUCTION: Exercise under environmental conditions of severe heat and humidity stress can lead to poor performance and many athletes experience exertional hyperthermia during training and competition. Due to the increase of competitions in countries with adverse climate conditions, acclimation of the athletes is becoming more frequent. However, little is known on the effects of acclimation training on the athlete's inflammatory response and health.

This study main objective was to determine the effect of exercise in classic laboratory environmental conditions (NC), as well as in conditions of environmental heat and humidity stress (HS), in physiological and inflammatory (IL-6, IL-15, IL-10, TNF-α, IL -β, IL-1ra, sCD14) markers in athletes, before and after a heat acclimation (HA) protocol.

METHODS: Eight endurance athletes, who compete at the Portuguese national level (37.5 ± 11.21 years) underwent an acclimation training protocol, in an indoor climate chamber, consisting of 2 weeks of training under 35°C and 55% humidity, with 3 sessions/week of increased duration (40, 60, 80, 90, 100 and 110 mins). The week before a progressive 4 min step VO2max test at 21ºC and 55% humidity and another one at 34ºC and 55% humidity were performed with 2 days interval. The same tests were repeated the week after the acclimation protocol. Physiological variables were evaluated during the VO2max tests at two intensities (moderate LAC= 2mmol/l and high LAC= 4mmol/l). Inflammatory markers concentrations were determined by ELISA (Thermofisher, UK) before and after the VO2max tests.

RESULTS: Although there were no significant differences in speed ($p = 0.58$), a small improvement in running speed was obtained for the HS environment at moderate intensity (2mmol/l), after acclimation (ES = -0.2). In the physiological variables, significant differences were found for VO2max, total energy expenditure and RPE ($p < 0.05$) (NC x HC at 2mmol/l). Important differences in effect sizes were identified for cardiovascular (HR; SBP; DBP), and thermoregulatory (body temperature; dehydration) adaptations. For the inflammatory markers, IL-6 and IL-15 showed decreases in their concentrations after HA compared to previous values under the same environmental conditions ($p < 0.05$). Significant differences in the sCD14 soluble endotoxin receptor ($p < 0.01$) were found in the HS environment after acclimation. A percentage of dehydration of at least 1.25% of total body weight can cause increases in IL-1β concentrations and, associated to this, an increase in endotoxin leakage from the gut, manifested by increases in sCD14 plasma concentrations.

CONCLUSION: Acclimation training was effective in promoting several physiological adaptations. Although IL-1β levels were increased in athletes at the time of HS after acclimation, IL-1ra levels were also higher at that time, suggesting a trend for athletes to maintain their inflammatory balance and immune system functionality.

ICE SLURRY INGESTION BEFORE AND BETWEEN EXERCISE ALTERS ENDURANCE EXERCISE CAPACITY AND COGNITIVE PERFORMANCE IN A HOT ENVIRONMENT

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INTRODUCTION: Compared to temperate environments, the core and mean skin temperatures increase in the heat faster, resulting in increased cardiovascular, metabolic, and thermal perceptual loads and decreased endurance exercise performance. Cooling the body may be one such approach since this strategy can alleviate the physiological and perceptual strain in a hot environment. This study investigated the effects of ice slurry ingestion before and between exercise on thermoregulatory responses, endurance exercise capacity and cognitive performance in a hot environment.

METHODS: In a randomised cross over design, ten trained men (age, 22.1 ± 1.6 years; height, 1.72 ± 0.07 m; body mass, 63.5 ± 8.8 kg; VO2max, 60.6 ± 4.3 mL·min·kg-1) who were not acclimatized to the heat performed three 20-minute bicycle exercises at 50% watt max followed by an exercise at 80% watt max until exhaustion in a hot environment (32°C, 60% relative humidity). The subjects consumed frozen ice slurry (-4°C: ICE) or beverage of the same composition (32°C: CON) during a 8-minute of pre-cooling after warm-up (ingestion volume: 4 g·kg-1) and three 7-minute rests between exercise bouts (ingestion volume: 2 g·kg-1).

RESULTS: The changes in rectal, mean skin, deep-forehead, heart rate in the ICE condition during constant-load exercise was significantly lower than that of the CON condition ($p < 0.05$). Rating of perceived exertion, thermal sensation, and thermal comfort were significantly improved in the ICE condition. Exercise time to exhaustion at 80% watt max was significantly prolonged in the ICE condition compared with CON condition (79 ± 39 vs 232 ± 71 sec, respectively, $p < 0.05$). Cognitive performance (shifting attention test) was also improved in the late phase of constant exercise under ICE condition compared with CON condition. Sweat rate and rate of dehydration in the ICE were significantly lower than that of the CON condition.

CONCLUSION: Ingestion of frozen ice slurry before and between exercise bouts in a hot environment reduces increase in core and skin temperatures during constant-load exercise and improves perceptual thermal strain, exercise and cognitive performance. These improvements in ICE may be due to low thermal and perceptual strain during the constant exercise. The lower increase in core body temperature during constant exercise was suggested to be a cooling effect on the body due to the continuous intake of frozen ice slurry not only before exercise but also between exercises. This applied cooling method is an effective heat countermeasure for sports activities in a hot environment.

Physiotherapy

EFFECTIVENESS OF THE RSQ1 DEVICE RECUPERATION PROTOCOL IN THE TREATMENT OF SPORTS INJURIES

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INTRODUCTION: Injury during sports activities (sports injury) is common in case of insufficient preparation and warm-up before training, due to fatigue and too strenuous training, as well as during uncontrolled exercises on equipment in the gym. RSQ1 device (Physicare International B.V., Zaandam, The Netherlands) is a unique device for neuromuscular stimulation with a high-frequency signal of over 10kHz. Its advantages compared to other devices for electrotherapy: it accelerates circulation almost instantly, creates hypertrophy, increases saturation, engages a large number of motor units as well as a quick analgesic effect.

METHODS: Case study: Our subject is 24 years old female professional basketball player, with 14-16 hours spent on the court (including a game as well) per week. During one practice, while sprinting, sharp pain appeared on the lateral side of the quadriceps muscle. After positive (painful) palpation and slight strength testing, a radiologist specialist performed an ultrasound (US) diagnostic. It was confirmed muscle tear (grade II) of m. vastus lateralis and the size of the tear was 1,2 cm wide. Hemorrhage and liquid around the injured tissue were present as well. It was suggested 3 weeks of rest with physical therapy included and US control every 7 days.

First time during the rehab of sportsmen with muscle tear the RSQ1 recuperation protocol included 24hrs on the injured muscle. Only during the bathing and physical therapy sessions (cryotherapy, magneto therapy, laser, and interferential current therapy - which lasted one hour), RSQ1 was removed. Immediately after the therapy session, RSQ1 was put back on injured place and a recuperation protocol was set. During the RSQ1 session, electrodes are placed on the injured limb. The injured athlete is trained to use this device at home and keep it working on 24hrs per day.

RESULTS: After 3 days of being injured, the athlete felt capable to use muscle more without pain so the isometric exercises for the quadriceps muscle were included together with the RSQ1 device on it. Seven days after the injury, a US diagnostic was done with results of only a visible 0,8 cm muscle tear and almost complete disappearance of hemorrhage and local

liquid. Fourteen days after the injury, the US showed that there is not any tear noticeable on the injured area. RSQ1 device is now also included during the process of isometric and concentric exercises for quadriceps muscle. Recuperation protocol was still constantly included.

CONCLUSION: Three weeks after the injury, the US showed no signs of injury and the dynamometry testing showed only 15% less strength in the injured leg than before the injury. According to the manufacturer, this protocol results in an increased blood flow and a higher saturation of the blood in the treated area (goes up to 30%), which causes a faster recuperation of the muscle tissue. The athlete was able to return to the court earlier than expected.

RELIABILITY OF THE TRUNK FLEXOR ENDURANCE TEST USING DIFFERENT INCLINATION ANGLES

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INTRODUCTION: The sit-up has been used as a physical fitness test or a trunk flexor training. According to Axler et al. (1997), the internal pressure of the lumbar intervertebral disc during sit-up is approximately 3350 N, which means the same as the load for developing possible low back pain in hard labors reported by the National Institute of Occupational Safety and Health. The trunk flexor endurance test (TFET) has been reported as a safer endurance test than the sit-up, although previous studies have used various degrees of trunk inclination. Thus, it is not clear which inclination angle should be used in the TFET. For example, as a physical fitness test for health promotion in older age groups, an inclination angle of about 55 deg seems to be safer and less difficult. On the other hand, an inclination angle of about 45 deg seems to be more difficult and suitable for athletes. Therefore, the purpose of this study was to determine the reliability of the TFET using different inclination angles.

METHODS: The subjects were 15 physical education students (8 men, 7 women). The mean (standard deviation; SD) of age, height, and weight of the subjects were 20.7 (0.5) years, 165.3 (6.4) cm, and 59.3 (8.9) kg. The TFET was performed as following procedure; 1. Set the tilting table at randomly assigned angle (45deg, 50deg, or 55deg) and take a sitting position so that the whole back is in contact with the tilting table. 2. With the knees flexed at 90deg and the hands placed on the chest, The test starts by shifting the tilt table 10 cm backward, and the subject should keep the starting posture as long as possible. 3. When the posture becomes unmaintainable and the back touches the tilt table again, the test ends. The holding time of each angle was recorded twice (1st/2nd) one week apart in two weeks. All subjects performed the TEFT at 3 angles (total 6 measurements in 6 weeks). Intraclass correlation coefficient (ICC) was calculated to determine the test-retest reliability.

RESULTS: The mean value (SD) of the 1st / 2nd holding time in the TEFT were 160.3 (88.5) / 168.5 (72.4) seconds at 45deg, 263.7 (122.2) / 274.7 (129.7) seconds at 50deg, and 363.5 (208.9) / 385.5 (207.2) seconds at 55deg. As a result of the reliability test, ICC (1,1) was 0.907, 0.943, 0.970 and ICC (1,2) was 0.951, 0.970, 0.985 in the order of 45deg, 50deg, 55deg.

CONCLUSION: As a result of this study, very high reliability was observed for all three inclination angles. Reliable measurements could be performed at any angle in the TEFT. It will be suggested that one trial is sufficient so that the ICC (1, 1) was highly reliable. The holding time was the shortest at 45deg and the longest at 55deg. It may be too long to conduct this test at 55 deg as a physical fitness test. Further research will be needed to determine the validity of each angle.

EXERCISE, NEUROMUSCULAR ELECTRICAL STIMULATION AND THERMAL THERAPY COMBINATION EFFECTS ON PATELLO-FEMORAL PAIN

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INTRODUCTION: Patellofemoral pain (PFP)is a common musculoskeletal disorder of the knee. PFP causes knee pain, quadriceps strength loss and impaired motor performance. Neuromuscular electrical stimulation (NMES) is currently used to improve muscle strength and rehabilitation medicine to restore muscle properties. Superficial heat treatment is one of the most widely used physical therapies for knee injuries. The aim of this study was to assess the efficacy of superimposed NMES, and heat therapy combined with strengthening exercises to improve the recovery of quadriceps strength and function in patients with PFP.

METHODS: A single-blind randomized controlled trial was performed with 10 patients who diagnosed with PFP. After baseline testing, patients randomized to two groups: group A; NMES with strengthening exercises, Group B; Combined NMES/Heat therapy with strengthening exercises. The patients in both groups were treated 3 times a week for 4 weeks.

The primary outcome measure was quadriceps muscle strength over 4 weeks. The secondary outcomes were physical function performance and knee pain. The primary analyses used repeated measures, linear mixed mixed-effects models with a random effect for subject, time as a continuous variable, group as a categorical variable, and a group and time interaction to test for differences in change over time among the groups.

RESULTS: Both groups improved in quadriceps muscle strength and forward step-down test in the PFP limb over the 4 weeks period. The group B (NMES/Heat therapy) improved to a greater extent than the group A in the quadriceps muscle strength, but no significant group differences in forward step-down test.

CONCLUSION: After NMES, Heat and strengthening exercises for 4weeks, we found improvements in quadriceps muscle strength and physical function performance.

EFFECTIVENESS OF A SOFTWARE-BASED REHABILITATION METHODOLOGY FOR SHOULDER INJURIES. A PRELIMINARY STUDY.

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INTRODUCTION: Sports-related shoulder injuries represent a challenge for clinicians because of the large variety of clinical entities involved and the broad anatomic structures that can be affected. Furthermore, commonly performed orthopaedic tests have demonstrated limited accuracy for diagnosing the injury despite considerable research efforts. Clusterization of tests has been demonstrated to improve diagnostic accuracy[1]. The aim of this study was to describe a comprehensive injury management software prototype integrating both a clinical- and functional cluster -based diagnostic and adapted rehabilitation prescription. Preliminary clinical effectiveness reports were also analysed.

METHODS: A longitudinal cohort study was performed recruiting up to 31 participants (18 male; 13 female). After the medical diagnosis and any requested supplementary evaluations (i.e., radiological examinations) were made, the participants were evaluated before and after the rehabilitation program by using a previously published evaluation model for shoulder injuries [2]. A comprehensive functional and clinical screening testing battery was recorded in the REHABI software prototype. Using an artificial intelligence decision-making scheme, the identified functional deficits were used to customize the individual rehabilitation plan of every participant. A deficit-based disability score was developed to monitor patient recovery rate. Descriptive statistics were calculated and paired (pre -post) T-Test executed in order to determine significance ($p< 0.05$) differences from pre to post rehabilitation evaluations. Phyton software was employed for statistical analysis.

RESULTS: The disability score was significantly reduced (7.5±3.6 points Pre; 3.6±2.2 points Post; $p<0.0001$) during the rehabilitation process. There was a mean of 31,7± 79.7 % reduction across all the patients.

CONCLUSION: It seems that the employment of a cluster based functional and clinical shoulder evaluation and rehabilitation prescription model by the use of the REHABI software is effective for sports related shoulder injuries. The wide SD value for the overall mean % of improvement may be related to the non-estructural injury specific profile of the patients recruited for this study.

T2 HAMSTRING MUSCLE ACTIVATION DURING THE SINGLE-LEG ROMAN CHAIR: IMPACT OF PRIOR INJURY

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INTRODUCTION: The single-leg Roman chair exercise has recently been proposed as a hamstring exercise that may be effective for prevention and during the rehabilitation of hamstring injuries [1, 2]. However, the activation of the individual hamstring muscles during the single-leg Roman chair hold remains largely unknown. Knowledge about the preferential activation of different muscles during this exercise may help practitioners with more effective exercise prescription. Specifically, in case of previous injury, the BFlh has demonstrated to be subject to neuromuscular inhibition, leading to lower levels of activation during exercise compared to the non-injured status. This inhibition might be present up to up to 18 months post injury despite individuals training and competing at pre-injury levels [3 – 5]. Although this inhibition may initially be beneficial to protect the injured tissue from further damage, it might also reduce the force production and hence adaptations to training on the long-term, which in turn may compromise performance and increase the risk of re-injuries [5]. Previous studies have shown inhibition of previously injured hamstrings during eccentric exercises, but it is unknown whether this effect is also present during an isometric position-control exercise such as the single-leg Roman chair hold (SLRCH). This cross-sectional study therefore investigated muscle activation during the SLRCH in individuals with a prior hamstring injury. Muscle activation was assess using the transverse relaxation (T2) time for the biceps femoris long and short heads (BFlh, BFsh), semitendinosus (ST), semimembranosus (SM), and adductor magnus (AM) and compared within and between legs. Muscle cross-sectional area was also investigated. T2 times increased for all muscles, except for the AM in both legs.

METHODS: This study used a repeated-measures design to investigate hamstrings muscle activation during the single-leg Roman chair exercise. Muscle activation during the exercise was investigated by determining differences in the exercise-induced increases in the transverse (T2) relaxation time after the exercise. All tests were performed within a period of approximately 6 months in the MRI department of the Catholic University of Valencia.

RESULTS: In both legs, the ST showed a larger increase in T2 time compered to all other muscles. The BFlh showed a smaller increase in T2 time in the injured leg as compared to the uninjured leg, while there were no differences between legs for other muscles. Muscle cross-sectional area did not differ between the legs.

CONCLUSION: Overall, the ST is preferentially activated during the SLRCH in both the uninjured and injured leg, and the BFlh in the previously injured leg was activated less compared with the uninjured leg, despite no differences in muscle cross-sectional area.

ISOKINETIC STRENGTH PROFILE OF THE ROTATOR MUSCLES OF HIGH-LEVEL BOXERS

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INSEP

INTRODUCTION: The practice of high-level boxing repeatedly strains the shoulder [1,2] and few studies have explored the isokinetic profile of the rotator muscles of the boxer. Our objective was to describe and compare isokinetic muscle profiles of the shoulders of high-level boxers by laterality and gender.

METHODS: A total of 14 male (age = 21 ± 1.9 years, height = 180 ± 10 cm, mass = 68 ± 12 kg) and 5 female (age = 19 ± 0.7 years, height = 167 ± 7.1 cm, mass = 57 ± 5.1 kg) of the French Boxing Team took part to this cross-sectional study. A clinical examination and a bilateral shoulder isokinetic test were carried out for all the athletes of the French Boxing Team as part of the annual medical check-up. The muscle strength of the internal rotators (IR) and external rotators (ER) of the shoulder were measured on an isokinetic dynamometer (Biodex system 4, Biodex Medical Systems, New York, USA) in the concentric mode at 60°/s and 180°/s, and the eccentric mode at 60°/s. The ER : IR concentric ratio at 60°/s was also calculated

RESULTS: The statistical analysis of the data shows in males, a difference between the rear arm and the front arm only on the external rotators in the concentric mode at 60°/s (0.53 ± 0.08 vs. 0.50 ± 0.07, P = .03). For females, this trend is also apparent with a rear arm stronger than the front arm, but only at the 10% threshold. When comparing the ER : IR concentric ratio at 60°/s between men and women, significant differences were observed in the rear arm (0.63 ± 0.10 vs. 0.85 ± 0.14, P = .002) and the front arm (0.61 ± 0.09 vs. 0.80 ± 0.12, P = .005).

CONCLUSION: The isokinetic profile of high-level boxers, men and women, appears to be symmetrical between the rear arm (considered as the dominant one) and the front arm, with the possible exception of the external rotators peak force in the concentric mode at 60°/s, which is higher on the dominant side. On the other hand, there are differences in muscle profile between men and women, with a ER : IR concentric ratio at 60°/s, significantly higher in women than in men. This difference in muscle profile between male and female boxers should thus be explored in the context of certain shoulder diseases.

Psychology

DEVELOPMENT OF SPORTS TEAM GRATEFUL CLIMATE QUESTIONNAIRE

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Gratitude has been conceptualized as an emotion, mood, or affective trait that has consistently positive effects on individuals thoughts and actions. Although most studies follow a conventional approach to studying gratitude at the individual level, gratitude can also be conceptualized at a level beyond individuals. Developing a measurement of grateful climate is an essential step to examining the function of a grateful climate in a team or group context. Accordingly, the purpose of this study was to develop a valid and reliable measure of the grateful climate of sports teams. This study used multilevel confirmatory factor analysis to evaluate the factor validity of the Sports Team Grateful Climate Questionnaire using a sample of 431 adolescent athletes from 56 teams in Taiwan. In addition, nomological validity and incremental validity were also examined in this study. The results indicated that the 9-item Sports Team Grateful Climate Questionnaire has good convergent validity, nomological validity, and incremental validity. This scale can be a useful tool for future empirical studies aiming to better understand the grateful climate and identify the role of the grateful climate in sports teams.

COMPARATIVE ANALYSIS OF BREATHING THROUGH BODY MOVEMENT

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Introduction

The hot issue these days, living in the age of 100 years of health, is about the body. Mental health is just as important as physical health. From this point of view, breathing, which connects the body and mind, is very important. This study aims to examine breathing through the movement of the body and what role it plays in human physical health and mind.

Methods

This study focuses on Pilates, which is popular as a rehabilitation exercise for the purpose of rehabilitation treatment and injury prevention, and attracts social attention from many people, and the breathing method of Korean dance, which is said to express Korean emotions. As for the research method, first, theoretical considerations were made by analyzing previous studies on respiration and health, and then the researcher directly observed the movements of teachers who teach Pilates and Korean dance to derive the results. The verification of the results was performed through triangular verification by 5 experts and research subjects.

Results and discussion

Pilates is an exercise method that relaxes and strengthens the body at the same time, helping you to accurately recognize and control your body. In particular, it strengthens flexibility and muscle strength around the spine, which is the center of

the body, and stabilizes the symmetry of the body up, down, left, and right with exercises that increase balance and stability of the body to maintain balance. Pilates breathes using the lower abdomen, and when exhaling, the lower abdomen must be strongly tightened to help prevent the face and spine from collapsing backwards. By doing so, the waist is not overburdened and the lower abdomen is pulled up to supply enough oxygen to the entire body and torso.

On the other hand, breathing in Korean dance takes the form of Danjeon breathing based on the principle of inhaling and exhaling to empty the lower abdomen. In Korean dance, most of the movements are by bending the lower body. When this movement is performed, breathing is exhaled, and the process of returning to the normal position is a state of breathing in.

Comparing these two exercises, Pilates makes the core muscles elastic and uses a breathing method that purifies the inside of the body to relax and release the tense state of the body. In addition, there are effects such as concentration, control, precision, stability, and body alignment through breathing, which are the basic principles of rehabilitation treatment.

In this way, if Pilates is more focused on maintaining the external health of the body, Korean dance can be seen as affecting mental health, which is an internal flow. In Korean dance, breathing determines the quality of dance movements and expresses the unique style and resentment of Korean dance. Breathing has the meaning of simple oxygen supply for humans to breathe and maintain life, but Korean dance helps peoples mental stability by expressing human thoughts and emotions as they are through breathing.

SELF-PRESENTATION MOTIVES, SELF-CONCEPT AND THEIR RELATIONSHIP WITH THE INTENTION TO BE PHYSICALLY ACTIVE IN HIGH SCHOOL STUDENTS

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Introduction

Knowing the main reasons why people start or choose to carry out a certain activity, such as physical exercise or sport, as well as the factors that determine the permanence or abandonment of this choice (Varela et al., 2011) is important to contribute to the creation of physical exercise programs that counteract sedentary lifestyle in the population. Leary and Kowalski (1990) theorized that self-presentation (or impression management) is the process by which people attempt to influence and control the impressions others have of them. The aim was to identify the relationship between self-presentation and self-concept with the intention of being physically active.

Methods

689 high school students aged 11 to 15 years old, and of both sexes participated. (307 boys and 319 girls), who answered the booklet of questionnaires that measure the variables in question.

Results

Spearmans rho correlation matrix showed that the intention to be physically active was significantly associated with impression motivation (rho= .44; p =.000), and with impression construction (rho= .27; p = .001), but it was not significantly associated with self-concept (rho= -.08; p = .06).

Conclusión

There are behaviors and motivations that drive young people to practice or abandon physical exercise; while the way in which young people perceive themselves does not have a significant influence. So the desire to create an impression in others that oneself performs physical exercise, as well as the behaviors used to affect the impressions that others have about them (eg, running faster when another sees them or accompanies them) makes the young people want to be physically active. It is supported that self-presentation is an essential part of interpersonal behavior, since self-image can influence how each person is valued and treated by others (Leary & Kowalski, 1990).

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SYMPATHETIC AND PARASYMPATHETIC CHANGES IN ARCHERS AFTER A COURSE OF BIOFEEDBACK TRAINING

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Introduction

The autonomic nervous system has two main branches: the sympathetic nervous system, which is responsible for preparing the human body for action in times of danger and stress, and the parasympathetic nervous system, which regulates the resting state of the body. In this regard, biofeedback training can adjust these systems.

Methods

The method of the present study was quasi-experimental with pretest-posttest design with control group. The participants of the present study were 15 of the best archers in Tabriz. Statistical samples were selected as available and randomly assigned to experimental (n = 8) and control (n = 7) groups. The amount of sympathetic and parasympathetic changes of participants in the test stages (pre-test, post-test 1 and post-test 2) were recorded and measured through a biofeedback device that included breath, heart rate, galvanic and skin temperature. The duration of biofeedback intervention in the experimental group was 20 sessions, which began with breathing exercises, then HRV training and then skin temperature and galvanic exercises were added, respectively. Both groups practiced archery and the experimental group did biofeedback training in addition to archery exercises. Research data were analyzed using descriptive and inferential statistical methods including analysis of variance with repeated measures and using SPSS software version 26.

Results

The findings in the two control and intervention groups were descriptively different and analytically they reached the significant limit in some cases, the results were in skin conductivity (P=0.07) and heart rate (P=0.1). Also, the mend of the intervention group after stress (recovery) reflected by the parameters of skin conductance response, high frequency of heart rate and low frequency of heart rate in the intervention group was more favorable than the control. For the skin conductance response, the reduction of about (0.11 Usiemens) and for the LF/HF ratio of the heart beat frequency values of about (1-1.5) were obtained.

Discussion

The results showed that the changes of the obtained parameters indicate sympathetic and parasympathetic activity, which were descriptively. It can be concluded that biofeedback training help the athletes to recover better from the sympathetic arousal caused by tensions, in addition, the combination of sympathetic and parasympathetic, especially in the cardiovascular scale, is more optimum in archers trained by biofeedback, so they Physical and mental physiological point of view will have better flexibility and restoration and all these things can lead to better performance of athletes.

INFLUENCE OF LOWER-LIMB MUSCLE STRENGTH ON NEURAL OSCILLATIONS DURING RESPONSE PREPARATION IN COGNITIVELY HEALTHY ELDERLY ADULTS

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Introduction

Previous research has linked lower limb muscle strength to cognitive slowing in healthy elderly adults. However, it is not well understood whether this cognitive decline is related to the development of response preparation prior to motor execution. Therefore, the aim of this study was to explore the cognitive and neural mechanisms underlying the relationship between lower limb muscle strength and response preparation in elderly adults.

Methods

This study included 40 cognitively healthy elderly adults with higher (n = 20; male = 11; aged 70.40 ± 5.15 years) and lower (n = 20; male = 9; aged 71.50 ± 4.98 years) levels of lower-limb muscle strength. The muscle strength of the gastrocnemius and quadriceps femoris was assessed using manual muscle tests (MMT) conducted by experienced physical therapists. The participants completed a choice reaction time (RT) task with variable foreperiods (500ms and 1500ms) while their brain activity was recorded using electroencephalography (EEG). To measure their lower limb RTs, the participants were asked to press pedals with the corresponding foot in response to the task.

Results

The behavioral results showed that elderly adults with higher levels of lower-limb muscle strength had faster RTs than those with lower levels, regardless of the length of the foreperiod. Time-frequency analysis of EEG data revealed that those with greater lower-limb muscle strength had stronger beta power modulation in central brain areas during the preparatory period compared to those with lower muscle strength, particularly in the longer foreperiod condition.

Discussion

The results suggest that lower limb muscle fitness may be associated with faster motor execution of the lower-limbs under different levels of temporal uncertainty. The weaker beta oscillation observed in elderly adults with poorer lower-limb muscle strength may indicate less efficient preparation for a response during longer foreperiods. In conclusion, maintaining good lower-limb muscle strength may be important for establishing optimal processing for responding, particularly for speeded tasks, in elderly adults.

PREDICTORS OF COPING AMONG COLLEGE ATHLETES WITH CAREER CHOICE STRESS

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INTRODUCTION: Due to college athletes' long-term focus on sports training and competition and their reliance on sports excellence-based programs to enter college without having to take the academic entrance exam, they generally have poor academic performance. Compared with college students, college athletes are often faced with learning difficulties, as well as a lack of career exploration and decision-making abilities. To maintain training effectiveness in sports, most college athletes take advice from their coaches and parents on decisions related to pursuing further studies. They have

relatively few opportunities to make decisions on their own, and their career decision-making experience is also insufficient. Due to the above-mentioned problems, many college athletes not only face more career decision stress but also choose to cope with the stress in a negative way, which adversely impact their subsequent career development. Coping refers to the cognitive and behavioral efforts of individuals in dealing with internal or external needs that exceed their own resources. The coping response that individuals adopt when they face external stress is regarded as one of the important elements influencing emotions and well-being.Past studies have investigated individuals' coping and influential factors from a holistic approach but have rarely explored the impact of specific stressors on the coping of individuals. Therefore, the results of the present study can expand the breadth and depth of academic research in the field of coping.

METHODS: This study explores the relationships between social support, career decision-making self-efficacy, negative mood regulation expectancies, and how college athletes cope with career decision stress. In total, 1,312 valid questionnaires were returned. The data obtained were statistically analyzed using structural equation modeling.

RESULTS: The results showed that social support was positively related to career decision-making self-efficacy(ß =.52, $p < .001$), negative mood regulation expectancies (ß =.35, $p < .001$), and coping(ß =.13, $p < .001$). Career decision-making self-efficacy was positively related to negative mood regulation expectancies(ß =.37, $p < .001$) and coping(ß =.71, $p < .001$). Negative mood regulation expectancies were positively related to coping(ß =.18, $p < .001$). In addition, The Sobel's test showed that career decision-making self-efficacy mediated an indirect relationship between social support and coping ($z = 6.94$, $p < .01$) and that negative mood regulation expectancies mediated an indirect relationship between social support and coping ($z = 5.72$, $p < .01$)

CONCLUSION: The findings indicated that social support, career decision-making self-efficacy, and negative mood regulation expectancies have direct or indirect relationships with college athletes' cope with career choice making stress. These findings suggest that career supports are required to provide athletes with assistance to improve their career decision-making self-efficacy, and subsequent career behaviors. In addition, enhancing career decision-making self-efficacy will help college athletes cope with career stress in a more positive way. Individuals with more positive negative mood regulation expectancies are more resistant when faced with and stress and will also adopt a more optimistic coping toward career decision making problems.

THE INFLUENCE OF ATHLETES IRRATIONAL BELIEFS AND PERFECTIONISM ON COMPETITIVE ANXIETY

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Introduction

In this research, we investigated the influence of irrational beliefs (demandingness, awfulizing, low frustration tolerance, depreciation) and perfectionism (adaptive and maladaptive) on competitive anxiety (cognitive and somatic) in Hungarian amateur and professional athletes. Previous studies have shown that irrational beliefs are able to predict the emergence of competitive anxiety. Furthermore, greater irrational beliefs have been linked to greater perfectionism as well. The association between irrational beliefs and perfectionism and their combined effect upon anxiety has not been investigated in sport contexts. Hence, we hypothesized that the influence of irrational beliefs on competitive anxiety is mediated by perfectionism.

Methods

Competitive anxiety (CSAI-2), irrational beliefs (iPBI) and perfectionism (SAPS) were measured by questionnaires in 219 Hungarian athletes. We ran the descriptive statistics and Pearson intercorrelations of all the normal distributed variables using IBM SPSS program. Hayes model 6 was used to test the direct and indirect effects of irrational beliefs and perfectionism on competitive anxiety.

Results

In serial atemporal multiple mediation analysis, we found that both adaptive and maladaptive perfectionism have a significant partial mediator role in the relationship between irrational beliefs and competitive anxiety. Both the total irrational beliefs score and the four subscale scores have direct and indirect effects on cognitive competitive anxiety where adaptive and maladaptive perfectionism playing a mediator role. Depreciation beliefs had a direct, demandingness and awfulizing had an indirect effect on somatic competitive anxiety when both forms of perfectionism were mediators.

Discussion

These findings support our hypothesis that irrational beliefs and perfectionism are influence on the emergence of competitive anxiety in Hungarian athletes. Overall, athletes who set dogmatic standards for themselves and are not able to handle frustration, tend to awfulizing and disparagement themselves face greater competitive anxiety. The following process is influenced by perfectionist traits such as overly high expectations and a disproportionate focus on mistakes. The obtained findings have important practical application for sport psychologist because based on our results rational emotive behavior therapy (REBT) may be an effective intervention to reduce perfectionism and competitive anxiety in athletes, the specific effectiveness of this intervention with athletes requires further longitudinal research.

ANALYSIS OF PSYCHOLOGICAL EVALUATIONS IN ACADEMIES OF FOOTBALL ELITE

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Abstract

The use of science and technology applied to sports demands the investigation of effective methods and techniques that allow the increasingly necessary improvement of sports training and the inclusion and participation of the psychologist as a permanent demand and tool in team sports. Today the tactical preparation, its control and evaluation form in the sports training process is recognized as the first step to develop and improve in teams of 1st category in Mexico and the world, as well as the psychological preparation, imbued within the tactical preparation, that is why the great sports potencies in the world are currently striving to optimize this important process of preparing the athlete. Sports psychology has developed and consolidated its presence in the entire field of competitive sports practice. This science acts in the individual and group aspect, teaching the athlete to eliminate negative thoughts or to use concentration techniques, in addition to making the smartest decision at the most suitable moment. Sports Psychology nourishes from the sources of Social Psychology for the necessary explanation of these phenomena considering the background and development of social thinking (Predvechni and Sherkovin, 1986).

Method

The evaluation consisted in the application of a battery of psychological variables tests, which were applied in January and April 2019 to four categories of the Football Club. 11 psychological constructs were evaluated in total, its descriptive statistics were calculated according to category (U20 - U17 - U15 - II) and the moment of application (T1 and T2). Likewise, the changes in the psychological variables were analyzed according to the moment of application, the prediction of burnout and satisfaction with the life of T2 was analyzed based on the interpersonal styles of the coach generated in T1.

Results and Discussion

According to the results of the study both in the comparisons by variables, times (T1 and T2) and categories, it is important to act in a brief form in the sub-20 and second division categories, since they are at risk of truncating an adequate integral development of the soccer player, predicting a burnout and few intentions to continue with a physically active life as soon as he concludes his stage as professional soccer player.

FINANCE:

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THE MECHANISM AND PREDICTORS BETWEEN MINDFULNESS AND FLOW STATE IN ELITE ATHLETES

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Background: Mindfulness interventions have been proved a benefit to promote flow stated and competitive anxiety in elite athletes. However, few studies explored possible mechanisms between those factors and also less is known about if there is any baseline condition as predictors to predict the better outcomes.

Methods: 40 elite athletes of national level were recruited to participate 4 weeks workshop of Mindfulness Sport Performance Enhancement (MSPE). They were evaluated based on mental health condition (i.e., anxiety, depression, and sleep condition) and the outcome variables were flow state and competitive anxiety (i.e., confidence, somatic anxiety, and cognitive anxiety) at pre- and post-workshop.

Results: We found that trait mindfulness mediated the relationship between all three aspects of competitive anxiety with the flow state, and the cognitive anxiety among them has even reached a fully mediated effect. However, the baseline mental health condition did not reach significance to predict flow enhancement after MSPE.

Conclusion: Our findings suggest the mechanism that competitive anxiety negatively related to flow state via trait mindfulness. The baseline mental health is not a good predictor of MSPE intervention and future research should investigate possible predictors other than anxiety, depression, and sleep condition.

ACTIVE LIFESTYLES CONTRIBUTE TO MENTAL HEALTH IN HEALTHY YOUNG MALES

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INTRODUCTION: Daily lifestyle habits play an important role in maintaining mental health. In order to improve quality of life in the future, it is necessary to identify the lifestyle habits that are essential for maintaining mental health. Adequate physical activity (PA) can contribute to the primary prevention of mental disorders. In this study, we investigated the characteristics of the daily habits of individuals with positive mood states, with a particular focus on PA.

METHODS: Twenty-two physically and mentally healthy young males (18-25 years, body mass index (BMI) 23.0 ± 2.7) participated in this study. They completed the Profile of Mood States (POMS) questionnaire before and after the 4-week

measurement period. The Total Mood Disturbance (TMD) score for the negative mood state was calculated from the POMS results. To measure daily PA during the period, subjects wore triaxial accelerometers every day. The measured PA was categorised by intensity as follows: sedentary behaviour (1.0 metabolic equivalent (MET) ≤ x < 1.5 METs), light-intensity PA (1.5 METs ≤ x < 3.0 METs), moderate-intensity PA (3.0 METs ≤ x < 6.0 METs), and vigorous-intensity PA (≥ 6.0 METs). Resting metabolic rate was measured by indirect calorimetry after an overnight fast. Habitual food intake was assessed by a brief self-administered diet-history questionnaire. Pearsons correlation analysis and stepwise multiple regression analysis were performed to examine the relationship between changes in TMD score and lifestyle habits over a 4-week period. A statistical level of $p < 0.05$ was accepted.

RESULTS: Fourteen of the 22 participants showed increased TMD scores over the 4-week measurement period. Daily PA was significantly associated with changes in TMD scores. Changes in TMD scores were positively correlated with energy expenditure during sedentary behaviour ($r = 0.506$, $p = 0.016$) and negatively correlated with energy expenditure during moderate-and vigorous-intensity PA ($r = -0.544$, $p = 0.009$), adjusted for total energy expenditure. These results suggest that individuals who are more physically active feel more mentally positive than individuals who are less physically active. Energy expenditure during sedentary behaviour and moderate-and vigorous-intensity PA independently influenced changes in TMD scores (adjusted $R2 = 0.444$, $p = 0.001$). Sleep duration and food intake were not associated with changes in TMD scores in this study, however.

CONCLUSION: Physically and mentally healthy young males with more sedentary behaviour experienced negative feelings, whereas those with more moderate-and vigorous-intensity PA experienced positive feelings. Replacing sedentary behaviour with moderate-to-high levels of PA may help to improve mental health. Given that the explanatory power of the regression model for changes in TMD scores was 44.4%, more detailed research on other lifestyle factors such as diet and sleep is needed.

DOES FEAR OF FAILURE CONSISTENTLY NEGATIVE? PSYCHOLOGICAL FLEXIBILITY INHIBITS THE NEGATIVE EFFECT OF FEAR OF FAILURE ON SPORTS PERFORMANCE.

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NATIONAL TAIPEI UNIVERSITY OF TECHNOLOGY

Introduction

Fear of failure is an aversive emotional response of fear or worry when an individual targets internal standards or goals and fails to achieve them (Conroy & Elliot, 2004). Existing studies take a negative view of fear of failure on performance because fear of failure causes athletes to overanalyze situations and drain individual cognitive resources, leading to lower performance. However, whether fear of failure is negative for all athletes or whether athletes with specific characteristics can attenuate this negative effect is unclear. Based on the Cognitive-motivational-relational (CMR) theory, we argued that psychological flexibility would inhibit the negative effect of fear of failure on sports performance because athletes with high psychological flexibility can keep their attention resources at the target even if they perceive the feeling of fear without getting caught up in it. Psychological flexibility, identified as willingness to contact undesirable thoughts and feelings while acting in a manner congruent with values and goals (Hayes, Luoma, Bond, Misuka, & Lillis, 2006). As such, we expect that only athletes with lower psychological flexibility would be more likely to feel insufficient cognitive resources and unable to respond to situational demands, thus reducing sports performance.

Methods

The present research used a two-wave longitudinal design to examine our hypothesis. We recruited 362 athletes (243 male and 119 female athletes) aged 16 to 18 years old (M age= 16.78, SD = 0.48). At Time 1, we administered the athlete questionnaires (The performance failure appraisal inventory, Personalized Psychological Flexibility Index, subjective performance, and demographics). Six months later (Time 2), the athletes were asked to complete the questionnaires on subjective performance a second time. The participants complete the survey in person. The time interval was chosen to accommodate the athletes' schedules.

Results

The result supports our hypothesis that fear of failure has negatively correlated with their subjective performance. To understand whether psychological flexibility would weaken the adverse effects of fear of failure, we examine the interaction between fear of failure and psychological flexibility. We found that while controlling for subjective performance at Time 1, fear of failure was negatively associated with subjective performance at Time 2 for low levels of psychological flexibility. We also found that fear of failure did not reduce subjective performance at Time 2 for high levels of psychological flexibility.

Discussion

The primary contribution of this study is identifying psychological flexibility as a moderator of associations between fear of failure and sports performance. Practically, coaches can therefore utilize different approaches to help athletes regulate their emotions to improve performance based on the athletes characteristics (i.e., psychological flexibility).

PREDICTING LEISURE-TIME PHYSICAL ACTIVITY (PA) LEVEL IN UNIVERSITY OF ZAGREB STUDENTS USING THEORY OF PLANNED BEHAVIOR (TPB) AND SELF-DETERMINATION THEORY (SDT) BASED CONSTRUCTS

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UNIVERSITY OF APPLIED HEALTH SCIENCES

Introduction

Importance of physical activity in psychophysical health preservation is well established, and increasing physical activity level of insufficiently active student population should be goal of public health actions. For them to be efficient, it is necessary to determine all factors, including psychological, that are related with physical activity level.

The aim of this study was to determine relationship between theory of planned behavior (TPB) and self-determination theory (SDT) based constructs and student leisure-time physical activity.

Methods

Participants were 1304 University of Zagreb students (857 female, 447 male), average age 20,72 years. Croatian version of IPAQ (Pedisic et al., 2011), which measures adult PA, and Croatian version of EMI-2 (Vlasic et al., 2002), which measure 14 exercise motives, were used. Using factor analysis, 3 higher order factors were extracted (psychological, social and health exercise motives). Also, The Locus of Causality for Exercise Scale (Markland and Hardy, 1997), which consists of 3 items that assess the extent to which individuals feel that they choose to exercise rather than feeling that they have to for some reason, and Theory of planned behavior questionnaire regarding physical activity, created for the purpose of this research, were used.

Results

Regression analysis showed that predictor variables (psychological, social and health exercise motives, locus of causality for exercise, and TPB variables – intention to be physically active, attitudes toward physical activity, subjective norms of physical activity participation, perceived control of physical activity) explain 13,5% of student leisure-time physical activity variance ($p<0,01$). All predictor variables, except for attitudes toward physical activity and subjective norms of physical activity participation, proved to predict student leisure-time physical activity significantly.

Conclusion

Understanding students motivation differences with regard to their leisure-time PA is really important when it comes to creating intervention programs that aim to increase student population PA. The results show that different theory approaches to physical activity motivation should be considered when creating such programs.

Key words: physical activity, students, leisure.time, psychological factors

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EXPLORING NEGATIVE EFFECTS OF STEREOTYPE THREATS FROM PERSPECTIVES OF SCHOOL BELONGING AND ACADEMIC AVOIDANCE STRATEGIES

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Introduction

Recent studies have demonstrated that negative stereotypes about the academic performance of athletes (e.g., the "dumb jock" stereotype) negatively affect their academic performance, attitudes, and career planning outcomes. In addition, preliminary intervention studies have reported that small-scale social psychological interventions (e.g., identity security intervention and self-complexity intervention) benefit student-athletes. In addition to impairing performance, stereotypes also deflate motivation prior to athletic performance. Thus, the present study aimed to explore the relationship among stereotype threat, school belonging, and avoidance strategies and to examine their influence on the academic values and career-related opinions of athletes. Furthermore, a subgroup analysis by age was conducted.

Methods

In total, 399 valid questionnaire responses were collected from a sample of student-athletes, including 174 senior high school students, 118 first- and second-year university students, and 107 third and fourth-year university students. The participants of the present study all completed a questionnaire that measured their perceptions of stereotype threat, school belonging, avoidance strategies, academic values, and career aspiration.

RESULTS: The results indicated that student-athletes in different academic stages had different perceptions. With regard to the participant's perception of stereotypes, the participants indicated that they were stereotyped more by their peers than by other individuals. Furthermore, senior students (i.e., third and fourth-year university students) were more prone than senior high school student-athletes to adopting avoidance strategies (self-handicapping, avoiding help-seeking, and

avoiding novelty). Finally, the regression results indicated that school belonging and avoidance strategies partially mediated the relationships of stereotype threat with academic values and career aspiration.

Discussion:

The results of the present study are consistent with those of other studies, suggesting that negative stereotyping can limit the self-confidence and future development of athletes or cause them to lose interest in exploring other careers. In addition, the negative effects of stereotype threats may influence athletes by reducing their level of school belonging and increasing their proclivity toward adopting avoidance strategies. A long-term application of such strategies harms academic performance and results in interrupted education. Through an investigation of the experiences of athletes, key insights that facilitate the development of academic and career consultation for athletes can be obtained. Future studies should focus on issues of school belonging and avoidance strategies to help schools foster more conducive environments for athletes.

FACTORS FACILITATING AND HINDERING THE MOTHER ATHLETES' SOCIALIZATION PROCESS

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Introduction

The participation of women athletes in world-class competitions has increased significantly. Specific conditions other than pregnancy and childbirth might hinder mother-athletes' involvement in athletics. However, only a few studies have investigated mother athletes, especially their participation as elite athletes, unlike "father athletes." The purpose of this study was to explore systems supporting mother-athletes' socialization after pregnancy and giving birth.

Method

We conducted semi-structured interviews that asked two main questions: (1) What triggered you to be a mother-athlete? (2) What are the critical physical, social, and psychological episodes of this process? We selected two study participants based on the following criteria: (1) competed in the Japanese National team at international competitions or played as a Professional (2) returned to athletics after pregnancy, birth, and childcare. Participant A, who was in her 30s, had a planned pregnancy and birth and returned to athletics after giving birth. Participant B, also in her 30s, had a natural pregnancy and birth and returned to athletics after giving birth. We conducted interviews twice with each participant and analyzed all the responses by referring to Trajectory Equifinality Model (TEM). We anonymized the participant's sport, the age at pregnancy, and the interview date to protect their privacy.

Results

In the physical, social, and phycological processes of becoming a mother athlete, we identified eight shared facilitating factors and nine individual facilitating factors. In contrast, we identified three shared hindering factors and seven individual hindering factors. Examples of shared facilitating factors include (1) gynecologist, (2) family and partner, which is triple counted within the three criteria, (3) self-acceptance of physical change after birth, (4) pioneering, (5) kids, and (6) social role after birth. Moreover, examples of hindering factors include (1) lack of information after pregnancy, (2) physical change after birth, and (3) role conflicts. These findings suggest that multiple factors are related to becoming a mother athlete and remaining competitive in top-level athletics.

Discussion

This study explored factors related to mother-athletes' socialization during pregnancy, childbirth, and childcare as conditions specific to women and their life plans to remain competitive in their fields as women and athletes. We suggest that future studies include larger samples and develop more comprehensive support systems for mother-athletes' socialization. This study's limitations include not examining the broader context of mother-athletes' socialization and not investigating cultural aspects of socialization. We suggest that future studies compare support systems for athletes in Japan with that for working mothers because several studies have investigated support systems for working mothers.

CLASSIFICATION OF SOMATIC BODY NARRATIVES IN ATHLETES

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UNIVERSITY OF KOKUSHIKAN

Introduction

During counselling, athletes often complain about trouble they are having with movement, performance, and physical discomfort. These body-related complaints are equated (in this study) with the athlete's experienced-body ('body'). Therefore, in this study, 'body' seen as the mediator between mind and body. Classifying body-related narratives in terms of the relationship between mind and body will allow for a better grasp of an athlete's internal experience at a particular moment.

Purpose

The aim of this study was to classify the 'body', as experienced by athletes and described in counselling sessions, in terms of the relationship between mind and body.

Methods

In this study, the cases of two adolescent athletes whose counselling sessions had already been terminated were selected for detailed retrospective analysis. Somatic body complaints (narratives) were extracted from their counselling records and then classified by the first author. This tentative classification was then refined by a group of sport psychologists (triangulation).

Results and Discussion

After analysis, three main types of 'body'(narrative) were found.

1) Complaints suggesting that the conscious mind tries to direct the body, but the body disobeys. For example,

'When my feet hit the ground (while running), I don't want just my feet, but my entire body, including my upper body, to absorb the impact… but my body doesn't respond. My feet alone take the impact and push-off all on their own. To make things worse, my back feet lift off the ground but don't come forward as far as I'd want them to. My arms swing just fine, but my legs lag behind, and my body as a whole gets all out of sync.'

2) Experiencing the body moving as if it has the initiative, while the mind watches from the side lines. For example,

'(While running), my legs are like two sticks with no power at all. I don't even try to fix it... I just go with it. I think, "Oh no, I can't do anything" about it, but I don't stop. I just feel the sensation of not being able to do it, and there's nothing I can do to help. It's like my body is being moved along by some outside force .'

3) Experiencing somatic body symptoms that are treated as if they have nothing to do with the mind. For example,

'I try to get ready for practice and go from my room to the practice field. It's fine up to that point. But when I open the door, my body starts to feel strange. My legs become stiff, and I can't even stand. I start breathing faster and faster, and before I know it, I'm hyperventilating…'

Athletes' complaints about their bodies express their internal states (the relationship between their mind and body). Furthermore, the body, which is experienced at the image- level, intervenes with these complaints. Therefore, during counselling it is necessary to pay attention to the narrative presence of the body, which mediates between the mind and body.

EFFECT OF PROLONGED SITTING ON COGNITIVE FUNCTION: A RANDOMIZED CROSS-OVER TRIAL TO TEST THE MODERATING EFFECT OF INTERMITTENT EXERCISE

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1. KYUSHU SANGYO UNIVERSITY, UNIVERISTY , JAPAN; 2. UNIVERSITY OF NORTH CAROLINA, USA; 3. NATIONAL INSTITUTE OF FITNESS AND SPORTS IN KANOYA, JAPAN

Introduction

The limited number of studies investigating: (i) the effect of acute prolonged sitting on executive function; and (ii) the moderating effect of breaking-up prolonged sitting on the aforementioned have reported inconsistent findings[1,2]. Therefore, we tested the hypothesis that: (i) executive function will be reduced following 3 hours of uninterrupted sitting; (ii) executive function will be preserved when the 3 hour sitting is broken-up by performing 1 min of half-squat exercises every 20 min.

Methods

For this randomized cross-over trial, twenty inactive participants (45% women, 21±1 years) completed two 3 h sitting conditions: (i) uninterrupted (CON); and (ii) interrupted with 1 min bodyweight half -squats every 20 min (EX). Executive function was measured using the color word Stroop test (CWST) and Trail Making Test-B (TMT-B). The felt arousal scale was used to assess arousal level. Mental fatigue, concentration, and motivation were assessed using visual analogue scales, labeled from 0 mm (not at all) to 100 mm (extremely).

Results

For the congruent and neutral tasks, the interaction, time, and condition effects were non-significant ($P>0.05$). There was a significant interaction effect ($P=0.01$) for incongruent task, with completion time increasing (worse) by 4.2% for CON and decreasing (improved) by -3.5% for EX. There was a significant interaction effect ($P=0.04$) for TMT-B, with completion time increasing (worse) by 3.3 sec for CON and decreasing (improved) by 3.8 sec for EX. In both conditions, the arousal level significantly decreased by -21.7% for CON and by -4.9% for EX condition (time effect: $P=0.01$). The mental fatigue increased by 285% for CON and 157% for EX with a significant interaction effect ($P=0.04$). Similarly, the concentration decreased by -28.7% for CON and by -9.2% for EX with a significant interaction effect ($P=0.048$). Motivation also significantly decreased by -27.9% for CON and by -17.1% for EX in both conditions (time effect: $P<0.001$).

Discussion and conclusion

Compared to the uninterrupted condition, breaking-up prolonged sitting with intermittent half-squats had favorable effects on executive function, arousal, concentration and mental fatigue. The half-squat strategy was chosen because no equipment is necessary, and skill level requirements are minimal. Additionally, the activity can be performed in-place, meaning the environmental restructuring is not needed. Considering the promising findings, further study is warranted to determine whether this strategy can be feasibly implemented within home, schools and work settings.

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EMOTIONAL INTELLIGENCE AND SELF-ESTEEM: UNIVERSITY STUDENTS WITH DIFFERENT CULTURAL AND SPORT CONTEXTS

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Introduction: Emotional Intelligence (EI) has been understood as the set of responses to intrapersonal emotional information, identification, and management of ones own emotions; and interpersonal, recognizing emotions in others and relating to others (Salovey & Mayer, 1990). Self-esteem, understood as the appreciation that each person has about oneself, has been considered to be shaped by culture, emotions, thoughts and experiences (Rosenberg, 1989). The aim of this research was to describe EI in its factors of emotional attention, clarity and repair, and self-esteem in university students; and compare them based on the country (Mexico and Spain), gender and sports practice for competitive purposes. Methods: Participated 423 university students (49% Mexican, 51% Spanish; 66.5% women, 32.3% men, 1.2% non-binary; 17.5% practice competitive sport) with a mean age of 22.83 years. They completed the Trait Meta-Mood Scale (TMMS-24) and Rosenberg Self-Steem Scale (RSE) questionnaires. Results: The comparative analyses were: 1) significant differences in emotional repair, where the university students in Mexico present higher means (Beta = .28); 2) significant differences in emotional attention (Beta = .18) and repair (Beta = .04), when comparing by gender; and 3) when comparing according to the sport practice, significant differences were found in emotional repair (Beta = .43) and self-esteem (Beta = .30), with higher means in those who practice competitive sports. The MANOVA revealed significance in the crossover by country and sport [F(4) = 3.02]. Discussion: The practice of competitive sports seems to interact with the three EI factors and with self-esteem in a differentiated way by country, providing evidence for future lines of cross-cultural research on EI.

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RELATION BETWEEN EXERCISE INTENSITY AND EFFECTS OF ATTENTIONAL FOCI ON PERCEIVED EXERTION

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Introduction

Research has suggested that internal and external attentional foci influence perceived exertion during aerobic exercise. However, some studies have reported no influence of attentional foci on perceived exertion, and no study has taken account for the influence of exercise intensity on the effects of attentional foci. The present study examined whether differences in exercise intensity influence the effect of attentional foci on perceived exertion during aerobic exercise.

Methods

Seven healthy men (mean age, 22.0 ± 1.7 years) volunteered in this study. After an incremental cycling test, they performed 12 cycling tasks (three intensities: 40%, 50%, and 60% maximal oxygen consumption [VO2max] × four conditions; control, internal focus, auditory external focus, and visual external focus) spaced at least 24 h apart. The cycling task began with a warm-up (5 min), followed by the main cycling at 40%, 50%, or 60% VO2max (10 min), and ending with a cooling down period (5 min). In the internal focus condition, the participants were asked to focus on bodily sensations during cycling. In the audio external focus condition, they focused on auditory stimuli and were asked to count the number of times they heard "Dog." In the visual external focus condition, they focused on the front monitor and were asked to count the number of times they saw "Dog." In the control condition, the participants received no specific instructions and performed cycling as they typically did. During the cycling task, perceived exertion was measured five times using the Borg's RPE 6–20 scale: at the end of the warm-up, at 2 min 30 s, at 5 min, at 7 min 30 s, and at 10 min in the 10-min cycling. Two-way mixed linear model 4 × 5 (condition × measurement time) repeated-measures ANOVAs were computed for each exercise intensity to compare the effects of attentional foci on RPE.

Results

For each exercise intensity, the results showed a significant main effect of time ($P < 0.01$) but no significant main effects of condition (40% VO2max, $P = 0.06$; 50% VO2max, $P = 0.73$; 60% VO2max, $P = 0.85$) or interaction (40% VO2max, $P = 0.88$; 50% VO2max, $P = 0.99$; 60% VO2max, $P = 0.77$). Regardless of the attentional foci, the RPE increased during cycling.

Discussion

The results suggest that attentional foci have no effect on perceived exertion during moderate-intensity cycling exercises. This result is inconsistent with those of previous studies. One possible reason is that the cognitive load might be low in the auditory and visual external foci. Therefore, insufficient cognitive load may lead to a decrease in the effect of external focus on perceived exertion. However, considering the P value for 40% VO2max was 0.06, attentional foci might influence perceived exertion during cycling at 40% VO2max. Future studies need to increase the number of participants to clarify the relation between exercise intensity and the effect of attentional foci on perceived exertion.

THE PSYCHOLOGICAL CHARACTERISTICS OF PEAK PERFORMANCE IN TAIWANESE OLYMPIC ATHLETES: A QUALITATIVE STUDY

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Introduction

The peak performance of athletes has always been expected to appear frequently by coaches and players and to clearly understand the nature, appearance, and development control strategies. Gardner (2009) suggests that the studies of athletes' peak performance can help athletes to achieve and maintain the feeling of 'in the zone' and the state of idea performance. In the past, most of the research on the psychological state of peak performance's data was studied by athletes in Western countries. In addition, only few studies recruited Olympic athletes as participants. The psychological state of athletes peak performance might be affected by different competitive levels and cultures, so it is necessary to establish local data to understand the psychological state and characteristics of peak performance of elite athletes in Taiwan, and then provide a basis for subsequent assistance in athletes psychological skills training.

Method

The qualitative research method was used in this study. Participants were 16 Taiwanese elite athletes and 10 coaches who participated either 2016 Rio Olympic Games or 2020 Tokyo Olympic Games. Sixteen athletes won 1 silver medal and 4 bronze medals in Olympic Games. The data was collected through the semi- constructed interview. After received the informed consent, participants were interviewed around 50 to 60 minutes.

Results

The results of the study found that Taiwanese Olympic athletes and coaches reported the following consistent psychological characteristics when athletes experiencing peak performance: high self-confidence, maintaining a normal mindset, full focus and engaging, enjoy the competition, and relax. The important factors affecting the peak performance of elite athletes are: Adequate preparation, support of significant others, completely execute the pre-competition planning, and pre-competition routine.

Discussion

In accord with the previous sport psychology theoretical and empirical literature, this study has found self-confidence, normal mindset, focus, enjoyment, and relax are the crucial elements of peak performance for Taiwanese Olympic athletes. In addition, this study also found the important factors such as preparation, social support, execution of pre-competition plan, and pre-competition routine affect athletes' peak performance. The results provide evidence for the idea that the optimal state for peak performance requires a highly developed ability to identify and then self-regulate a range of cognitive, emotional, and behavioral factors relevant to the individual athlete and the requirements of the competition environment.

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THE RELATIONSHIPS BETWEEN MINDFULNESS, FLOW, CONCENTRATION, AND EMOTION REGULATION IN COLLEGE ATHLETES: A FMRI STUDY

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Introduction

Previous studies indicated that flow, concentration, and emotion regulation are important factors related to athletes' peak performance. In recent years, mindfulness has been used for athletes to improve their psychological skills (Gardner & Moore, 2012). The purpose of this study was two-fold. First, to examine the relationships of mindfulness to flow, concentration, and emotion regulation. Second, Functional Magnetic Resonance Imaging (fMRI) was used to examine the differences between high and low mindfulness college athletes on regions of interest (ROI).

Method

The participants were 201 the Division-I college athletes in Taiwan. They were asked to complete questionnaires which measured mindfulness, flow, concentration, and emotion regulation. In the second phase, 42 participants were recruited in the high mindfulness group (n=21) and the low mindfulness group (n=21) according to their score of mindfulness. All participants received a functional MRI scan after informed consent. The two groups of participants watched instructions and sports field pictures in different situations (motion, neuter).

Results

In terms of the relationships among college athletes' mindfulness, flow, concentration, and emotion regulation, mindfulness was positively related to flow and negatively correlated with anxiety. Mindfulness was not correlated to concentration. Regarding the differences between high and low mindfulness college athletes on regions of interest (ROI), there were no significant differences on ROI such as insula, anterior cingulate cortex, prefrontal cortex, and amygdala. Interestingly, the results of one-sample t test found that high mindfulness group athletes had higher activation on the area of cerebellum and thalamus in the motion condition than in the neuter condition. In addition, low mindfulness group showed higher

negative activation on inferior occipital gyrus in the motion condition. Compared to the motion condition, higher activation on Pre- and Post-central than neuter condition.

Discussion

In accord with the hypotheses, the findings revealed that college athletes' mindfulness trait was positively related to flow and negatively related to anxiety. However, no correlation between mindfulness and concentration. The results of this study did not support the hypothesis that the differences between high and low mindfulness college athletes on regions of interest (ROI). However, it was interestingly found that there were differences activation on different brain area in the motion and neuter conditions. high mindfulness groups athletes used more brain resources for the information integration in the motion condition than the neuter condition.

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ASSESSMENT MOTIVES FOR ATTENDING AN ELITE SPORT SCHOOL (ESS) – QUESTIONNAIRE FOR 9 TO 10 YEARS OLD MALE AND FEMALE ATHLETES

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Introduction

Psychosocial characteristics are given an essential role in the context of talent development. It is assumed that various motives determining the attendance of an elite sport school may have an impact on the later sports career. However, there are only few researches indicating young athletes´ reasons to learn and practise at an ESS. Therefore, our study aims to develop a questionnaire to assess explicit motives, based on the example of track and field athletes. Using explicit motives, individual dispositions and their long-term effects on elite sports performances, can be determined.

Method

Fundamental to developing the questionnaire was the 2 x 3 motive taxonomy by Gabler (2002). Four items each collect data about a person-centred and social-centred perspective classified in (1) motives related to performing sport practice (2) motives related to the results of sport practice and (3) motives related to sport practice as a means for other purposes. The factorial validity of the instrument was examined using exploratory factor analysis on data collected from 405 young athletes (f = 190, m = 215) at the age from 9 to 10 years old who applied for the ESS in Magdeburg and Halle (Saxony-Anhalt, Germany) in the period from 2016-2022. 138 athletes (f = 65, m = 73) have received a recommendation for the ESS.

Results

The exploratory factor analysis could not confirm the 2 x 3 motive taxonomy. After an item reduction a 2-factor solution with 8 items each was identified: factor 1 "gain recognition through practising athletics" and factor 2 "goal and purpose of practising athletics". Both factors make up 44.17% of the total variance. The KMO-coefficient is .903 (Chi2 = 1,834.65; df = 120; $p < .001$). Internal consistency analysis revealed acceptable Cronbachs alpha coefficients (factor 1 $\alpha = .804$, factor 2 $\alpha = .826$). Athletes with a recommendation for ESS tend to show higher values of the two factors, but the results are not significant. A higher level of both factors correlates, more than coincidentally, with better performance in throwing, running and jumping disciplines as well as in the combined events. However, a higher value in factor 1 is associated with a decrease in confidence and self-efficacy after one year of training.

Discussion

The adapted questionnaire is an appropriate instrument for measuring young athletes´ explicit motives for attending an ESS. The trainers will receive an assessment of the later ESS students. The results indicate that the motive "recognition" initially requires higher physical and athletic performance. However, in the long term it can also lead to unfavourable expression of psychological characteristics, resulting in negative performance development. Appropriate pedagogical-psychological support should therefore be given to young athletes, especially during the first years at the ESS, in order to promote appropriate personality development.

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PHYSICAL ACTIVITY AND ANXIETY SYMPTOMS IN COLLEGE STUDENTS: THE ROLE OF INTENSITY AND DOMAIN

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Background

There has been an increase in college students physical inactivity over the past decade, and college students engage in a higher sedentary time than the general young adult population. This is not only associated with an increased risk of chronic disease but also leads to mental health problems. Anxiety disorders constitute a major part of the disease burden in mental health. A growing body of evidence supports the role of physical activity in maintaining mental health and preventing anxiety symptoms. However, due to the heterogeneity of previous studies, there is a lack of knowledge regarding effective physical activity intensity and domain in relation to anxiety prevention. We aimed to examine the association

between physical and anxiety symptoms among college students and whether it can be modified by the role of intensity and domain.

Methods

Nine hundred and twenty-seven college students (mean age = 19.42) were recruited from Shanghai, China. Physical activity was assessed using the 24-hour Movement Behaviours Questionnaire, through which the intensity and domain of physical activity were reported. Anxiety symptom was evaluated using the Self-Rating Anxiety Scale. The cross-sectional association of physical activity with anxiety symptoms was examined using multiple linear regression.

Results

Associations between intensity and domain-specific physical activity and anxiety symptoms were not uniform. Within the leisure domain, light (β = -0.10, 95%CI, -0.20 ~ -0.01, $p < 0.05$) and moderate (β = -0.19, 95%CI, -0.35 ~ -0.03, $p < 0.05$) intensity physical activity was inversely associated with anxiety scores ($p > 0.05$), whereas vigorous intensity physical activity was not associated with anxiety scores in college students ($p > 0.05$). Within transport and household domains, physical activity was not associated with anxiety scores regardless of intensity ($p > 0.05$).

Conclusions

The findings indicated that leisure-time physical activity of light and moderate intensity was associated with anxiety among college students. The associations of physical activity with anxiety symptoms varied by the intensities and domains of physical activity.

ROOM FOR IMPROVEMENT: A MIXED STUDY OF LIFE SKILLS DEVELOPMENT IN HIGH SCHOOL STUDENT-ATHLETES

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This study examines the experiences of student-athletes and school sport stakeholders (e.g., coaches, teachers) concerning student-athletes' needs in terms of life skills development through high school sport programs in Québec. A mixed design was used to analyze participants recruited from 10 high schools offering sport-study programs. Student-athletes (n = 854) completed questionnaires on their experiences of sport participation and the life skills they had acquired. Semi-structured interviews were held with 14 focus groups of student-athletes (n = 79) and 14 focus groups of school sport stakeholders (n = 77). Quantitative data were analyzed descriptively and qualitative data were analyzed thematically. Results showed that not all student-athletes had optimal life skills in four areas: (a) mental skills (i.e., time management, goal setting, emotional regulation, self-confidence); (b) healthy eating habits (i.e., fruit and vegetable's consumption, body image satisfaction, nutritional supplements); (c) physical and mental recovery (i.e., stress and performance anxiety management, sleep quality); and (d) safety behavior (i.e., safe behaviors, concussion awareness, knowledge of potentially dangerous ergogenic substances, positive climate). The findings highlight specific needs of student-athletes that should be targeted in future multidisciplinary support programs for school sport stakeholders to better equip them to foster life skills and positive development in student-athletes through high school sport.

THE EFFECT OF PUTTING PERFORMANCE OUTCOMES ON EEG MARKERS DURING THE PREPARATION PERIOD OF SUBSEQUENT PUTTS

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Introduction

When a skilled athlete makes a mistake, the athlete will refer to previous experiences in their working memory to make adjustments in subsequent trials. As the three stages of motor learning point out, when a skilled athlete needs to allocate attention for their motor performance, their initial procedural movement process will rely on declarative knowledge and their behavioral process also shifts from an automatic process to a controlled process according to the dual-process theory. However, the psychophysiological mechanisms underlying this motor adjustment have rarely been explored. Therefore, this study intends to use EEG markers to explore these mechanisms. Specifically, we examine whether the elevated left temporal (T7) α2 (An EEG marker for verbal-analytic and language processing) is the main process for motor adjustment, instead of the right temporal (T8) or other frequency bands (α1 and β1).

Methods

Eighteen right-handed skilled golfers (handicap < 18) were recruited for this study. The participants were requested to perform 60 putts while EEG was recorded. Theα1 (8-10 Hz), α2 (10-12 Hz), and β1 (12-15 Hz) from T7 and T8 were compared between previous successful and unsuccessful trials. A 2 (Performance: after holed, after unholed) × 2 (electrode: T7, T8) × 3 (Frequency band: α1, α2, and β1) three-way repeated measure analysis of variance (ANOVA) was employed to examine the performance effects. A statistical level of $p < 0.05$ was accepted.

Results

The 2 × 2 × 3 three-way repeated measure ANOVA showed an approaching significant main effect on performance [$F(1, 17) = 3.457$, $p = .08$, $\eta 2p = .169$]; subsequent trials to failed putts showed higher α1, α2, and β1 power in both temporal electrodes. Neither the three way interactions of performance × electrode × frequency band $F(1, 17) = .074$, $p = .798$, η2p

= .004, nor the two way interaction involving performance [performance × electrode F (1, 17) = 1.810, p = .196, η2p = .096, performance × frequency band F (1, 17) = 1.003, p = .331, η2p = .056] reached significance.

Discussion & Conclusion

This study examined whether skilled golfers, following a putting failure compared with putting success, engaged in more verbal analysis as attentional reinvestment in movement adjustment during the preparation period for their next putt. Results showed that trials after a failed putt were preceded by higher EEG power in α1, α2, and β1 in both T7 and T8 sites. Although this performance main effect only approached statistical significance, this finding suggests that the performance could be affected by previous performance outcomes and a reinvestment for movement adjustment likely explains changes in EEG markers.

Keywords: Hemisphere, Golf, Electroencephalograph, Movement adjustment

STRATEGIC SELF-TALK FOR ANXIETY REGULATION: COMPETITION TIME.

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Self-talk interventions have proven effective in lowering anxiety levels in young athletes in field experiments, however, such experiments cannot resemble real competitive conditions. The purpose of the present study was to explore the effects of a strategic self-talk intervention on pre-competition anxiety and self-confidence in young swimmers. Fifty-five competitive swimmers initially agreed to participate in the study. Eventually, 38 (22 females) with a mean age of 14.72, training on average 5.86 times per week for an average of 14.02 hours, completed the requirements of the study. Swimmers competed in two qualifying for the national championship competitions that took place at an 8-week interval. Hence, the self-talk intervention was implemented over the 8-week period in-between these competitions. During this period, participants of the experimental group received a tailor-made intervention based on an opening need assessment session. The purpose of the intervention was to assist swimmers to develop specific self-talk plans for the competition but also to change unproductive self-talk. The importance of the competition was assessed one day before the competition, whereas pre-competition anxiety and self-confidence were assessed approximately 15 minutes before the start of each swimmer's main race. Preliminary analyses showed no differences in baseline anxiety and self-confidence between the intervention and the control groups; in addition, no between or within-group differences were recorded for competition importance. Two-way (2x2) mixed model MANOVA showed a significant multivariate group by time interaction, F(3, 34)= 3.00, p< .05, partial η2= .21. Examination of the pairwise comparisons revealed that for the intervention group cognitive and somatic anxiety were reduced and self-confidence was increased, whereas no significant differences were recorded for the control group. The findings of this pragmatic intervention study may lack the methodological rigor of controlled lab experiments due to the dynamic and unpredicted competitive environment, however, they hold important ecological validity, thus complementing previous findings from field experiments.

EFFECT OF VOLUNTARY EXERCISE ON DEPRESSION IN HIGH-FAT-FED MICE

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Backgrounds: Regular exercise has been reported to prevent not only obesity, but also mental disorders. In humans, a reduced risk of depression was reported in individuals engaged in high activity and moderate activity as compared with those at low activity (Paffenbarger, et al., 1994). Additionally, the voluntary wheel running induces an antidepressant-like effect in some behavioral tests of rodents (Duman, et al., 2008). On the other hand, previously published studies have shown that obesity or high-fat diet (HFD) related cognitive impairment, depression and anxiety (Lof, et al., 2022). However, the details of the effect exercise on depression in HFD-fed-mice are unknown. Therefore, the purpose of this study was to determine the effect of voluntary exercise on the antidepressant-like behavior in HFD-fed mice.

Materials and methods: Four-week-old C57BL/6 male mice (n=48) were used for the experiment and all mice were treated voluntary wheel running for 10 weeks. Diets were either normal dietary intake (CD) or HFD. Body weights were measured weekly. Half of the mice on each diet were then loaded with or without social defeat stress (SDS) for 10 days, followed by a sucrose preference test (SPT). Organs (body fat, adrenal glands, and thymus gland) were removed under anesthesia. This study was approved by the Animal Experimentation Committee of Kawasaki University of Health and Welfare (#19-005).

Results: No changes in wheel running activity were observed with different diets, but body weight in HFD mice during the voluntary wheel running period was significantly higher than that in CD mice. In both dietary groups, voluntary wheel activity was decreased during SDS loading (p<0.01). Furthermore, the HFD induced lower voluntary wheel activity in mice regardless of SDS loading (p < 0.05). The assessment of depression-like behavior by SPT showed significant differences between diets (p<0.01). Also, significant differences in thymus, adrenal, and body fat mass were observed by diets and SDS loading.

Discussion: HFD intake induced the decreasing SPT, which indicates depression-like behavior, and atrophy of the thymus gland. These results indicate that the depression-preventive effect of voluntary exercise habits is strongly influenced by HFD intake. Thus, dietary composition influences the effect of exercise. Furthermore, the response to a 10-day SDS load also resulted in atrophy of the thymus, that exercise habits do not necessarily lead to resistance to stress. These results suggest that a combination of exercise and diet is important for the prevention of depression.

REAL-LIFE STRESSORS AND RECOVERY EXPERIENCES OF SPORTS STUDENTS - AN AMBULATORY ASSESSMENT STUDY

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Students of all disciplines report various stressors during their daily lifes, such as exam periods or financial problems (Hurst et al., 2013). Recovering from stress is important to prevent ill health. The extent to which these real-life stressors influence recovery experiences of sports students, has not yet been investigated. Thus, the aim of this study is to investigate how to which stressors over the day are associated with recovery experiences in the evening. Compared to other subjects, studying of sports science is characterized by specific conditions (e.g., sport practical courses and examinations), which may also lead to negative health consequences (e.g., injuries; Bastemeyer et al. 2021). Therefore, the second aim of this study is to examine whether the context (e.g., study-related) of a perceived stressor predicts recovery experiences.

A total of 86 sports students (m = 33, w = 46, d = 1) were examined on five consecutive days within the exam period of the 2021 summer semester. Students were surveyed six times a day approximately every two hours via smartphone app (LifeData LLC). They were asked if they had perceived a negative event in the last two hours (yes/no) and, if "yes," in what context (leisure, study-related) (Almeida et al., 2020). Recovery experiences (e.g., relaxation, control, psychological detachment and mastery) were recorded every evening, using the Recovery Experience Questionnaire (Sonnentag & Fritz, 2007). To examine the extent to which daily stressors were associated with recovery experiences at the end of the day, multilevel analyses were computed in SPSS.

When any stressor was present, we found significant associations between stressor and relaxation (ß = -.491, SE = 0.16, p = .002) and between stressor and control (ß = -.395, SE = 0.16, p = .011). With the onset of a stressor, these recovery experiences decreased in the evening.

While the results showed that the occurrence of a stressor predicted less relaxation and less control in the evening, this was not observed for detachment and mastery. To explain these results, future studies should investigate which stressors and how the intensity and the appraisal of a stressor predict recovery experiences in the evening. Within sports students´ education, recovery strategies should be addressed to prevent ill-health and maintain study-related performance. Especially in stressful phases (e.g., exam periods) it is important to recover well. However, the results of this study show that stressors may hinder recovery.

RELATIONSHIP AMONG PERCEIVED PHYSICAL COMPETENCE, GROSS MOTOR SKILLS, AND PHYSICAL ACTIVITY LEVELS IN A SAMPLE OF ITALIAN 9 TO 11-YEAR-OLD CHILDREN

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This study analyzed the relationship among Perceived Physical Competence, Gross Motor Skills, and Physical Activity Levels in a sample of 119 Italian 9-11-years old-Children (M=55; F=64; Mage=10.09; SD=0.57).

The instruments administered were: (1) the Italian version of Ulrichs (1992) Gross Motor Development Test (TGMD), to assess Gross Motor Skills (Locomotion and Object Control Skills); (2) the Italian version of the Self-Description Questionnaire (SDQ; Marsh, 1988) for children and pre-adolescents (Camodeca et al. (2010), to measure the perceived physical appearance, perceived physical competence, self-esteem, and self-concept; and (3) the Physical Activity Questionnaire for children and pre-adolescents (PAQ-C-it; Gobbi et al., 2016), to assess physical activity levels.

Mediation analysis showed that perceived physical competence (independent variable) affects gross motor skills (dependent variable), with the mediation of physical activity levels (mediating variable) (R2=.21; Total ES=2.33 p<.001; PA levels Ind. Eff.=.14 p<.001). Gender is a significant covariate in the relationship between perceived physical competence and gross motor skill, but not between perceived physical competence and physical activity levels.

Results emphasized the key role of perceived physical competence in understanding PA-related behaviour in children. Furthermore, levels of physical activity had significant positive effects on perceived physical competence and the latter, in turn, affects physical activity levels.

Gross Motor skills are not uniform and there are significant differences between genders in gross-motor skills (locomotion and object control), therefore, from an educational perspective, teachers and educators should offer a wider range of activities such that all children can exercise all gross-motor skills. For those skills in which children are less able, activities that allow them to improve are advised, starting from their interests and their perceived self-efficacy. A game-based approach (GBA) should be considered in order to make the activities attractive to boys and girls (TGfU SIG, 2021).

Sociology

THE SOCIOLOGY OF CHILDHOOD AND THE LEARNING OF MOVEMENTS IN TRADITIONAL CHILDRENS GAMES

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Introduction

Childrens culture, object of study of Sociology of Childhood, covers various forms of play, among which are the traditional games practiced by groups of children in the streets, squares and schoolyards such as hopscotch, jump rope, kite, marbles, hide-and-seek, etc. In a dialectic articulation between action and thought, children need to master body movements that require a certain level of learning. Traditional games are activities that provide an exceptional set of motor experiences through which the child learns new moves and bodily possibilities (Mello, 2006).

The objective of this study was to analyze the learning process of children in their attempt to master the existing complex motor skills in traditional games. The theoretical framework comprised a trans-disciplinary dialogue between the Sociology of Childhood (Corsaro, 2005; Sirota, 2006) and the historical-cultural theory (Vygotski, 1997).

Methods

The study followed a qualitative approach of ethnographic orientation. Fieldwork was conducted in a public elementary school located in the city of Rio de Janeiro, with children ranging from 6 to 10 years of age who freely played traditional games in the schoolyard.

The tools used included observations of the children during their games, records in field journals, audio, photographs, personal interviews and interviews with groups of children.

Discussion of Results

Following the theoretical and methodological orientation of the Sociology of Childhood according to which children are actors of social processes (Sirota, 2001; 2006), we collected the children's testimonial statements on how their learnings of motor skills take place in the practice of traditional childrens games, being these data central to our research.

The observations and statements indicated that the learning of motor skills of traditional games occurs initially by imitation in the group to which the child belongs. The child observes and tries to reproduce the movement made by another child. However, the observation and movement reproduction are not enough for the child to fully master the necessary movements of the games, especially those which are more complex.

It is fundamental to have the mediation of peers with a deep knowledge of the movements required by the game so that the child can make progress in his learning. The learning of movements in traditional games occurs under conditions predisposed by the zone of proximal development (Vygotski, 1997) through collaboration and guidance among peers.

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PATRIOT, FEMINIST AND GEN-Z ROLE MODEL: ILLUSORY MEDIA PORTRAYALS OF EILEEN GU IN CHINA

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Introduction: 18-year-old Eileen Gu is the undoubted spotlight of the world with a three-medals debut in 2022 Winter Olympics, and as the host country, China has crafted overwhelming media coverage towards the naturalized skier to boost national pride. Therefore, by making a comprehensive text analysis of coverage of Eileen Gu, this paper aims to figure out how Chinese media build up a perfect female athlete that's totally different from those in the past on its home-hosted Beijing Olympics and thereby boost national pride through a series of innovative media narratives.

Methods: 341 news pieces from June 1, 2019, to April 14, 2022 were downloaded from Wisers News Database with the keyword "Eileen Gu" and used for in-depth text analysis through KH-Coder, a text data mining software developed by Japanese scholar Koichi Higuchi. The software generates a list of key words by frequency and a keyword co-occurrence bumble network is developed, which exhibits the and reveal the media narrative behind.

Results: Eileen Gu, as a new female athlete icon, emerged as a perfect puppet for Chinese propaganda due to a combination of her transferred citizenship, her historical achievements in winter sports and her family background and personal charm. Based on these conditions, China has kicked off its propaganda machine three years old and its media strategies could be boiled down to three perspectives, namely patriotism, feminism and Olympic spirit. Gu is shaped as a naturalized athlete passionate about traditional Chinese culture, a Gen-Z feminist with dual success in terms of academics and her sport career and a Chinese sportsmanship ambassador exhibiting friendliness, modesty and generosity to her competitors and teammates.

Discussion: The three narratives above are proved to be really effective and well absorbed by the Chinese audience with all age ranges as most of them are isolated from the global Internet with a long-standing firewall and the stated-own media would never write about controversies about Gu due to strict censorship. Thus, in the cocoon of information created by the Chinese authority, Gu dominated the trending topics on both news media outlets and social media platforms during the whole Winter Game period. However, the flawless image of Gu collapses soon after her return to America alongside tempting fame and financial rewards as a viral celebrity. It is such a shameful lesson for the Chinese to come to know via news imported from western countries via VPN that the hero and idol they admired seem to be a fence-sitter trying to behave in the way people like in China and America respectively. Illusory as Gus media image is, the years-long cam-

paign yielded satisfying results since Gus completed her mission and win big with her dual nationality while the authority managed to achieve their propaganda goals and win more gold medals in the home-hosted Winter Olympics.

Sport Management and law

THE ENGAGEMENT OF LOCAL COMMUNITY TO IMPROVE A BRANDING OF HOST CITY THROUGH SPORTS EVENT: A CASE STUDY OF INDONESIA AND MALAYSIA

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Since the successful of Indonesia as host country of Asian Games 2018, many sport events have been prepared by the government, such as Moto GP in 2022 and FIFA World Cup U-20 in 2023. On the other hand, Malaysia as a neighborhood country also uses sports event as an effort to increase the economy and provide opportunities for its citizens to take part in it. In tourism literature, it has been claimed that sports mega-events are a steadily growing tourism segment which directly attracts significant numbers of tourists and generates substantive tourism receipts, while also improving the host country's market position, and changing the image of the associated tourist destination. Based on data from the Malaysian Central Statistics Agency in 2020, sports events are the top five reasons for local residents to visit an area. However, the success of sports events as marketing tool cannot be separated from the participation of the local community. This qualitative research aimed to identify and analyze the role of local community to improve a branding of host city used two major sports event in Indonesia and Malaysia, namely the MesaStila 100K Ultra Marathon and Tour de Langkawi. By using an open survey method that can be filled out online via the Google Form application, 45 informants came from participants agree to fill the questionnaire that has seven indicators, consisted of 1) Brand Salience, 2) Brand Association, 3) Brand Resonance, 4) Brand Loyalty, 5) Service Experience, 6) Journey Experience, and 7) Sharing Value through Event. After data collected and analyzed using NVivo 12 Pro, we found that as many as 68.88% participants in sports event pushed to visit a certain place and gain new experience. That condition makes a good place for local community to introduce local culture through cultural festival or entertainment stage. Apart from having side events, the services provided to the participants are also important, where as many as 37.78% of the participants stated it. The local community is hoping to give the best service there and through sports event, it was the best way to give a local hospitality. With the best quality service to participants, they will spread the positive image they get and can make them come back in the future. Participants also said that they would like to visit the area again because of the attractive location and beautiful scenery. This is shown by the presence of 43.18% of participants who said the location and scenery were an important part for them to come back. On this part, local community has a major duty to take care and maintain the attractiveness of tourism destination. Based on those statements, it can be concluded that new experiences, attractive locations, activities that can introduce local culture, and services are an important part that can be done by local community to improve branding of sports events host city.

HOW CAN GREEN ADVERTISING ELICIT SPORTS TOURISTS SELF-CONTROL TO EXHIBIT GREEN TOURISM BEHAVIOR? THE ROLE OF CONSTRUAL-LEVEL THEORY

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Introduction

Environmental protection and conservation have become one of the highest priorities for the tourism business (Kim & Stepchenkova, 2019). Following these trends, sports tourism researchers also start to consider how to elicit tourists self-control and exhibit green tourism behavior. Based on the strength model of self-control (Baumeister et al., 2007), we argue that sports tourists with self-control might line with the social standard to exhibit more green tourism behavior. That is because they might consider the long-term benefits to the natural environment and then regulate their behavior to engage in green tourism behavior. Furthermore, high-level construal would lead individuals to focus on long-term or distal perspectives rather than short-term outcomes and exhibit goal-directed behavior (Fujita et al., 2006). As such, we argue that the high construal-level green advertising would elicit the sports tourists' self-control to concern about environmentally friendly in the future and then exhibit green sports tourism behavior.

Methods

The study participants were 361 tourism participants (232 females and 129 males) who were recruited in college in Taiwan and volunteered for the study. Among the 361 participants, the mean age was 22.19 years (SD = 8.37), who had sports tourism experience in the past month. An experimental study was conducted to test the proposed hypotheses. A 1 (self-control) × 2 (fewer pictures and more words advertising claim vs. more pictures and fewer words advertising claim) between-subjects design was employed. The participants first read a brief description of the procedures and instructions and then were asked to complete a questionnaire that consisted of demographic items and questions about self-control and Chinese social desirability. Next, the participants were exposed to one of the two green tourism behavior advertising messages used in this study.

Results

The result supports our hypothesis that sports tourists' self-control was positively correlated with their green tourism behavior. To understand whether the different advertising claims would enhance the relationship between participants self-control and green tourism behavior, we examine the interaction between self-control and ad manipulation. The result indicates that participants with greater self-control produced a higher level of green tourism behavior when they reviewed the high-level construal design advertisement.

Discussion

This study expands our understanding of individuals self-control in green sports tourism and highlight self-control acts an important role to guide sports tourists to exhibit green tourism behavior. In addition, we advance the current understanding of self-control and the construal level of environmental psychology literature by identifying the interactive effect between self-control and the construal level theory on how to influence environmentally friendly behavior in sports tourism.

A STUDY OF SPORT INDUSTRY FORECASTING AND MANAGEMENT BY POLITICS IN TAIWAN

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Introduction

Deep learning drives many services of artificial intelligence that improve automation, performing analytical and physical tasks without human intervention. An Artificial Neural Network (ANN) model that can predict future sports industries in Taiwan was developed. Through the governments public information, to advance sport management and brief sport policy, this study captured the development and current situation of the sports industry in Taiwan by analyzing the domestic sports industry and the literature and then constructing the sports industry management system consistent with the government unit and the industry.

Methods

According to the public information disclosure of Gross Domestic Product (GDP), Gross National Product (GNP), general income, the Number of Firms, and the employed population of 12 sports industries, we planned to explore and discuss the construction model and forecasting sports industry during 2008-2018. In the first stage, we utilized the neural network analysis to evaluate and forecast for the "industrial forecasting model." of consulting for the government and sports business. In the second stage, Considering the application of the BCG matrix is a powerful means of simplifying complex issues regarding sport policy. The BCG matrix is a 2 × 2 matrix initially used to compare sports industries based on the total value of all the goods and services produced within Taiwan and all the income generated by nationals of Taiwanese sports industries made within or outside Taiwan. Based on the results of deep learning analysis, sports industries are classified into the quadrants Stars, Dogs, Cash cows, and Question marks.

Results

In the first stage, we figured out predictions with GDP and GNP in 2019 of 12 sports industries. In the second stage, we classified Stars stands for increasing GDP and GNP as "sports stadium or construction industry."

Cash cows stand for increasing GNP, and decreasing GDP, as "rental of sports products or equipment." The question mark represents decreasing GNP but increasing GDP, and no industry match in the study. The dog represents both decreasing GNP and GDP as "educational services for leisure sport," "wholesalers and retailers of sports products or equipment," "sports performances," "health care for sports," "sports tourism," "sports wagering," "sports media or information publishing," "sports agent, management consulting or administration industry," "eSports Industry," and "professional sports or amateur industry."

Discussion

We planned to figure out the research gaps between government departments and the sports industry, the advantages of research in the field of sport management, "data specialization" and "data rarity," and the academic research and connects the physical education and sports policy and development issues, and connects the sports industry with the practical contribution and benefit of the academic and practical integration of the sports industry.

RELATIONSHIP QUALITY AND WELL-BEING FOR EMPLOYEES' PARTICIPATION IN SPORT AND RECREATIONAL CLUB ACTIVITIES

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Relationship quality and well-being for employees' participation in sport and recreational club activities

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Abstract

INTRODUCTION: Relationship quality are focused on trust, adaptation, communication, cooperation, promise, and satisfaction. Moreover, employee well-being is a type of individual experience, which is related to the time line when individuals engage in activities that match with value pursuits and comprise the instant experience related to temporary emotion-

al or sensory feelings and accumulated experience related to continuous mind or spiritual feelings (Diener, Suh, Lucas, & Smith, 1999). Nevertheless, the effects of relationships outside work on employee well-being mainly consider the relationships with teammates (Sweetman, Luthans, Avey, & Luthans, 2011) or group members (Holzgreve et al., 2020). The purposes of this study were: (1) to explore the correlation between relationship quality and well-being of employees' participation in sport and recreational club activities, and (2) to examine linear relationship among the employees' participation in sport and recreational club activities on relationship quality and well-being.

METHODS: The data consisted 250 valid questionnaires were completed by C Financial Holding Co., Ltd. throughout their internal sport and recreational club members (131 males, 119 females), age ranged 41-50 years old for all participants. Measures included relationship quality and well-being scales. Data analysis methods included the descriptive statistics, Pearson correlation analysis, and linear regression analysis.

RESULTS: The results reveal the positive correlation among relationship quality, life satisfaction, and positive emotions ($p < .05$). Satisfaction and commitment to life explained a significant proportion of the variance of positive emotions (Adjusted $R2 = .46$, $p < .05$). Commitment has a significant proportion of the variance of subjective well-being(Adjusted $R2 = .29$, $p < .05$).

DISCUSSION:

Based on this study, it concluded that companies should invest in community activities actively as the linkage with relationship quality in the future and to improve employee satisfaction and enhance well-being. Consequently, a brief discussion suggests that the theoretical perspectives of these significant variables need to be considered for further implications and study.

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RESEARCH ON ATHLETE WELFARE SYSTEM IN CHINA

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Introduction

The athlete welfare work is mainly carried out by various levels of sport administrations and sport associations in China. A support system for athlete development is very essential for athletes to strike a balance between sport and work/education.

Methods

The methods of literature review, expert interviews and statistical analysis are applied in this research. Face-to-face interviews were conducted with some government officials and athletes.

Results

The General Administration of Sport of China has issued several guidelines aiming to strengthen athletes' education and career planning. A variety of seminars and training sessions have been organized to help retiring athletes to go through transition period smoothly.

In recent years, a lot of investigations into athletes' welfare have been conducted in different provinces and municipalities, and new athlete liaison working groups have been formed to know more about athletes' needs. The Beijing Sport Administration established an information platform for retired athletes in 2019. The Tianjin Sport Administration cooperated with related education departments and social security departments in formulating athlete welfare policies.

China Sports Foundation has been providing Disability Mutual Aid Insurance for elite athletes all over the country, and multiple entrepreneurship grants for retired athletes who want to start a business.

Discussion

To further enhance the support system for athlete development in China, it is suggested that we diversify the development pathways for our athletes and make full use of the athlete welfare departments, so as to care for athletes through the whole process from enrollment into sports teams to retirement. It is also advised that commercial insurances should be offered to athletes as a lifetime guarantee, and new information technology should be utilized more efficiently to facilitate athletes' career transition.

IT'S NOT JUST FOOTBALL: TESTING A SPILLOVER EFFECT OF SATISFACTION WITH FOOTBALL TEAM PERFORMANCE ON FAN'S EMOTIONAL EXHAUSTION AT WORK

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Introduction

Football is one of the world's most popular sports and is beloved by 265 million sports fans worldwide. The affective state of sports fans was significantly affected by the winning or losing results of the team they support. Although a number of studies have demonstrated that sports fans' emotional reactions are likely to influence the attitudes and behaviors towards their teams, whether and when such subsequent affective states spill over to fans' lives outside sports, such as work lives, is rare to be explored. Guiding by an integrated perspective of affective event theory (Weiss & Cropanzano, 1996) and the Work-Home resource model (ten Brummelhuis & Bakker, 2012), we proposed that sports fans have higher satisfaction with football team performance might reduce the experience of emotional exhaustion at work. Because watching a sports game may constitute a vital event for sports fans, people who assess a sports event of as satisfactory tend to develop positive affective states. Such positive affective states are served as a contextual resource that replenishes in the non-work (home) domain and might prevent the depletion of personal resources and experience emotional exhaustion in the work domain. Further, research suggests that team identification involves emotional ties and a sense of belongingness toward a focal team, strongly influencing fans' thoughts, attitudes, and behaviors (Delia & James, 2018). As such, we expect that those sports fans with higher team identification would be more likely to respond to the favorable affective event and experience less emotional exhaustion at work.

Methods

Ninety-one satellite football fans in Taiwan who support various European professional football teams (e.g., Paris-Saint German, Borussia Dortmund, Real Madrid, or Tottenham Hotspur) were recruited. Participants provided weekly survey data two times a week over a period of four work weeks. Multilevel modeling was adopted to test research hypotheses.

Results

The results indicated that satisfaction with football team performance did not significantly predict fans' emotional exhaustion at work. However, satisfaction with football team performance significantly reduced fans' emotional exhaustion at work for those with higher team identification. Overall, our hypotheses were partly supported.

Discussion

This study provides several implications. First, by examining the role of satisfaction with football team performance, our study expands the understanding of leisure-work facilitation, that is, the spillover effect from leisure to work. Second, with respect to the literature on recovery and sport management, our study goes beyond the factors regarding sport participation (physical activity) and identify the beneficial role of sports spectatorship, which also provides practical implication to practitioners in promoting occupational health through sports.

PARTICIPANTS SATISFACTION AND EVENT ATTACHMENT: AN ONLINE INTERNATIONAL MARATHON IN TAIWAN

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Introduction

The global sports industry has lost more than US$ 60 billion due to the COVID-19 pandemic; the sports industry has lost revenue from event attendee fees, media broadcasting, and corporate sponsorship of sporting events (CNBC, 2020). Thus, innovative strategies and the development of new sporting event opportunities are crucial for event organizers to maintain profitability. Taiwan's Rice Heaven Tianzhong Marathon, the most hospitable marathon in Taiwan, was held online in 2021 due to the COVID-19 pandemic. The event attracted more than 9,000 participants and featured charitable activities such as rice donations and tree planting. Based on previous studies, a strong attachment enhances event participants' cognitive, emotional, and behavioral responses toward events (Iniesta-Bonillo et al.,2016; Fu et al.,2019). Therefore, the aim of this study is to understand the perceived satisfaction of participants by evaluating the event attachment toward the online marathon event.

Methods

This study evaluated participant satisfaction, event attachment, and participant demographics for the 2021 Taiwan's Rice Heaven Tianzhong Marathon, which has been held every year since 2012. Through purposive sampling, a total of 374 valid completed questionnaires were obtained. Analysis of variance, correlation analysis, and moderated hierarchical regression analysis were performed.

Results

The findings indicated that gender ($t(372)=4.053$, $p<.05$) and marriage status ($t(372)=-3.218$, $p<.05$) were significantly associated with event attachment. In addition, attendance history was significantly associated with event attachment, and event attachment was significantly associated with event satisfaction. Furthermore, functional knowledge, emotional importance, and symbolic expression had significant explanatory power for event satisfaction with a total of 20.8 % variance explained. A significant interaction effect between event attachment and attendance history toward participant

satisfaction was observed with a total of 18.5 % variance explained through hierarchical regression analysis; attendance history moderated the effect of event attachment on event satisfaction (F(1,370)=29.249, p=.018).

Discussion

Participants' perceptions of event attachment influenced their satisfaction with this online sporting event. Male participants had more agreement in event attachment than did female participants. Additionally, married participants had more agreement in event attachment than did unmarried participants. These findings emphasize that event attachment is crucial for online sporting events. Other sporting event organizers may wish to develop strategies that encourage event attachment, such as virtual interaction with participants or other online activities to sustain the events. Future research could expand upon this framework by examining other variables, such as repurchase behavior, to explore actual participant behavior during online sporting events.

THE DETERMINANTS OF CROSS-BORDER SPORT CONSUMPTION IN GUANGDONG-HONG KONG-MACAO GREATER BAY AREA(GBA)

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Purpose – The purpose of this study was to examine the relationships between product or service, catering, accommodation, shopping, sightseeing, transportation, ease of customs, currency exchange and behavioral intentions, as well as whether individual attitudes have mediation effects on these factors toward behavioral intentions in the context of cross-border sports consumption in Guangdong-Hong Kong-Macao Greater Bay Area.

Design/methodology/approach – A structural equation model was used to analyze the mediation effect of individual attitude on the influencing factors toward behavioral intentions. The group comparison was used to compare the different effects of various factors on the citizens in the three places.

Findings – Results showed positive impacts of (a) individual attitudes on behavioral intentions, and demonstrated (b) individual attitudes mediate relationships between catering, accommodation, shopping, ease of customs, currency exchange and behavioral intentions, (c) individual attitudes partially mediate relationship between product or service and behavioral intentions, and that (d) individual attitudes do not mediate the relationship between transportation and behavioral intentions. Compared with Hong Kong and Macao citizens, the ease of customs has greater impact on Guangdong citizens. Catering, shopping, sightseeing and currency exchange have greater impact on Macao citizens than those in Guangdong and Hong Kong.

Practical implications – The current research is aimed at contributing to practical applications by identifying the drivers of consumer attitude and behavioral intention in sport consumption in Guangdong-Hong Kong-Macau Greater Bay, and hence proposing effective strategies to improve consumer-perceived service quality and promote the development of sport industries in bordering cities.

Originality/value – The findings contribute to the literature in several ways. First, it tests the relationships between product or service, catering, accommodation, shopping, sightseeing, transportation, ease of customs, currency exchange and behavioral intentions with emphasis on the mediating effect of individual attitude in the context of cross-border sports consumption in Guangdong-Hong Kong-Macao Greater Bay Area. Second, the study broadens the knowledge in the context of cross border sport participation. Third, this study confirms that it is much different between cross border shopping and sport participation.

Keyword: cross-border sports consumption, sports industry, Guangdong-Hong Kong-Macao Greater Bay Area, behavioral intentions

CLINICAL EXERCISE PHYSIOLOGY ACCREDITATION: AN AUDIT OF EXISTING STANDARDS

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Health professions such as clinical exercise physiology (CEP) are founded on a set of standards that outline base level knowledge, skills and competencies to define the roles and scope of practice of the profession. Despite the practice of CEP having many common features regardless of the country in which it is conveyed, a harmonised set of international standards does not exist.

PURPOSE: To systematically audit the professional standards for the five countries recognised as having existing national certification systems for CEP. METHODS: The audit process was conducted using a modified scoping review protocol based on the documentation provided by the American College of Sports Medicine (ACSM), Exercise & Sports Science Australia (ESSA), British Association of Sport and Exercise Sciences (BASES), Canadian Society for Exercise Physiology (CSEP), and Sport and Exercise Science New Zealand (SESNZ). Two reviewers independently extracted data from the standards documents and results were cross checked by relevant experts from each jurisdiction. RESULTS: There was commonality of themes for 60% of all content extracted. The overall coverage of themes was 60%, 67%, 76%, 88% and 98% from New Zealand, Canada, USA, UK and Australia respectively. CONCLUSION: There is a common core of themes covered by all current national standards for CEP across the five nations audited, but there is variable coverage in the remaining 40%. These findings are important for understanding the differences in current training and certification of CEP professionals, and how this might influence the internationalisation of the profession.

THE VERIFICATION OF THE ISOLATION BUBBLE SYSTEM FOR OLYMPICSCAMP -ETHNOGRAPHY OF THE FRENCH NATIONAL TEAM-

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In February 2021, amidst the spread of the new coronavirus (Covid 19), the Tokyo Organising Committee for the Olympic Games published a set of rules and regulations that adopted an isolation bubble system. The bubble system is a bubble system in which the Games are operated in such a way as to envelop the host city in a giant bubble, blocking athletes and officials from contact with the outside world. In addition to regular PCR inspections before and after entry and during the Games, strict curfews are imposed at the Games venue to ensure isolation. This bubble system is now becoming established as the new modality for international sporting events. A concrete example of the bubble system for infection control at the Tokyo Olympics is that athletes will be tested for Covid19 within 72 hours before leaving the country and will continue to be tested regularly during the Games. They must then download a health management app called COCOA or O C H A . The scope of activities is also limited to the athletes village, competition, and practice venues, and public transport is not allowed for travel. After entering the country, the athletes activities are restricted to the competition and training venues and the athletes village. Furthermore, as a rule, they must leave the country within 48 hours of the end of the Games. Nevertheless, while such strict and thorough infection control measures reduce the risk of infection, it can be imagined that athletes placed in a bubble (external isolation) will experience increased stress. Under the extreme tension of the Olympics, what kind of stress will athletes place inside the bubble face, and how will they accept the isolation of the bubble environment for the Games? I was appointed by the French Olympic Committee as the local head co-ordinator of the Taekwondo team and spent time with the team in isolation. As a sociologist, I was motivated to accompany the team to the pre-camp and observe the normative awareness of the living environment of the Olympic team in the bubble and the governance within the organization.

In this research, I accompanied the overseas team to the teams pre-camp as a local attendant and spent time with the team in the pre-camp, and observed them in the same bubble, eating the same life, conducting interviews in French, and recording their behavior and words using the ethnographic method. Regarding living in isolation, we found that the lawns as a relaxation zone, ice baths, and the provision of Japanese food served as a stress buffer for the athletes. To ensure that they felt protected rather than isolated, weekly online meetings were held for two months before the camp to promote communication. Thanks to the various considerations by the pre-camp host municipality and facilities, the players did not feel so burdened. The athletes did not feel any discomfort because they had already been using the bubble system for more than a year for their training camps in France.

THE RELATIONSHIP AMONG CONSUMPTION VALUE, EMOTIONAL ENJOYMENT, SOCIAL ATTITUDE, INTENTION TO CONTINUOUS PARTICIPATION AND INTENTION TO LEAVE OF GOLF PARTICIPANTS: FOCUSING ON THE MZ GENERATION

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Introduction

Along with COVID-19 pandemic, as the preference for outdoor sports increased, golf population in South Korea, including the MZ generation(born between 1980 and 2010), has increased(Seo, 2022). The MZ generation in Korea enjoys golf as part of their consumption value. However, stablising COVID-19 is leading to an increase in other outdoor activities, causing a decrease in golf participants. In particular, the MZ generation is increasingly giving up continuous participation in golf due to the cost burden. As such, the MZ generation's participation in golf decreases, leading to a slowdown in the overall growth of the golf industry in Korea. Therefore, the purpose of this study is to investigate the relationship among consumption value, emotional enjoyment, social attitude, intention to continuous participation and intention to leave of golf participants in the MZ generation. This study would be meaningful in contributing to the development of the Korean golf industry by leading the MZ generation to continuous participation in golf.

Methods

Data were collected from 493 MZ generations with golf rounding experience by using convenient sampling method. After removing 184 cases of incomplete questionnaires, 309 were used for data analysis. For the study, frequency analysis, reliability analysis, Confirmatory Factor Analysis (CFA), correlation analysis and Structural Equation Model (SEM) were conducted by using SPSS 20.0 and AMOS 20.0.

Results

The overall validity and fit did not seem acceptable, $\chi 2(df) = 492.812$ (224, $p<.001$). Nevertheless, CFI = .937, TLI = .922, RMSEA = .062 and SRMR = .057 exceeded fit index recommended by Bagozzi & Dholakia (2002), and therefore overall validity and fit can be considered a good model for the study. As a result, emotional value positively affected emotional pleasure, $\beta=.784$, $t=8.131$, and social value significantly influenced social attitude, $\beta=.891$, $t=9.418$. Also, emotional pleasure and social attitude have a positive effect on intention to continuous participation, respectively, $\beta=.719$, $t=10.529$ and $\beta=.247$, $t=4.397$. However, emotional pleasure was not significant for intention to leave, $\beta=-.386$, $t=-5.108$.

Conclusion

The findings found that emotional and social values were important for forming positive emotion, attitudes and continued participation in golf. In addtion, it was confirmed that emotional pleasure was essential to prevent the MZ generation from participating in golf. Therefore, stakeholders in the golf industry should revitalise the golf community which can enhance interation between the MZ generations. Lastly, it is necessary to pay attention to satisfying the joy between participants rather than the intrinsic joy of golf.

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Sport Technology

THE RELIABILITY AND VALIDITY OF THREE COMMERCIAL DEVICES IN MEASURING THE MOVEMENT VELOCITY IN UNILATERAL RESISTANCE EXERCISES

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INTRODUCTION: Velocity-based training (VBT) is a novel resistance training method that uses instant feedback of each repetition (e.g., mean or peak velocity) to manipulate training load [1]. In the field, optimal implementation of VBT relies on the use of valid devices in order to prevent the natural variation in training from being masked by measurement errors in the device itself [2]. Several studies have explored the reliability and validity of many commercial devices in bilateral exercises [3-5]. However, given the prevalence of unilateral movement patterns in many sports and the fact that many unilateral exercises are commonly programmed [6,7], we recommended more information is needed relating to VBT during unilateral resistance training. Therefore, the aim of this study was to evaluate the reliability and validity of three commercial devices in measuring mean velocity (MV) and peak velocity (PV) during unilateral resistance exercises.

METHODS: Nineteen strength-trained young men completed two sessions consisting of one set of 2-3 repetitions against 6 sub-maximal loads (40, 50, 60, 70, 80, and 90% of one repetition maximum [1RM]) during the Bulgarian split squat and lunge, respectively. The PV and MV were recorded simultaneously by linear transducers (GymAware), accelerometer (Push), smartphone application (My Lift) and compared to a 3D motion capture system (Vicon) for all repetitions. For reliability, the coefficient of variation (CV) and the interclass correlation coefficient with 95%CI (ICC, two-way random, absolute agreement) were used to evaluated the absolute and relative reliability respectively for devices in this study. For validity, linear regression analysis, Bland-Altman limits of agreement (LoA), standard error of the measurement (SEM), mean absolute percentage error (MAPE) and Hedge's g effect sizes were used to evaluate the validity of each device compared to the 3D system.

RESULTS: GymAware was the most reliable (CV < 10%) and most valid (r = 0.920 to 0.960, r2 = 0.847 to 0.922, SEE = 0.029 to 0.037m/s; bias = -0.02 to 0.00m/s, 95% LoA = -0.08 to -0.07m/s, ES < 0.2) in MV measurement, but would overestimate in PV measurement (bias = 0.02 to 0.06m/s, 95% LoA = -0.15 to -0.26m/s, ES = 0.06 to 0.35). Push was the less reliable especially at higher intensities (> 80% 1RM) and valid with substantial differences and 95% LoA well above the acceptable levels (95% LoA: MV = ± 0.07m/s; PV = ± 0.11m/s) both in MV and PV measurement. My Lift was reliable but limited in validity of MV measurement (bias = -0.03 to 0.04m/s, 95% LoA = -0.08 to 0.15m/s).

CONCLUSION: GymAware can confidently be used as an alternative to 3D motion capture systems if measuring MV in unilateral resistance exercises, with some caution given to estimations of PV. However, the reliability and validity of Push and My Lift in measuring movement velocity during unilateral resistance exercises were questionable. We suggest against the utilization of Push and My Lift for velocity-based resistance training, when using unilateral resistance exercises.

ASSESSMENT OF WELLNESS AND FATIGUE IN COLLEGIATE SOFTBALL PLAYERS

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INTRODUCTION: The purpose of this study was to investigate wellness and fatigue throughout an off-season resistance training program in collegiate softball players using objective and subjective methods.

METHODS: Seventeen (n = 17) female collegiate softball players participated in off-season resistance training sessions as part of team training. Resistance training sessions took place two to three times per week over six weeks for a total of 13 sessions. Objective measures of fatigue were obtained for each resistance training session using vertical jump and handgrip strength. Vertical jump height was assessed using a jump mat in which participants performed three trials, and the best attempt was recorded. Handgrip strength was measured using a handgrip dynamometer with participants performing three trials using their dominant hand. The best attempt was recorded as the session's handgrip strength. Subjective measures of fatigue were collected using a wellness questionnaire prior to each resistance training session. The wellness questionnaire consisted of questions related to hours slept, sleep quality, nutrition, soreness, academic stress, and sport practice difficulty based on a scale of one (lowest) to five (highest) for applicable questions. Spearman's rho was used to analyze correlations among variables. Alpha was set at 0.05.

RESULTS: Over the six weeks, participants reported an average of 6.67 (SE = 0.077) hours slept, ratings of 3.45 (SE = 0.069) for sleep quality, 2.96 (SE = 0.049) for nutrition, 2.47 (SE = 0.074) for soreness, 3.09 (SE = 0.059) for academic stress, and 1.60 (SE = 0.064) for sport practice difficulty. Vertical jump height average was 52.22 cm (SE = 0.149). The average for handgrip strength was 39.0 kg (SE = 0.871). Positive correlations were found between hours slept and sleep quality (r_s = 0.280, $p < 0.001$), sleep quality and vertical jump (r_s = 0.196, $p = 0.005$), nutrition and grip strength (r_s = 0.175, $p = 0.011$), soreness and academic stress (r_s = 0.185, $p = 0.007$), and soreness and practice difficulty (r_s = 0.456, $p < 0.001$). Negative correlations were found between hours slept and academic stress (r_s = -0.162, $p = 0.019$), sleep quality and nutrition (r_s = -0.172, $p = 0.013$), sleep quality and soreness (r_s = -0.202, $p = 0.003$), sleep quality and academic stress (r_s = -0.213, $p = 0.002$), nutrition and vertical jump height (r_s = -0.242, $p < 0.001$), soreness and vertical jump height (r_s = -0.172, $p = 0.014$), and soreness and handgrip strength (r_s = -0.156, $p = 0.024$).

CONCLUSION: Monitoring wellness and fatigue uncovered numerous areas impacted in the overall wellbeing and performance of collegiate softball players. Athletes and coaches should emphasize the importance of sleep quality and nutrition for mental and physical performance. Soreness also plays a role in athlete performance as evidenced by the corresponding vertical jump height and handgrip strength. Further investigation is necessary to understand the causes of these relationships.

ANALYSIS OF METAVERSE APPLICATION IN PHYSICAL EDUCATION

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INTRODUCTION: Since 2021, the concept of the Metaverse has gradually become a hot topic in the world. The development of information technologies, such as VR, AI and blockchain, provides a solid technical guarantee for the realization of the Metaverse. In addition to the need for educational reform, Metaverse empowering physical education will become a typical feature of educational informatization.

METHODS: Literature reviews and expert interview

RESULTS: From the perspective of teachers, firstly, Metaverse will promote the role transformation of physical education teachers. Second, Virtual physical education teachers will appear. Virtual teachers not only have low cost, but also can serve students in different regions and schools which will greatly promote education equity. Third, Metaverse will assist the professional development of physical education teachers. Teachers or researchers from the whole world can become creators and owners of high-quality physical educational resources in the Metaverse world.

From the perspective of students, first, Metaverse will provide ubiquitous and verifiable intelligent learning paradigm. Through ubiquitous and verifiable learning, students can use flexible human-computer interaction on the Metaverse sports training platform to verify the accuracy of sports actions on the premise of minimizing the risk of sports injury. Second, Metaverse will provide an experiential learning process of deep immersion. It can break through the space limitations of traditional physical education, students can conduct real-time smooth interaction and intelligent feedback during sports learning. Whats more, Metaverse will promote the realization of individualized physical education. In the era of the Metaverse, students will have a Metaverse pass in addition to his/her ID card and passport, they can enter any virtual sports space for learning and training according to their personal interests and needs.

From the perspective of sport universities, Metaverse is a new generation of Internet based on blockchain. the process data and final data of physical education activities can be truly recorded based on blockchain, therefore, not only will realize the precise educational management and evaluation based on data, but also it can provide the possibility for the establishment of university credit bank. The graduation certificate will be digital, carrying more detailed learning information, so the establishment of the Metaverse sport universities will become a reality and provide new motivation for the development of high-quality sports education.

CONCLUSION: Physical education is an important component of education, Metaverse will provide a new platform for modern physical education, the concept, strategies, management and evaluation of it will be greatly developed by Metaverse, these changes will play a key role in the development of future physical education.

DEVELOPMENT OF ICT PLATFORM SERVICE MODEL TO ACCELERATE DIGITAL TRANSFORMATION OF TENNIS INDUSTRY IN SOUTH KOREA

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INTRODUCTION: Since Steve Jobs iPhone debut, the use of mobile media has created an optimal environment in which users can directly generate, store, and share data on the Internet. In terms of market capitalization, 7 out of 10 major IT companies are leading the world. Major platform companies such as Amazon, Google, Facebook, and Apple are building their own platforms, allowing users to stay there, and using them as the core strength of their businesses. As a result, the importance of platforms has risen throughout the industry, and the platform has changed the paradigm of the industry and even the value chain [1]. ICT (Information Communication Technology) based platforms also play a very important role in the distribution and distribution channel of cultural content. Even so, this ICT platform technology must be applied to the analog sports scene in line with the trends of the times. Even though many people enjoy sports and the implementation of platform services where suppliers and consumers meet has come technically enough, there are still no platform services being used at actual sports sites, furthermore, there is not enough of insightful prior research on how to provide them.

Therefore, this research would like to develop an efficient platform services model to develop and disseminate in the Tennis industry market of South Korea, which is rapidly increasing with young people.

METHODS: To carry out this research, we would like to develop a platform service model using the business model canvas strategy [2]. In addition, to analyze the problems in the Korean tennis industry market and develop a platform service model, we conducted focused interviews and in-depth interviews with 10 people involved in the tennis industry.

RESULTS: The research stage is 1) macro and micro environment analysis of the tennis industry market, 2) Tennis industry stakeholders analysis, 3) differentiating factors and user-customized core value analysis based on competitive product analysis of the existing market, 4) to develop a platform service design model that utilizes the business strategy canvas.

CONCLUSION: The findings of this research are as follows; first, segmentation of the market of tennis industry stakeholders, second, how to solve the problems of tennis industry stakeholders, third, how to communicate with tennis industry stakeholders, 4th, what kind of relationship will be formed with tennis industry stakeholders, 5th, how to generate revenue from tennis industry stakeholders, 6th, how to control physical and human resources to execute the business model, Seventh, what are the core activities of the platform service, Eighth, how to form core partners, Ninth, what are the costs required to operate the business. Finally, we would like to suggest an efficient platform business model of O2O, B2B, B2C, and B2G based on this.

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THE MEASUREMENT OF INTERNAL AND EXTERNAL LOAD IN BADMINTON SINGLE AND DOUBLE GAME

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INTRODUCTION: The local positioning system (LPS) with the inertial measurement unit (IMU) can measure the players external load such as movement distance, speed, position, and Player Load (PL). The internal load of the players can be measured by heart rate (HR) monitors and rating of perceived exertion (RPE) (1). This study used LPS and HR monitors to record the cumulative load of badminton players during the simulated games, and observed the relationship between external and internal load.

METHODS: Fifteen mens college badminton players (age: 21.2 ± 1.6 years, training experience: 7.5 ± 3.7 years) participated in this study. Each player wore a LPS sensor (Goalgo T1, Tromin Technology Co., Ltd., Taiwan) (2) on the left shoulder and a HR monitor (Polar H10) on the chest and played a simulated single and a simulated double game in badminton. Total distance covered (TDC), triaxial (PLTotal) and uniaxial PL (anteroposterior [PLAP], mediolateral [PLML], and vertical [PLV]) (3), Banister's TRIMP, and session RPE (sRPE) were collected and calculated.

RESULTS: The results of this study showed that the Banister's TRIMP (21.09 ±9.21 a.u.) in the single game were higher than the Banister's TRIMP (13.12 ±7.09 a.u.) in double game. External load measured showed that TDC (594.73 ±119.33 m) and PLTotal (71.40 ±23.11 a.u.) in the single game were higher than the TDC (486.99 ±79.89 m) and PLTotal (54.51 ±18.21 a.u.) in double game. Significant Pearson's correlations between the sRPE and the TDC ($r = .75$, $p < .01$) and between the sRPE and the PLTotal ($r = .48$, $p = .07$) were observed in the singles game. In the double game, the sRPE was significantly related to the PLV ($r = .70$, $p < .01$) and the sRPE was related to the PLTotal ($r = .68$, $p < .01$).

CONCLUSION: The physiological load (Banister's TRIMP) and external load (TDC and PLTotoal) of mens single game was higher than double game. The factors affecting the subjective load of singles and doubles players are different. The main factor affecting the sRPE for singles players is horizontal movement distance, while for doubles players, it is vertical movement. Movement distance and vertical movement load may be the suitable load indicators for evaluating singles and doubles players load.

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RELIABILITY OF COEFFICIENT OF DETERMINATION OF LINEAR REGRESSION MODEL BY ANGULAR VARIATION OF ACCELERATION DATA OF EACH PART OF THE BODY

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INTRODUCTION: The Acceleration sensors have been attached to various parts of the body, and have come to be widely used not only for posture analysis but also for occupational kinematical analysis. The aim of this research is to minimize the feeling of wearing the sensor and to measure the physical load by a simple measurement method based on highly accurate posture examination and individual properties of kinematical analysis.

METHODS: In this study, three subjects were asked to wear accelerometers (manufactured by HITACHI) in seven locations on their both thighs, both lower legs, both wrists, and back in a work environment that imitating regular cleaning room. The average of unit data per hour (min.) was calculated. Due to the characteristics of the sensor, the value of the vertical (Z) component is set to 1G, and the number of squats per unit time (min.) and the operation time (sec.) were measured.

Each parameter was then examined from a linear regression model. In addition, we also re-verified the data this time with a simple gyro acceleration sensor (WitMotion Shenzhen Co., Ltd.).

RESULTS: The objective variable was the squatting time, and the explanatory variable was the value of the acceleration sensor attached to each part of the body. As a result, a relatively high accuracy result was obtained (r2 = 0.712) even when the device was worn on the right lower leg in the identically as the four locations extracted from the sensor (r2 = 0.777).

In addition, the acceleration x, y, and z were converted to the angle θ using the acceleration sensor and the number of squatting per unit time (sec.), and the relationship between the angle θ (Y) and the squatting time (sec.) was clarified. From these results, it was found that the greater the angle, the longer the squatting time. Therefore, it was suggested that a squatting state can be estimated.

As in the past, we also obtained knowledge that supports the results with a simple gyro accelerometer.

CONCLUSION: We used squatting time as the objective variable, and examined the correlation coefficient, which is the reliability of the joint angle (θ) extracted from the acceleration sensor. This result suggests that it is possible to detect actual squatting with a small number of accelerometers for discern squatting motions.

In the future, it will be a basic material for calculating more precise movement characteristics and physical load from the relationship with each joint angle such as vertical acceleration changes and crouching posture (θ).

INVESTIGATING THE AGREEMENT BETWEEN FORCE PLATFORM AND PLANTAR PRESSURE INSOLE DATA IN BAREFOOT AND SPORT-SPECIFIC FOOTWEAR CONDITIONS ACROSS FOUR DIFFERENT MOVEMENT PATTERNS

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BROCK UNIVERSITY

INTRODUCTION: Conducting applied sport research in real-world settings is challenged by the lack of portable instrumentation that produces valid and reliable data that is collected without interfering with the athletes movement and is meaningful to sport performance. The purpose of the study was to compare and contrast data collected simultaneously from a force platform and a plantar pressure insole to provide support for the use of the XSENSOR® pressure insoles in a sport-performance environment.

METHODS: Data was collected in two conditions. The barefoot condition consisted of the insole on a force platform in isolation and the in-skate condition consisted of the insole inside a speed skate boot on a force platform. A single-participant design was conducted whereby an injury-free female completed multiple trials in both conditions. A P6000 Force Platform (BTS Bioengineering Corp., MI, Italy) was used to collect force data and a X4 Foot and Gait Measurement Systems plantar pressure insole (XSENSOR® Technology Corporation, AB, Canada) was used to collect pressure data in the two conditions across four movement patterns; static stance (SS), anterior-posterior sway (AP), medial-lateral sway (ML), and lateral jump (LJ).

RESULTS: Intraclass correlation coefficients (ICC) and Bland-Altman plots revealed excellent agreement between the cumulative centre of pressure (CoP) path length (mm) measured from the force platform and insole in the barefoot condition across the four movement patterns. Moderate agreement was revealed between the cumulative CoP path length (mm) in the in-skate condition across the SS and LJ patterns and poor agreement between the cumulative CoP path length (mm) in the in-skate condition across the AP and ML sway patterns. Bivariate Pearson product-moment correlations revealed significant positive correlations between time-series force (N) data and time-series pressure (psi) data in both conditions across the four movement patterns ($p < 0.05$).

CONCLUSION: Results confirmed that the XSENSOR® insoles were capable of collecting data comparable to a gold-standard force platform. The level of agreement could be attributed to the high resolution (233 sensels/insole) and high sampling frequency (150 Hz) of the insoles. These results are consistent with a recent study comparing insole plantar pressure data to known pressures and contact areas applied by an inflatable bladder in a non-human model [1]. The current study further investigated the use of XSENSOR® insoles in a human-model under two conditions; a human foot in isolation and a human foot inserted into sport-specific footwear, namely speed skates. Outcomes provided researchers and practitioners with empirical support and confidence to employ the X4 Foot and Gait Measurement Systems plantar pressure insoles (XSENSOR® Technology Corporation, AB, Canada) outside of a laboratory setting in a real-world sport environment to collect and analyze in-skate plantar pressure data during on ice performance.

1. Parker et al. (2023)

VALIDITY AND INTERUNIT RELIABILITY OF CATAPULT VECTOR S7 10HZ GLOBAL NAVIGATION SATELLITE SYSTEM UNITS FOR ASSESSING ATHLETE MOVEMENT PATTERNS IN HOCKEY

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INTRODUCTION: Global Navigation Satellite System (GNSS) receivers, most commonly Global Positioning System (GPS) receivers, are frequently used to monitor external training load, which informs training decisions, substitutions, and athlete recovery in elite-level hockey. Since no peer-reviewed research has considered Catapult Sports' newest GNSS device, the Vector S7 10 Hz, the aim of this study was to determine the validity and interunit reliability of this device for tracking athlete movement patterns in hockey.

METHODS: A repeated measures and validation design was utilized with 10 national level hockey athletes (5 male, 5 female) completing 14 laps of a 487 m sport simulation circuit designed to mirror movement patterns in a hockey match. Each participant wore two Vector S7 GNSS units, and, during each lap, completed 4 short shuttles with change of direction (COD). The primary outcomes for validation and reliability were speed and distance, measured via the GNSS units and criterion measures (timing gates, stopwatch, and measuring tape). Validity was evaluated via t-tests, percent standard error of the estimate (%SEE), and Pearson correlations, and interunit reliability was assessed via paired sample t-tests, coefficient of variation (CV) and interclass correlations.

RESULTS: The Vector S7 units had an overall mean bias of 2.8% ($p<0.001$), which increased to 14.3% on a 13 m T-shaped shuttle. Percent SEE was < 2.25% for all but the shortest two (13 m T-shaped and 8.5m V-shaped) COD shuttles where %SEE increased to 7.0% and 10.3%, respectively. Interunit reliability was very good, with an overall CV of 0.3% and all CV values < 3.1%.

CONCLUSION: The mean bias of the Vector S7 units was larger than that measured in previous Catapult devices; however, bias over the shuttles and %SEE was comparable to previous results. The interunit reliability was notably better than earlier models. As the Vector S7's bias was very consistent, it could be easily corrected for, with a multiplicative factor of 1.0286, making these devices a valid and reliable measure of athlete movement patterns in hockey.

TENNIS SERVE VOLUME, DISTRIBUTION AND ACCELEROMETER LOAD DURING TRAINING AND COMPETITION FROM WEARABLE MICROTECHNOLOGY.

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TENNIS AUSTRALIA

INTRODUCTION: This study investigated serving volume, frequency and accelerometer loads of elite female tennis players via machine learning algorithms for stroke even detection developed from global positioning systems (GPS) and micro-electro-mechanical systems (MEMS) devices. Specifically, these wearable technology metrics were analysed across session type (practice vs. match-play) and drill type (e.g., serving vs. point-play) during training and tournament blocks to inform coaching decisions and serve training prescription.

METHODS: Five elite female tennis players (18.8 ±2.9y) wore a commercial GPS and MEMS device (Catapult Vector S7) during a tennis season. Training and tournament blocks were determined from individualised athlete schedules. Monitoring occurred during practice sessions and official singles and doubles matches. Within practice sessions, drills that involved the serve were classified as "serving drills" or "point play drills". Prototype machine learning algorithms were used to detect serve strokes at 98-99% precision alongside measures of intensity from the accelerometer and gyroscope. Three key variables of the serve were analysed and included absolute and relative; 1) serve volume, 2) serve load (arbitrary units [AU]) and 3) rotation magnitude (revolutions per second [rps]). Due to the small sample size, effect size analyses were performed using Cohen's d statistic with 95% confidence intervals across and within block type, session type and drill type.

RESULTS: Large effects were observed for greater serve load during official matches compared to training and tournament practice sessions (d = 0.97-1.07 [95% CI = 0.69-1.30]). Further analysis of session-level data showed trivial differences in rotation magnitude per serve across all conditions (d = 0.03-0.06 [95% CI = -0.01-0.09]). Within training blocks, large ES existed for higher cumulative serve volume (d = 0.82 [95% CI = 0.54-1.10]) and serve load (d = 0.85-1.10 [95% CI = 0.33-1.34]) during point-play drills. However, serving drills involved greater serve frequency (n.min-1) (d = 1.10-1.87 [95% CI = 0.59-2.19]) and relative serve load (AU.min-1) (d = 1.35 [95% CI = 1.06-1.65]). Serving drills had a small ES for increased rotation magnitude during tournament blocks (d = 0.43 [95% CI = 0.02-0.88]), whilst trivial ES were observed for point play drills (d = 0.19 [95% CI = -0.14-0.53]).

CONCLUSION: Serve volume remains highest in official match-play compared to individual practice sessions. Further, this study presents initial evidence that serving during official match-play demonstrate greater accelerometer demands compared to practice. This could indicate the usefulness of wearable technology metrics for serving practice in tennis to ensure training outcomes are replicating competition outcomes. An increased focus on serving frequency within tennis monitoring strategies may also have important implications for adolescent athletes that require careful training prescription.

VALIDATION OF PREDICTED JOINT ANGLES BASED ON INERTIAL MEASUREMENT UNITS AND AUTOMATED LANDING ERROR SCORING SYSTEM

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INTRODUCTION: The landing error scoring system (LESS) [1] and unilateral landing error scoring system (ULESS) [2] can be used as screening tools for sports injuries. However, it is time-consuming to use these systems for evaluating the landing pattern, and the scoring process required well-trained expertise such as therapists or trainers, which prevented the system to be widely used [3]. We aimed to utilize the inertial measurement units (IMU) sensor to develop an automated LESS/ULESS.

METHODS: Nineteen participants performed bilateral (BJL) and unilateral (UJL) jump-landing. By using a 3D motion capture system, camera and IMU, different analysis methods (3D motion analysis, 2D image, and IMU's prediction model) were used to obtain knee, hip, and trunk angles collected at initial contact (IC), maximum knee flexion (MKF) and range of mo-

tion (ROM) from IC to MKF during BJL and UJL. Intraclass correlation coefficient (ICC) was obtained to assess inter-method reliability. Bland-Altman plots was used to compare the angle obtained by each analysis methods with the 3D motion analysis for concurrent criterion validity. Wilcoxon signed-rank test was used to examine mean differences. Finally, participants' movement quality was evaluated by expert LESS raters (2D image) using the LESS rubric and by self-developed code that automates LESS scoring (3D motion analysis, and IMU's prediction model).

RESULTS: In the BJL and UJL tasks, the variables obtained from the IMU model showed moderate to excellent inter-trial correlations (ICC > .5) for the measured angles at all movement events, except for the trunk angle at the IC in UJL task which showed poor inter-trial correlation (ICC < .5). In Bland-Altman, both the predicted angle obtained from IMU and measured angles obtained from 2D image were within 1.96 times the standard deviation compared to the values calculation from 3D motion analysis, except for the hip and knee angles at MKF and ROM in BJL and for the knee angles at IC in UJL. There were significant differences (P < .05) in hip angle at IC, hip and knee angles at MKF, knee angle ROM in BJL, hip and knee angles at IC, hip, knee, and trunk angles at MKF, and hip, knee, and trunk angles ROM in UJL.

CONCLUSION: The joint angles estimated from the IMU model showed moderate to excellent reliability during BJL and UJL tasks of LESS. These preliminary results may allow further study to embaddd the predicted model in an automatic scoring system in practice. In addition, the automated LESS/ULESS developed in the current study can be used for most items except for knee valgus, standing width, and overall impression which cannot be scored based on joint angles. Finally, future works should address the challenges in defining events in the real-world scene not from the three-dimensional motion capture system but from a practical kits which consist of fusion of different devices.

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ARTIFICIAL INTELLIGENCE-BASED GOLF SWING ANALYSIS SYSTEM

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INTRODUCTION: We propose an artificial intelligence-based software system that analyzes the dynamics of a golf swing and provides targeted suggestions to help golfers improve their swing and reach their full potential. In our proposed system, a machine-learning model is applied to a large dataset of golf swings to identify patterns and relationships between the shoulder trajectory and ball flight. The system then uses computer vision techniques to track the movement of the golfers shoulder during the swing. The data collected from the tracking is then used to make predictions about the quality of the swing. Based on the predictions, the system automatically generates suggestions to help the golfer improve their swing. To be specific, the rotational angles from the player provide valuable information about the dynamics of the golf swing and can help to identify areas for improvement.

METHODS: The tool detects two key frames: the setup position where the player holds the golf club in front of them, and the follow-through (FT) position where the golf club head is farthest toward the front. Based on the two key frames, the coordinates of the shoulder joints in each frame are identified by a machine-learning based computer vision tool, MediaPipe. Then, the rotational angles of the shoulder during the swing are computed by our algorithm which involves finding the difference between the initial and final coordinates of the shoulder joint, and then using trigonometry to convert this difference into angles in the horizontal and vertical plane as follows.

RESULTS: In our experimentation, we analyzed golfer's swing and the outcomes especially focused on ball flight after swing. Our experimental results indicate a strong correlation between the shoulder rotation angle and the ball flight, with an increase in the shoulder rotation angle leading to a greater distance of the ball. This suggests that a complete shoulder turn is essential for generating power and maximizing the balls distance. By measuring the rotational angles and analyzing the correlation with the distance and angle of the ball, we can provide suggestions for improvement to help golfers improve their swing and reach their full potential.

CONCLUSION: In addition to providing guidance, the system can also track the golfers progress over time by comparing the results from multiple swings. This allows the golfer to see how they are improving and what areas they need to continue to work on. The use of the angles of the shoulder turn in our proposed system provides a more comprehensive and effective analysis of the golf swing, leading to more targeted and effective suggestions for improvement.

Overall, our proposed system can provide valuable insights into the dynamics of the golf swing and help golfers achieve their goals, making it a useful tool for golf coaches and players alike. Our proposed machine-learning based golf swing tutor can provide personalized and effective guidance to golfers of all skill levels.

PHOTOGRAMMETRY AND HOW TO MAKE BACKCOUNTRY SKIING SAFER

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MCI - ENTREPENEURIAL SCHOOL

INTRODUCTION: Mountains are becoming more and more the playground of athletes and adventure seekers. In Germany, the number of ski tourers has doubled to 500.000 in the last 10 years bringing along many injuries and deaths. There can be multiple reasons for injuries but downfall (2%), impact against obstacles (4%), getting lost (2%) and avalanches

(10%) can result from insufficient route planning and terrain judgement (DAV 2021, ÖKAS 2019). In this approach, the potential of photogrammetry and its enhancement of safety in the alpine are being analysed.

METHODS: Photogrammetry is the process of computing 3D environments based on images captured with conventional cameras or drones. Within about 40 minutes of drone flight, 550 images of different angles of a mountain were captured and rendered to a fully textured 3D model with 45 Million triangles. Then a team descended a very exposed and complex side of this mountain face first without and then with the option of planning their route using the 3D Model.

RESULTS: With the additional details from the 3D model, the team decided to ski a different line down the mountain as the model revealed 2 couloirs that had less exposure and therefore significantly less risk of downfall or high consequence avalanches. On the first approach ropes, harnesses and anchoring equipment were brought along as emergency tools for dead ends. With the detailed 3D model, it was clearly visible, that such tools would not be necessary as a safer route could be determined and followed easily by studying and screenshotting some of the relevant landmarks.

CONCLUSION: This approach clearly shows an improvement in terrain knowledge and route planning possibilities, while the advantages of using a photogrammetry model for ski touring will further be analysed in a separate study. Visual analysis is only the starting point of what this can be used for. The 3D models also allow the use of further data analysis and create filters based on factors such as snow coverage, steepness of terrain or calculating and simulating avalanches. In other sports athletes train the repetition of ever repeating movements based on anticipation and reaction. Bringing the surroundings of an athlete into a Virtual Reality simulator as accurately as possible will set the basis for developing such simulators. Those simulators are especially useful for sports with limited or costly access or to study athletes inside a lab while exercising their sports.

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Sports Medicine and Orthopedics

WEARABLE SENSOR TECHNOLOGY TO PREDICT CORE BODY TEMPERATURE: A SYSTEMATIC REVIEW

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INTRODUCTION: Exertional heat-related illness (HRI) is increasing in incidence as global temperatures rise, with heat-related deaths increasing by 74% globally from 1980 to 2016[1]. Despite the frequency and potentially fatal consequences of undetected HRI, coaches, trainers, supervisors, and employers currently rely on visible cues and subjective assessments of their athletes and employees for early detection, such as malaise, confusion, thirst, ataxia, or excessive sweating. The measurement of core body temperature (CBT) using existing rectal, esophageal, or pill thermometers has been shown to predict HRI and its severity, but these measurement methods are excessively invasive, obstructive, or costly for high acuity and high motion settings. Noninvasive prediction of CBT using wearable technology and predictive algorithms offers the potential for continuous CBT monitoring and early intervention to prevent HRI in athletic, military, and intense work environments.

1. Fernandez, M. Extreme Heat-Caused Deaths Have Jumped 74% in the Last 30 Years Available online: https://www.axios.com/2021/08/20/extreme-heat-killed-nearly-400000-people-globally (accessed on 1 December 2022).

METHODS: A systematic literature search was conducted in the Web of Science Core Collection database to identify works from 1 January 2000 until 31 December 2021 in which predicted CBT was compared to measured CBT in actively exercising subjects.

RESULTS: This systematic review identified 20 studies representing a total of 25 distinct algorithms to predict core body temperature using wearable technology. The unweighted average RMSE after removal of an outlier was 0.28 ± 0.14 °C. Clinical validity standards of RMSE less than or equal to 0.5 °C were met by 17 out of 18 algorithms. However, few algorithms incorporated individual and environmental data into their core body temperature prediction algorithms, despite the known impact of individual health and situational and environmental factors on CBT, thus limiting the population and settings in which these algorithms can be considered valid. High accuracy across variable conditions and subjects was observed in the two algorithms in this review that reported the use of ML methods.

CONCLUSION: Robust machine learning methods offer the ability to develop more accurate, reliable, and personalized CBT prediction algorithms using wearable devices through increased data processing abilities. The integration and interoperability of CBT prediction algorithms with existing HRI prevention and treatment tools, including heat indices such as the WBGT, athlete management systems, and electronic medical records, will further prevent HRI and increase the availability and speed of data access during critical heat events, improving the clinical decision-making process for athletic trainers and physicians, sports scientists, employers, and military officers.

PHYSICIAN-PATIENT SEX CONCORDANCE AND ABILITY TO CARE FOR ATHLETES

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INTRODUCTION: The effect of physician-patient sex concordance in medicine has been reported in many studies. However, agreement on whether physician sex has an effect on their ability to care for athletes of concordant or different sexes in sports medicine is not fully understood, and differences between surgeons and nonsurgeons has not been investigated.

METHODS: An anonymous survey was distributed to sports medicine physicians around the globe. Participants (n = 1,193) were asked to decide whether sex of the physician made them better suited to care for athletes of concordant or different sexes along with their personal background. Participants were sports medicine physicians trained in orthopedics (n = 472 [39.6%]) and nonorthopedics (n = 721 [60.4%]).

RESULTS: Chi-square analysis revealed that 35% of the orthopedics trained sports medicine physicians answered "strongly agree" or "agree" to the statement, "MALE sports medicine physicians are better suited that their female counterparts to care for MALE athletes," which was significantly higher than the non-orthopedic-sports medicine physicians ($p < 0.001$). Moreover, 6.2% of the orthopedic- sports medicine physicians answered "strongly agree" or "agree" to the statement, "MALE sports medicine physicians are better suited that their female counterparts to care for FEMALE athletes," which was significantly higher than the non-ortho-SM group ($p = 0.003$). Regression analysis revealed that orthopedic-sports medicine physicians agreed less than nonorthopedic-sports medicine physicians regarding the agreement on male physicians more suitable to care for male athletes (odds ratio = 0.61. $p < 0.05$).

CONCLUSION: Sex of the physician and athlete may have an effect on treatment but focusing on it too much may not be suitable for patient care

INJURIES IN INTERNATIONAL MEN'S SIXES LACROSSE: INJURY SURVEILLANCE OF THE BRITISH LACROSSE MEN'S NATIONAL TEAM DURING A NINE-MONTH TRAINING CYCLE LEADING UP TO AND INCLUDING THE WORLD GAMES 2022.

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INTRODUCTION: International lacrosse is expanding into new variants, including World Lacrosse Sixes (Sixes). Currently, no data exits on injury surveillance in this new, shortened version of the sport, which is currently under review for Olympic Games inclusion in 2028. The purpose of this descriptive epidemiology study is to analyse injury data in a Men's National Sixes lacrosse team across training and competition.

METHODS: This study prospectively observed injuries that occurred within a training and competition cycle of the British Lacrosse Men's National Lacrosse team in the build up to the World Games 2022. The data was collected by the team physiotherapist, injury incidence was calculated based on exposure and data categorized into injury type, body part, and mechanism.

RESULTS: 43 injuries were observed as a result of playing Sixes. Injury incidence rates varied between practice and tournaments. 11.6% of the injuries were time-loss injuries, 67.4% of the injuries were able to continue following treatment and 20.9% of the injuries were able to continue without any treatment. Injuries most frequently occurred in competitive matches (65.1%). The lower limb was the most commonly injured area (62.8%), with the lower leg predominantly being the most affected part of the lower limb (63.0%). Most injuries were sustained through a contact mechanism (48.8%) or an overload mechanism (37.2%). The most frequent injuries were contusions (25.6%) and muscle injuries (25.6%).

CONCLUSION: To our knowledge, this is the first epidemiologic study of Sixes lacrosse injuries. Injury rates differed to those of field lacrosse. Further research is required in epidemiology and risk factors for injuries of Sixes lacrosse.

RUNNER'S PERCEPTIONS OF MEDICAL COVERGE DURING THE 33RD « TOUR OF FASO »

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INTRODUCTION: The enthusiasm of African populations for cycling is growing. The medical coverage of the 33rd « Tour of Faso » was a great challenge due to insecurity issues. One of the major indicators of the quality of medical care is the satisfaction of runners. The aim of this study was to report the perception of medical service offered to riders who sustained injuries during the 33rd « Tour du Faso ».

METHODS: This was a cross-sectional descriptive study. We have included in this study all riders who sustained accidental traumatic injuries and treated during the 33rd « Tour of Faso ». A questionnaire was established to collect demographic data and perceptions of the 33rd « Tour of Faso » medical service.

RESULTS: The peloton of the 33rd International Cycling Tour of Burkina Faso was made up of 82 riders from Europe and Africa. A total of 24 cases of fall were recorded, representing 29.26% of the peloton. The mean age was 26.48 ± 4.40 years. They came from sub-Saharan Africa in 62.5% of cases. They had more than one Tour participation in 75% of cases. The identification of the medical team was easy for 87.5% of the victims. The same value was obtained for the assessment of the quality of care. Five cases of self-medication were reported. Among them, 4 gave personal reasons. The main suggestion was to strengthen communication about the medical service of the Tour.

CONCLUSION: Riders perception and knowledge of the « Tour of Faso » medical service need to be improved. Raising awareness is necessary.

ACUTE EXERCISE AND EXECUTIVE-RELATED OCULOMOTOR PERFORMANCE IN INDIVIDUALS WITH PARKINSON'S DISEASE

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INTRODUCTION: There is limited information available on which type of aerobic exercise is optimal for improving impairments in executive function and oculomotor control in individuals with parkinson's disease (PD). In the present study, we explored the effects of interventions involving acute bouts of aerobic exercise of varying intensity on executive-related oculomotor performance in individuals with PD.

METHODS: Twenty-three individuals with PD completed an acute bout of each of continuous moderate-intensity exercise (CMIE), high-intensity interval exercise (HIIE), and a rest session in counterbalanced order using a balanced within-subject cross-over design. Their neuropsychological and oculomotor performance parameters in the saccade paradigm at baseline and following each session were assessed.

RESULTS: There was no significant effect of acute CMIE or HIIE on the coefficient of variation of the reaction time (RT) in individuals with PD. However, HIIE induced significantly shorter RTs in the antisaccade condition ($p = .001$), and CMIE did so in both the prosaccade and antisaccade conditions (both $ps < .036$). In oculomotor performance, a change in saccade peak velocity only following CMIE ($p = .003$), not HIIE, was observed. However, the two acute aerobic exercise modes failed to significantly affect saccade amplitude and latency.

CONCLUSION: The present results suggest that acute HIIE and CMIE protocols may have various beneficial effects on executive-related oculomotor performance in individuals with PD.

EPIDEMIOLOGY AND SEVERITY OF MEDICAL EVENTS FOR MOUNTAIN BIKERS AND HIKERS TRANSPORTED BY AMBULANCE IN WESTERN AUSTRALIA 2015-2020

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INTRODUCTION: Outdoor activities offer physical and mental health benefits. However, incidents can occur requiring ambulance transport to hospital. This study aimed to describe the epidemiology and severity of traumatic and medical incidents for mountain bikers and hikers transported by ambulance within WA.

METHODS: This was a retrospective cohort study of ambulance-transported mountain bikers and hikers within WA from 2015-2020. Data were extracted from ambulance patient care records. Multivariable analyses were undertaken to identify variables associated with higher patient severity based on the National Early Warning Score (NEWS2)

RESULTS: A total of 610 patients required ambulance transport to hospital whilst mountain biking (n=329, 54%) or hiking (n=281, 46%). The median age of mountain bikers and hikers was 38 (24-48) years and 49 (32-63) years, respectively. Overall, 339 patients (56%) were male, and 271 (44%) were female. Most mountain bikers were male (n=274, 83%), whereas more females were hikers (n=166, 59%). Paramedics reported a fracture in 92 (28%) mountain bikers and 78 (28%) hikers. The predominant injury locations for mountain bikers were upper limbs and for hikers lower limbs. A total of 245 (74%) mountain bikers received analgesia and 190 (67%) hikers. Cases were trauma-related in 92% of mountain bikers and 55% of hikers. Around 23% of mountain bikers had NEWS2 scores above low risk compared with 30% of hikers. Unadjusted analysis showed a significant association ($p<0.05$) between the primary outcome (presence of more clinical severity) and the activity being undertaken with hikers being more likely than mountain bikers to have higher severity NEWS2 scores (OR = 1.5, 95% CI 1.02-2.1, p=0.037).

CONCLUSION: We found that both mountain bikers and hikers experienced incidents requiring transport to hospital by ambulance. Mountain bikers were younger and more likely to be male, with hikers older and more likely to be female. Mountain bikers sustain predominantly upper limb fractures and hikers typically sustain lower limb fractures. These findings show the importance of correct protective clothing for both mountain bikers (arm guards and shoulder pads) and hikers (well-fitted, suitable-soled, high ankle boots). Trauma-related incidents were more common in mountain bikers, but hikers had a higher level of clinical severity, as indicated by the NEWS2 scores. Hikers had a greater proportion of their vital signs outside of normal range according to the NEWS2 classification and overall, mountain bikers and hikers who were transported to hospital were more likely to have a higher NEWS2 if it was for a medical aetiology than a trauma-related one. Hikers new to the sport should consult with their general practitioner about their current fitness to undertake such an activity. Additionally experienced hikers should consider pre-existing health conditions before setting out on a hike in remote areas.

COMPARISON OF BONE METABOLISM MARKERS (BAP AND TRACP-5B) : ELITE VERSUS NON-ELITE IN COLLEGIATE MALE LONG-DISTANCE RUNNERS

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INTRODUCTION: The effect of exercise on bone health has received much attention in recent years. Overuse injuries, including stress fractures, are serious problems faced by athletes. Track-and-field athletes have the highest incidence of stress fractures than the other athletes (1). A stress fracture is a break in bone tissue caused by repeated minor external mechanical stress caused by activities, such as running, that can occasionally lead to a complete fracture. Stress fracture is a serious injury because it takes a long time for complete healing and prevents athletes from training (2). Bone strength is associated with bone density and quality (bone metabolism and collagen cross-linking). Low bone density has been reported to increase the risk of stress fracture. Nonetheless, as results based on bone density reflect nutritional condition and mechanical stress over several previous months, they are not suitable for early detection of stress fractures. This study aimed to examine the usability of some bone metabolism markers to prevent overuse bone injuries in collegiate male long-distance runners.

METHODS: The subjects included 18 elite collegiate male long-distance runners ([ER] height, 172.6 ± 5.5 cm; weight, 57.4 ± 4.9 kg; body fat percentage, 6.0% ± 2.0%) and 9 non-elite collegiate male long-distance runners ([NER] height, 169.0 ± 4.4 cm; weight, 57.4 ± 7.1 kg; body fat percentage, 11.5% ± 2.6%). Bone metabolism markers, such as bone alkaline phosphatase (BAP) and bone-specific tartrate-resistant acid phosphatase (TRACP-5b), were measured in both the groups. Body fat percentage was measured by bioimpedance analysis.

RESULTS: No significant differences were observed in the levels of BAP (ER 16.4 ± 3.9 vs. NER 15.5 ± 6.5 U/L) and TRACP-5b (ER 574.3 ± 162.6 vs. NER 656.4 ± 195.7 mU/dL) between the elite and non-elite collegiate male long-distance runners. However, the body fat percentage was significantly different between ER (6.0% ± 2.0%) and NER (11.5% ± 2.6%) ($p < 0.001$).

CONCLUSION: In this study, targeting 18 elite and 9 non-elite collegiate male long-distance runners, we conducted a questionnaire survey on physical characteristics and measured bone metabolism marker with the serum samples. The finding is as follows: In non-elite collegiate male long-distance runners, body fat percentage was significantly higher than that in the elite collegiate male long-distance runners ($p < 0.001$).

A COMBINED INFRARED METHOD WITH THERMAL IMAGING AND RASTERSTEREOGRAPHY TO ASSESS BACK CHANGES IN HEALTHY INDIVIDUALS: A CROSS-SECTIONAL STUDY

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INTRODUCTION: Musculoskeletal disorders in the healthy population are increasing as the assumption of incorrect posture is recurrent during daily activities. Non-invasive methods are spreading to overcome the need to screen many people without harmful effects. Rasterstereography provides information on changes in back posture; infrared thermography investigates body temperature reactions to different stimuli. These methods can identify specific changes before individuals experience pain or posture alteration. Therefore, we propose a combined infrared method with thermal imaging and rasterstereography to assess back changes and provide normative data for this method.

METHODS: In this cross-sectional study, 175 healthy individuals (85 men and 90 women) were analyzed, 29.25 ± 5.95 years old, weight 62.66 ± 7.4 kg, and 170.18 ± 7.20 cm in height. Spine 3D® evaluated the morphological structural aspect of the FLIR E54 back; the infrared camera measured the temperature of the back. The Student's t-test determined any significant differences between male and female rasterstereography and thermal images; Cohens effect size (d) showed significant differences between groups, while Pearson's correlation (r) highlighted the relationship between the two methods.

RESULTS: In the sagittal plane, the depth of the cervical region (males= 43.67 ± 9.99 mm vs. females= 31.74 ± 7.76 mm, d = 1.33) and the angle of lumbar lordosis (males= 36.39 ± 8.70 ° vs. females= 47.56 ± 8.47 °, d= -1.30) have a large effect size. In the coronal plane, shoulder obliquity (males= -7.23 ± 10.16 mm vs. females = -2.91 ± 9.93, d= -0.43) and vertebral deviation RMS (males= 3.01 ± 1.61 vs. females = 2.57 ± 1.48, d= 0.28) show a small effect size. In the transversal plane, the shoulder torsion has a small effect size (males= -0.25 ± 2.41 ° vs. females = -1.02 ± 2.43 °, d= 0.32). The back temperature shows gender differences in the cervical area (males= 33.84 ± 0.63 ° C vs. females= 34.29 ± 0.86 °C, d= -0.58) and the dorsal area (males= 33.14 ± 0.70 ° C vs. females= 33.64 ± 0.95 °C, d= -0.60). Furthermore, males showed a moderate correlation between the surface rotation of the vertebrae RMS and the cervical (r= -0.42), dorsal (r= -0.57), and lumbar (r= -0.48) regions. The female lumbar temperature is moderately correlated with the angle of lumbar lordosis (r= -0.43) and the dorsal temperature with shoulder torsion (r= 0.43).

CONCLUSION: The combined infrared method highlights an interesting correlation between the two suggested methods in the postural analysis of the back. Further studies in a pathological population may elucidate the mechanisms of spinal alteration and the thermal response of muscles.

USE OF SOCIAL MEDIA FOR SPORTS INJURY PREVENTION AND MANAGEMENT BY RECREATIONAL ATHLETES

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INTRODUCTION: The progressive growth of social media and its increasing engagement potential as a sports medicine information resource [1] together with the consistent prevalence of sport injuries suggests the possibility of social media as an effective platform for sport injury information provision [2]. This relatively new scope of study yields limited literature on social media for sport injury information and hence comprehensive insights are yet be drawn for applied practice.

METHODS: A descriptive cross-sectional study was conducted. 267 recreational athletes volunteered and completed a self-reported online 45-item questionnaire. The questionnaire included sections on demographics, sports participation and training, injury history, if medical advice was sought, preference of information sources to identify and manage the injury, information on social media usage and perceptions on its effectiveness in injury prevention and management.

RESULTS: Internet was the most preferred source of information (53.4%). 60.6% of recreational athletes reported to use social media as an information resource for sport injury awareness and management. 63.7% of these were below 25 and 17% above 50 years age. 82.1% participants self-explored the social-media options for information. Majority (35.8%) explored the social media for new injuries followed by those with chronic injuries (27.1%). Those with knee, ankle and lower back injuries more frequently resorted to social-media search. While 44% self-diagnosed the injury using information on social media, <50% of them found the information to be useful enough for injury awareness and management. Information presented by professionals (e.g., doctors & physiotherapists) were more commonly accessed. 55.1% participants found social-media to be convenient, allowed them to discuss and interact with those with similar problems, 70% intended to continue to use social-media for injury management and 90% believed that social-media can be a useful information resource for sports injury awareness and management.

CONCLUSION: Social media has the potential as a platform for sport injury awareness and management-related information, and recreational athletes seem to benefit from it for their injury treatment and rehabilitation. Given that information by professionals is more frequently accessed and perceived to be of higher credibility, practitioners and professionals may consider social-media platforms as a facilitator of information and service to the athletic population.

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RETURN-TO-SPORTS TRAINING AND LATE-STAGE REHABILITATION AFTER ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION AND FORMAL TREATMENT COMPLETION: A MULTICENTRE RANDOMISED CONTROLLED TRIAL

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INTRODUCTION: At the completion of the formal, medically prescribed rehabilitation following an arthroscopic anterior cruciate ligament reconstruction, only a minor share of athletes resolve their functional capacities. The end of the formal rehabilitation is, thus, not the end of the functional rehabilitation. Objective: To compare the intervention adherence and effectiveness of a specific, late-stage rehabilitation to usual care after anterior cruciate ligament (ACL) reconstruction.

METHODS: Design: Prospective, double-blind multicentre parallel groups randomized controlled trial (RCT). Participants aged 18-35 years after formal rehabilitation completion (on average 241 days post-reconstruction) were block-randomised to a 5-month neuromuscular performance intervention (Stop-X group) or to the Usual care (medically prescribed and individual formal rehabilitation) group. All outcomes were measured therapists- and assessor-blinded once a month. The knee separation distance at landing a drop jump was the primary outcome. Linear mixed models were calculated using the change scores.

RESULTS: N = 112 participants (Stop-X: 57; Usual care: 55) were analysed. Initially, the intervention frequency was higher in the Stop-X than in the Usual care group: 2.65 (standard deviation 0.96) units per week versus 2.48 (1.14) per week, respectively, in the first and 2.28 (1.02) versus 2.14 (1.31) per week, respectively, in the second month. No adjusted between-group*time(*baseline)-differences were found for the primary outcome. Baseline-adjusted between-group*time-effects favour the Stop-X-group at two months for knee problems during sport (KOOS-SPORT) (estimate = 64.3 [95% CI = 24.4 to 104.3] for the Stop-X), for confidence to return to sport (ACL-RSI) (62.4 [10.7 to 114.2]), for pain-associated knee problems (KOOS-PAIN) (82.8 [36.0 to 129.6]), during everyday activities (KOOS-ADL) (71.1 [6.4 to 135.7]), and for the limb symmetry index in the front hop for distance at months 3 and 4 ((0.34 [0.10 to 0.57]; 0.31 [0.08 to 0.54])). No between-group*time-effects occurred for kinesiophobia, symptom-associated knee problems or the Balance hops performance. Until the end of the intervention, 79% of the Stop-X and 70% of the Usual care participants ($p < 0.05$) have successfully returned to their pre-injury sport type and level.

CONCLUSION: In our multicentre RCT, we found that a 5-month, late-stage rehabilitation and return-to-sports training programme after an anterior cruciate ligament reconstruction and formal treatment completion programme to be slightly

superior to usual care. The intervention led to superior effects when compared to usual care in certain neuromuscular functions within the initial 3 months of the intervention as well as in return-to-sporty rates and time spans until return-to-sport. The low costs and the small benefit may justify its usage after formal rehabilitation completion.

FROM INJURY PREDICTION TO INJURY RISK ASSESSMENT, CAN WE MODEL REAL-TIME ACTIONABLE INSIGHT FROM HETEROGENEOUS TRAINING AND HEALTH DATA?

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INTRODUCTION: Overuse injuries occur without a specific, identifiable event that is responsible and, as such, still represent a substantial problem in many sports disciplines. Due to the gradual appearance of symptoms in the early injury phase, athletes are likely to continue to train and compete despite overuse conditions. The typical presentation and characteristics of overuse injuries make them difficult to capture. The process of sports injury occurrence depends on many factors and constraints that interact in ways that are often unknown [1]. Preventive routines are part of many training programs. Still, they are often based on subjective measures or periodical medical assessments that lack the warning sign of injury risk level at the moment of measurement. Combining medical evaluation with real-time performance and health output from wearables represents a potential for a real-time injury risk assessment and creates a need for a novel approach. This study developed a framework that incorporates heterogeneous training and health data from wearables and self-reported questionnaires to estimate the risk of injury.

METHODS: The simulation study was performed based on longitudinal data assessed weekly with the OSTRC questionnaire [2] in Dutch Olympic athletes. The data set included 11 participants followed over 52 weeks with dichotomous injury outcomes encountered within the data set. This approach assumes that an athlete is transitioning between different injury states over time depending on observable covariates. Such an approach considers that each athlete can change injury state many times over the course of follow-up. The latent Markov model [3] was used to model the probability of transitions between injury states for an individual athlete, depending on the simulated training load and gender.

RESULTS: The model provided the current injury state and the probability of transitioning to another state. We retrieved model accuracy between 88% and 95% in the model's ability to predict future injury states.

CONCLUSION: Probabilistic graphical models, such as those employed in this study, show promising results in injury risk assessment based on training and health data. The model's outcome may be used as a guideline in rehabilitation and to support practitioners in making real-time risk management decisions.

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COMMON RISK FACTORS FOR SPORTS INJURIES IN AMATEUR FOOTBALL MALES

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INTRODUCTION: Football is a confrontational sport with high intensity and fast rhythm, so it is easy to happen sports injuries in football. The occurrence of sports injury is closely related to the characteristics of sports events, sports venues, fatigue, age, and other factors, which are called the risk factors of sports injury. At present, there are relatively few studies on the risk factors of sports injury for ordinary male sports enthusiasts. Therefore, this study aims to identify the common risk factors of sports injury in amateur football men according to the questionnaire information.

METHODS: Based on expert interviews, a questionnaire was designed to investigate the risk factors of sports injury. The subjects were adult males who exercised regularly, professional training background and chronic diseases were not considered. Adult amateur football men are the target group for this study. Questionnaires are released through the Netease positioning and Questionnaire Star platform, and the questionnaires are collected in the form of electronic files. Trap questions, manual screening, and other techniques were used to evaluate the quality of the questionnaire. All data were analyzed using SPSS 26.0. Through descriptive statistics, mean±SD, the exploratory factor analysis (KMO > 0.6, P < 0.05), the contribution rates of different factors to sports injury risk of male football players were obtained.

RESULTS: A total of 10866 valid questionnaires were collected, among which 1018 data from the male who were amateur football were extracted and included in statistical analysis. According to the data from the questionnaire, the injury incidence rate of amateur male football players was 93.5% (965/1032). KMO=0.672 was obtained by exploratory factor analysis, and P<0.01 was obtained by Bartletts spherical test, indicating a significant correlation between variables. Factor analysis principal component method extracted 5 common factors, a total variance contribution of 73.6%. According to the characteristics of risk factors, five common factors were named, namely, strength quality (m1), exercise habits (m2), morphological characteristics (m3), fatigue recovery (m4), and sports grounds (m5), among which m1 contributed the most (24.3%). The aforementioned criteria provide a clearer explanation of the risk factors for sports injuries among amateur football men generally.

CONCLUSION: (1) the sports injury risk factors questionnaire designed in this study can effectively collect relevant information about sports injury risk factors of amateur male football players; (2) Strength training, exercise habits, morphologi-

cal characteristics, fatigue recovery, and sports grounds have significant effects on the risk of sports injury in amateur football men, the exposure frequency of risk factors should be considered to avoid sports injuries.

COMMON RISK FACTORS FOR SPORTS INJURIES IN AMATEUR BASKETBALL MALES

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INTRODUCTION: Basketball is a sport with great intensity and fierce confrontation, so sports injuries are easy to occur. There are many amateurs due to various internal and external factors, resulting in different sports injuries. Few pieces of research on the risk factors of sports injury in amateur males. So this study aims to extract information from a designed questionnaire, determine the risk factors that may predict injuries for amateur basketball males, and give advice on preventing injuries.

METHODS: A questionnaire was designed to investigate the risk factors of sports injury. It was distributed using NetEase positioning and Questionnaire Star platforms, aiming at regular exercise adults. The quality of the questionnaire was checked by means of trap questions, finishing time and manual screening, et al. Internal reliability was measured through the calculation of Cronbachs alpha coefficient. Exploratory factor analysis was used to evaluate construct validity by the Kaiser-Meyer-Olkin (KMO) and Bartletts sphericity test, cumulative variance contribution rates were obtained. Chi-square test was performed to estimate the odd ratios of risk factors. The data were statistically analyzed through SPSS 26.0; the significance level was 0.05.

RESULTS: A total of 18316 valid questionnaires were collected and 2431 questionnaires were amateur basketball males. The total Cronbachs alpha coefficient was calculated 0.705. Exploratory factor analysis (KMO=0.657) and Bartletts test of spherical ($p<0.01$), indicated a significant correlation between the variables. The principal component factor analysis produced four common factors: strength quality, exercise habits, fatigue recovery and exercise cognition. The total variance contribution rate was 71.1%. Chi-square test showed that strength training($p<0.001$, OR 0.548), "always"($p<0.001$, OR 0.347) and "often"($p=0.002$, OR 0.533) strength training with professional guidance, wearing professional sports shoes ($p=0.005$, OR 0.106), "always" warm-up($p=0.015$, OR 0.358), "always" ($p=0.006$, OR 0.315) and "often" ($p=0.003$, OR 0.300) relax were protective factors; machine load-bearing($p=0.001$, OR 2.258), free load-bearing($p=0.008$, OR 1.995) and tired or illness ($p=0.001$, OR 1.868) were damage factors.

CONCLUSION: The study results confirmed the validity and reliability of the questionnaire to evaluate injury risk factors in amateur basketball males. To evaluate the risk of sports injury, four aspects should be included: strength quality, exercise habits, fatigue recovery and exercise cognition. We suggest amateur basketball males follow advice including strength training , strength training with professional guidance, wearing professional sports shoes, warm-up and relaxation; avoid machine and free load-bearing training and do not exercise when tired or illness. The frequency of exposure to risk factors should be considered for basketball males to prevent sports injuries.

BIOIMPEDANCE ANALYSIS IS A NEW INDICATOR OF EXERCISE-INDUCED MUSCLE DAMAGE

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INTRODUCTION: Bioimpedance analysis (BIA), which measures the electrical resistivity of a living body by applying a weak electric current, has been used primarily to estimate body composition. In addition, BIA may be useful in assessing the degree of exercise-induced muscle damage (EIMD) resulting from intense eccentric contractions. Indeed, previous studies have reported a significant increase in extracellular water (ECW) content after the onset of EIMD. However, these studies only evaluated intracellular and extracellular water content and did not investigate other BIA parameters such as impedance, reactance, and resistance. Therefore, the purpose of this study was to analyse BIA parameters not reported in previous studies.

METHODS: Twenty-two healthy young men with limited exercise experience performed 50 dumbbell exercises at 50% of the maximum lifting weight, with a bias on eccentric contractions. All subjects performed the dumbbell exercise with the left arm. Measurements were performed to assess the degree of EIMD at 8 points on both arms before and immediately after, and at 1, 24, 48, 72, 96, and 168 hours after exercise. BIA parameters (impedance, reactance, and resistance), subjective muscle soreness (SOR), and maximal voluntary isometric muscle capacity (MVIC) were analysed. BIA was measured using InBody. After a two-way analysis of variance (left arm vs. right arm) was performed, BIA parameters were post-hoc tested using the Bonferroni method. A one-way analysis of variance was used to assess other EIMD measures followed by post-hoc testing using the Bonferroni method. The significance level was set at $p < 0.05$. All statistical analyses were performed using Predictive Analytics Software (PASW) version 26.0 for Windows (SPSS Japan Inc., Tokyo, Japan).

RESULTS: Results showed that SOR was significantly higher after 24 hours of eccentric exercise; MVIC was significantly lower immediately after exercise, and total body water (TBW), ECW, and intracellular water (ICW) were higher in the left arm than those in the right arm at all time points. Impedance, reactance, and resistance were lower in the left arm than those in the right arm at all time points.

CONCLUSION: Generally, histamine and kinins cause vasodilation and increased vascular permeability, which induce swelling at the site of injury. Therefore, the changes in intracellular and extracellular water content found in this study may be attributed to vasodilation and increased permeability. In addition, impedance reflects the amount of membrane proteins, resistance reflects the amount of body water as a conductor inside and outside the cell, and reactance reflects the

resistivity of the electrical capacitance of the cell membrane. In the present study, all BIA parameters were significantly altered, suggesting that EIMD may have caused changes in the amount of membrane proteins, the amount of body water as a conductor, and damage to the cell membrane.

TEMPORARILY INSUFFICIENT SLEEP DOES NOT NEGATIVELY INFLUENCE ON CAROTID ARTERY STIFFNESS RESPONSE TO CARDIOPULMONARY EXERCISE IN YOUNG ADULTS

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INTRODUCTION: Insufficient sleep is a prevalent global health issue and associated with cardiovascular disease (CVD) risk. Carotid artery stiffness, a clinical index of CVD, can be improved through regular physical activity. However, there has been a limited number of studies to investigate the combined effect of insufficient sleep and exercise on carotid artery stiffness. Therefore, this study aimed to assess the combined effects of cardiopulmonary exercise and insufficient sleep on carotid artery stiffness in healthy young adults.

METHODS: In a randomized cross-over design, six young adults (4 females & 2 males; 22.2±0.3 yrs) visited our laboratory at both insufficient sleep (IS; 3.0±0.1 hrs) and normal sleep (NS; 7.5±0.1 hrs) condition. All participants performed moderate intensity treadmill exercise for 30 minutes at 70% of peak heart rate. To compare and analyze any differences in changes in carotid artery stiffness measures in response to the exercise between two different sleep conditions, we assessed carotid artery compliance, distensibility, and β-stiffness index using an Aloka Prosound α7 ultrasound system and Cardiovascular Suite analysis software.

RESULTS: At baseline, there was no significant difference in carotid artery compliance, distensibility, and β-stiffness index between IS and NS conditions ($P \geq 0.72$). There was no significant condition by time interaction on carotid artery compliance, distensibility, and β-stiffness index between two different sleep conditions ($P \geq 0.56$).

CONCLUSION: Temporarily insufficient sleep does not negatively affect carotid artery stiffness indices at rest and their responses to cardiopulmonary exercise in healthy young adults.

CONSERVATIVE TREATMENT OF CAPITELLAR OSTEOCHONDRITIS DISSECANS IN YOUNG BASEBALL PLAYERS: IS ANNUAL ULTRASOUND ELBOW SCREENING EFFECTIVE?

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INTRODUCTION: Capitellar OCD is a typical sports disorder that occurs in the elbow joint of young baseball players and often requires surgical treatment. Reportedly, the prevalence of OCD is 2-3% among baseball players, and it is known that the earlier the stage of the disease, the better the outcome of conservative treatment. Capitellar OCD can be diagnosed by ultrasonography, and we have been recommending annual ultrasound (US) elbow screening for young baseball players in our community since 2008. The purpose of this study was to compare the results of conservative treatment of OCD detected by US elbow screening with those of OCD diagnosed only after a direct visit to a hospital and to investigate the usefulness of US elbow screening for young baseball players.

METHODS: During 2009-2019, 263 baseball players were diagnosed with capitellar OCD at our institution and satellite hospitals and 250 cases were followed up longer than 12 months were enrolled in this study. The patients were divided into a US screening group and a hospital group according to whether the diagnosis of OCD was made by US elbow screening or direct hospital visit. Age at the time of initial visit, stage of the OCD (stage I, II, or III), results of conservative treatment (complete healing, partial healing, or surgery), and period for return to sports were studied. The results were statistically compared between the two groups. A p value of <0.05 was considered significant.

RESULTS: There were 158 patients in the US screening group and 92 patients in the hospital group. The age at first visit was 12.0±2.1 y.o. in the US screening group and 13.9±2.1 y.o. in the hospital examination group. In terms of the stage of the OCD at the time of initial examination, percentage of the patients in the US screening group of the stage I, II and III were 60.8%, 31.0%, and 8.2%, respectively, while 21.5%, 41.9%, and 35.5% of the patients in the hospital group were in the stage I, II, and III, respectively.

The results of conservative treatment showed that 60.8% of patients in the US screening group had complete healing, 12.0% had partial healing, and 27.2% had surgery. On the other hand, 18.5% of patients in the hospital group resulted in complete healing, 10.9% resulted in partial healing, and 70.7% underwent surgery. Complete healing was significantly more common in the US screening group. There was no significant difference in the period to return to sports between the two groups.

CONCLUSION: Capitellar OCD is often asymptomatic or minimally symptomatic at the early stage when conservative therapy is effective. However, by the time the patient presents to the hospital directly with symptomatic OCD, the stage of the disease has often progressed. In this study, the US screening group was significantly younger and had more stage I lesions, and 72.8% of them were able to return to play conservatively. On the other hand, patients in the hospital group were significantly older and had fewer stages I lesions, and only 29.4% were able to return to play conservatively. The efficacy of US elbow screening is that it can detect capitellar OCD at an early stage with fewer symptoms and lead to conservative healing of the lesion and return to sports in a higher percentage of patients. US elbow screening had a positive impact on the outcome of conservative treatment of capitellum OCD.

STUDY OF STRATEGIES FOR STRESS FRACTURES IN RECRUITS BASED ON THE MALE ATHLETE TRIAD.

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INTRODUCTION: A stress fracture (SF) is a non-traumatic injury that occurs in the weight-bearing bones of the lower limbs and is mainly caused by a sudden increase in repetitive motion. A variety of internal and external factors can increase the risk of stress fractures, but previous studies have focused more on external factors. As the fitness of recruits changes, there is a need to consider the internal factors that cause fractures.

METHODS: This paper is a review of the causes of stress fractures in recruits at the present time, with reference to the national and international literature.

RESULTS: Stress fractures are incomplete fractures not caused by trauma. Extrinsic risk factors include previous footwear discomfort, inadequate vitamin D/calcium intake and poor environment. Athletes and military trainees, who may experience periods of increased physical activity during training that exceed their energy intake, often have this metabolic state. In athletes and military trainees, inadequate energy intake leads to disturbances in reproductive hormones. A prolonged decline in reproductive health will affect bone health, leading to stress fractures. Tenforde et al. define the clinical signs of relatively low energy intake (eating disorders), reduced testosterone levels (decreased libido) and low bone mineral density (osteoporosis) as the male athlete triad. This may be associated with an increased risk of stress fractures. Most studies on the "male athlete triad" have focused on male athletes. However, these signs are also common in military training for recruits.

CONCLUSION: The "male athlete triad" is an objective and complex syndrome in sports medicine that exists during military training and has a relationship between its three symptoms and stress fractures in recruits, and is an important internal factor contributing to stress fractures in recruits. There are gaps in the epidemiological features, clinical characteristics and treatment options for the "male athlete triad". A multicentre prospective study should be conducted to determine the internal and external causes of stress fractures in recruits, with a focus on the internal causes of the male athlete triad.

THE CLINICAL EFFECTIVENESS OF THE COMPLEX UPPER EXTREMITY LOW-INTENSITY RESISTANCE TRAINING COMBINED WITH BLOOD FLOW RESTRICTION IN THE TREATMENT OF TENNIS ELBOW

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INTRODUCTION: Tennis elbow was known as the lateral epicondylitis or lateral elbow tendinitis, such as inflamation of the origined site of common wrist externsors due to overuse. The symptom includes chronic pain, decrease muscular strength and reduced functional ability. Thereafter, mucular stenethening for wrist entensor within pain tolerance is important. However, few study investigated the effect of blood flow restriction (BFR) for muscular strengthening for clients with tendinopathy.

The purpose of this study was to investigate whether there is pain relief and painless grip strength and functional improvement in clients with lateral tendinopathy by combining low-intensity resistance training with or without BFR for 4 weeks, three times a week.

METHODS: A total of 11 clients were divided into two groups randomly; 5 subjects in the low-intensity resistance training combined with blood flow restriction group (LI-BFR), 6 subjects low-intensity resistance training groups (LI). Before and after training, the assessment and measurement tools include Visual Analogue Scale (VAS), Patient-Rated Tennis Elbow Evaluation Questionnaire (PRTEE), and pressure pain threshold (PPT) maximum painless grip strength (PFG) as the outcome measure.

RESULTS: After 4 weeks of training in the two groups(LI-BFR、LI), for within-group comparison, the VAS, PRTEE, PPT,PFG were significantly improved afer training($P < 0.05$). In the comparison of the changes between groups, the PFG and PPT improved significantly in the LI-BFR group compared with those in the LI group ($P < 0.05$) .

CONCLUSION: This study shows that the two groups (LI-BFR, LI) at 4 weeks can effectively improve pain, painless grip strength, tenderness threshold and function inclients with lateral elbow tendinopathy. Combined with blood flow restriction (LI-BFR) can provide better clinical rehabilitation training effects especially for improvements on pressure pain threshold and maximum painless grip strength.

GENETIC POLYMORPHISMS INFLUENCE ON SPORTS INJURIES AND MUSCLE DAMAGE

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INTRODUCTION: The practice of sports or physical activity has been acknowledged to be beneficial for health. However, the physical practice may also induce injuries related to the sport. Indeed, when related to 1000 hours of practice, injury incidence in training is 3.7 in football and 3.0 in rugby union whereas it increases to 36.0 and 81.0 (respectively) during matches. Injuries negatively affect the players' performance and health, and may have financial implications for the athletes and/or their clubs. Therefore, avoiding players' injuries became a priority and strategies are developed to limit them. Training workloads focused trainers' and researchers' attention as their monitoring allows to maximize the training processes and performance, and limit the occurrence of injury. Internal and external outcomes are used to characterize the

training and competition load. For the same external workload, the internal responses differ for each people leading to different levels of fatigue or exercise-induced muscle damage. While a high training load and a certain amount of muscle damage are necessary to induce adaptations and performance increase, excessive muscle damage favor injury occurrence. Great inter-individual variations have been observed following a same external training load. Scientific evidence support that several factors are involved in the occurrence of injury or exercise-induced muscle damage. Besides exercise characteristics, individual risk factors, such as genetics, seem to be a component to take into account in injury mechanisms. Particularly, single genetic polymorphism, an alteration in DNA sequence, may alter the protein structure and its function within the cell. Studies support that genetic polymorphisms may be considered as a predisposing factor. In this context, identifying injury-predisposing polymorphisms is of interest to improve training load prescription.

METHODS: A review was achieved to identify genetic polymorphisms which increase injuries and muscle damage susceptibility.

RESULTS: Several genetic polymorphisms have been identified during the last decade involving muscles, ligaments, or tendons-related genes. These genetic polymorphisms can impact, positively or negatively the risk, the incidence, and the severity of injuries. Among them, the major genes identified were ACE, ACTN3, COL5A1, IL6, MCT1, MMP3, and HGF.

CONCLUSION: The present study supports the interest to assess genetic polymorphisms in athletes to better individualize training strategies.

EFFECT OF VP CURRENT STIMULATION ON BONE HEALING IN A RAT TIBIA INJURY MODEL

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INTRODUCTION: Fractures are traumatic injuries that can occur in all age groups, from children to the elderly, and it is desirable to shorten the duration of treatment to prevent a decline in quality of life. On the other hand, a device that can energize a living body without contact has recently been developed. This device is characterized by the use of vector potential (VP) energization (VP energization stimulation), and its preventive and therapeutic effects on various musculoskeletal diseases are currently being investigated. However, the effect of VP current stimulation on bone healing after fracture has not yet been verified. Therefore, we aimed to investigate the effects of VP electric current stimulation on bone healing.

METHODS: Six 6W male Wistar rats (12 rats) were used as material. All rats were pre-reared for 1 week (at 7W rats), and then the tibia was injured by a 2.0 mm diameter drill to create a bone injury model, assuming a fracture. The VP intervention condition was 60 min/day, 7 days/week. At the end of the experimental period, rats were euthanized by carbon dioxide inhalation and tibiae were removed. Tibiae were subjected to various treatments and analyzed histologically and genetically.

RESULTS: Using μCT, the new bone formed at the site of bone injury in each group was analyzed. The results showed that bone mass and bone density were higher in EX than in CO. We also analyzed gene expression of bone formation markers in the bone injured areas using qPCR. both Col1a (gene name of type I collagen) and BGLAP (gene name of osteocalcin) were highly expressed in EX.

CONCLUSION: It is thought that the amount of bone formation by osteoblasts was increased in the bone injured area of EX compared to CO, and as a result, the formation of new bone was promoted. Thus, it was suggested that VP electrical stimulation may accelerate the healing of bone damage.

LOW BACK PAIN STATUS OF COLLEGE ATHLETES IN RELATION TO DIFFERENT MUSCULOSKELETAL PROBLEMS

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INTRODUCTION: As sport specialist clinicians, it is important to recognize reasons of low back pain in order to implement appropriate rehabilitation programs to reduce the risk of injury, thus finding athlete's problem faster and precisely is important. Biomechanically, hip muscles (hip extensors, gluteus muscles and tensor fascia lata) playing importance role in lumbo-pelvic stability during trunk rotation, jumping, and running. Report showed that hip musculoskeletal weakness, tightness, or discomfort associated with lumbar movement and/or change the ground reaction forces to the lower back. Therefore, the aims of the study were to clarify the prevalence and the characteristics of the low back pain in college athletes and find out the potential musculoskeletal problems of athletes with low back pain.

METHODS: A questionnaire survey and medical check-ups of college athletes competing at a national level in 10 universities in Taiwan was conducted. Eligibility criteria for this study were: age between 18~30 years old college students; active athlete; weekly training volume (at least 10 hr); a certain competition level (at least national events). The self-completed questionnaires form was distributed to all participants before the physical examinations and was collected on the day of the check-up. Each participant was asked to complete 5 orthopaedic tests on the day of the check-up.

RESULTS: 701 college athletes were included in this study, 563 male and 138 female. LBP on the day of the check-up was confirmed in 327 (46.6%), the mean VAS was 3.14 ± 1.82. The prevalence of LBP in last 4 weeks, 6 months, and 12 months were 343 (48.9%), 423 (60.3%), and 471 (67.2%), respectively. For demographic data, it showed that sports experience (OR 1.07, 95%CI 1.03-1.10, $p < 0.01$) and training load (OR 1.03, 95%CI 1.01-1.05, $p < 0.01$) slightly increased risk of low back pain. For previous injury history, the highest hazard value is on the pelvis (OR 2.52, 95%CI 1.25-5.08, $p = 0.01$). For muscu-

loskeletal examinations, Bonnet's Sign (OR 1.50, 95%CI 1.10-2.04, p = 0.01), Faber-patrick test (OR 1.39, 95%CI 1.02-1.92, p = 0.04), and Ober's test (OR 2.01, 95%CI 1.27-3.18, p < 0.01) were associated with LBP, but Thomas test and Ely's sign were not significantly associated with LBP.

CONCLUSION: The current study confirmed that Bonnet's Sign, Faber-patrick test, and Ober's test have significantly higher odd ratio in experiencing LBP athletes compared to no LBP athletes. This suggest that orthopeadic test is very helpful for sport health physicians to approach LBP athletes quickly and precisely, and it might help LBP athletes get better sooner, set up individual training program, and avoid future injury.

EXPLORING BARRIERS AND FACILITATORS TO DELIVERING INJURY PREVENTION TRAINING IN YOUTH SOCCER FROM GRASS-ROOT COACHES' PERSPECTIVES: A EUROPEAN STUDY

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INTRODUCTION: It is widely proposed that coach education in injury prevention could reduce injury rates in youth sport, with targeted workshops showing significant improvement in knowledge, understanding, attitude and confidence to deliver such injury prevention programmes [1]. There is strong evidence that injury prevention programmes can reduce injury risk and improve physical characteristics, yet programme awareness, uptake and adherence are often poor [2]. The aim of this study was to investigate perceived barriers and facilitators to adopting, implementing and maintaining an injury prevention programme through an inductive, qualitative lens.

METHODS: A total of 269 grass-root soccer coaches from 3 European countries (UK, Spain, Czech Republic) were recruited and completed a 2-hour injury prevention workshop. Data was collected using a validated questionnaire exploring knowledge, understanding, confidence to deliver and attitudes towards youth injury prevention A six-phase thematic analysis framework [3] was employed to identify and describe patterns of meaning.

RESULTS: Three predominant themes were identified: perceived challenges/barriers, facilitators and socio-environmental contributors. Perceived barriers included constraints (time), inadequate facilities/resource and athlete attitude sub-themes. Within the attitude sub-theme barrier, there was also a sense that lack of awareness from parents often isolates the coach. Facilitators included coach motivation and receptiveness, stakeholder support and perceived intervention effectiveness. Socio-environmental contributors particularly influenced coaches' perceptions of logistical or institutional barriers. Coaches were concerned that introducing another 'programme' would impact on training load targets and technical development, despite acknowledging the benefits of the programme., Coaches also felt more confident delivering when they had autonomy/freedom to make content-based decisions regarding their coaching sessions.

CONCLUSION: Stakeholders buy-in and coaches' receptiveness are key to successful adoption and implementation of injury prevention programmes. Future interventions should focus on organisational buy-in as well as up-skilling coaches. Continued coach education would empower coaches to make decisions regarding session content; reinforce their ability to deliver preventative programmes without extensive resource; whilst improving knowledge and confidence to educate youth athletes about the importance of injury prevention. Time should not be seen as a constraint to implementation and adding movements within technical sessions, rather than seeing them as a separate element at the start of sessions, would help reduce this perceived barrier.

1 De Ste Croix et al (2021); 2 Barden et al (2022); 3 Braun & Clarke (2006)

ACTIVITY DURING REST BREAKS, FITNESS LEVEL AND INJURIES IN PROFESSIONAL BALLET DANCERS

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INTRODUCTION: Working days of professional ballet dancers are characterized by long working hours and significant physical demand (Twitchett et al., 2010). Morning classes are followed by rehearsals and evening performances, with usually short breaks in between. Physical fitness is crucial for performance and injury prevention and many dancers undertake supplemental training to improve their fitness level (Dang et al., 2022). Less is known about the effects of rest-break activities. The aim of the study was to evaluate the difference in physical fitness and injury occurrence between dancers based on their activity during rest breaks.

METHODS: Participants were members of a professional ballet ensemble (n=40, 26 females; age (mean±SD) 31.3±7.7 y; height 170.2±7.2 cm; body mass 58.5±10.1 kg). Data on rest-break activity (active/inactive) during a working day was collected via questionnaire. Injury incidence and related time loss from dance was monitored during a one-year period. Muscular fitness was tested by curl-up repetition test, back extension, push-ups, plank and Sargent jump test. Aerobic fitness was assessed by Astrand-Rhyming cycle ergometer test. Balance was tested by single-leg 30s balance test and flexibility by sit-and-reach test and bilateral plantar flexion ROM. Dancers were tested in high-demand period of mid-season.

The differences in physical fitness and injury-related time loss between the active and inactive group were tested by Student's t-test. The relationship between rest-break activity and injury occurrence was tested by Chi-square test for independence.

RESULTS: Curl-up repetition test was the only test in which active and inactive group differed significantly (47.9±26.3 vs 33.0±16.8 (n; mean±SD), respectively, t=-2.2, p=.035). In all other tests, except Astrand-Rhyming and Sargent tests, there was a trend of better average results in the active group, although without significant difference. Age, supplemental training and ensemble position were accounted for. There was no significant association between rest-break activity and injury occurrence (Pearson Chi-square=0.61, p=.44). Eighteen participants were injured during the monitored period. There was no difference between active and inactive dancers in time loss duration due to injury (p=.21).

CONCLUSION: The only fitness component significantly better in dancers who choose active rest breaks was trunk muscular endurance. This could be attributed to the preferred activities reported by dancers. Although there was no significant difference in other tests, there was a trend of better results in the active group. The potential of implementing rest break activities aimed to improve particular fitness components should be further explored, keeping in mind the overall daily workload (Kozai et al., 2020).

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SERUM LEVELS OF BONE FORMATION AND RESORPTION MARKERS IN RELATION TO VITAMIN D STATUS IN PROFESSIONAL ATHLETES AND PHYSICALLY ACTIVE MEN DURING UPPER AND LOWER BODY HIGH-INTENSITY EXERCISE

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INTRODUCTION: Several reports on the effect of single exercise and regular training on bone marker levels have been published; however, the data are not consistent. Without a doubt, exercise intensity and its nature, in conjunction with dietary factors, determine the bone marker response. Of note, many indoor athletes who practice certain sports are vitamin D-deficient. Vitamin D plays an important role in bone metabolism. It also influences skeletal muscle strength, reduces muscle atrophy and parathyroid hormone concentration, and exerts many other effects . Despite of these positive effects, to the best of our knowledge, the acute effect of exercise on bone formation and resorption markers in relation to vitamin D status had not yet been assessed. Hence, the primary aim of the current study was to evaluate the effects of vitamin D status on changes in the serum PINP and CTX levels induced by Wingate anaerobic test (WAnT) in highly trained athletes and untrained young men.

METHODS: Sixteen elite male artistic gymnasts (EG; 21.4 ± 0.8 years-old) and 16 physically active men (the control group, PAM; 20.9 ± 1.2 years-old) performed lower and upper body 30-s Wingate anaerobic tests (LBWT and UBWT, respectively). For biomarker analysis, blood samples were collected before, and 5 and 30 min after exercise. Samples for vitamin D levels were collected before exercise. N-terminal propeptide of type I collagen (PINP) was analysed as a marker of bone formation. C-terminal telopeptide of type I collagen (CTX) was analysed as a marker of bone resorption.

RESULTS: UBWT fitness readings were better in the EG group than in the PAM group, with no difference in LBWT readings between the groups. UBWT mean power was 8.8% higher in subjects with 25(OH)D3 levels over 22.50 ng/ml and in those with 24,25(OH)2D3 levels over 1.27 ng/ml. Serum CTX levels increased after both tests in the PAM group, with no change in the EG group. PINP levels did not change in either group; however, in PAM subjects with 25(OH)D3 levels above the median, they were higher than those in EG subjects

CONCLUSION: Vitamin D metabolites affect the anaerobic performance and bone turnover markers at rest and after exercise. Further, adaptation to physical activity modulates the effect of anaerobic exercise on bone metabolism markers.

HOW DOES ACHILLES TENDON RUPTURE AFFECT SPORTS PERFORMANCE AFTER RETURN TO PLAY? A MEDIA-BASED, MATCHED-PAIRS ANALYSIS IN MALE ELITE BASKETBALL ATHLETES.

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INTRODUCTION: Achilles tendon rupture (ATR) represents one of the most devastating musculoskeletal injuries in sports. Most affected athletes require surgery and return to competition only after downtimes of about six to twelve months [1, 2]. It may hence be assumed that pre-injury performance levels cannot be fully restored during the complex rehabilitation process. This study aimed to compare both, simple and complex performance indicators in male NBA basketball players with and without a history of ATR.

METHODS: A total of n=42 NBA athletes with an ATR sustained between 1970 and 2022 were identified using official databases (e.g. NBA.com) and media-based registers. Both simple (e.g., points scored/rebounds/assists/blocks/steals/turnovers, all normalised per 36 minutes of playing time) and complex (e.g., player efficieny rating, points per possession, offensive/defensive rating) indicators of performance were extracted for the injured athletes as well as for a sample of n=42 controls, matched based on age, career duration, height, weight, pre-injury performance, and position. For both groups, differences were calculated between the reference season (pre-injury in ATR group) and the (consecutive) post-injury season. Mann-Whitney-U tests and related effect sizes were computed for group comparisons.

RESULTS: While both groups were not different with regard to 12 out of 17 performance indicators (p>.05), systematic differences with moderate effect sizes were observed for the remaining variables. Individuals with a history of ATR had a lower field goal (-1.5 %, p=.03, r=.27) and true shooting percentage (-2,9%, p=.006, r=.34), additionally achieving fewer blocks (-0.2, p=.005, r=.36), fewer points per possession (-0.09, p=.002, r=.40), and a lower game rating (-1 point, p=.02, r=.30).

CONCLUSION: Following ATR, performance can be restored with regard to most indicators of performance in elite basketball athletes. However, coaches and therapists need to be aware that some deficits continue to exist, requiring focused attention.

CONCUSSION AWARENESS IN KARATE CHILDREN INTERNATINAL COMPETITORS

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INTRODUCTION: There is a paucity of information about the awareness of young adolescents and children on concussions.

METHODS: A survey was conducted during the 2022 Cadets and Juniors World Karate Chamionships about concussions epidemiology and awareness in 14-15 year old children

RESULTS: Ninety percent of the registerede competitors answered the survey. they belong to 97 different countries

24.9 5 of the children stated that they did not know what a concussion is. ·5.75 believed that a concussion is a loss of conciousness

CONCLUSION: In light of the results, it is mandatory to increase the effort to teach the young karate players what a concussion and their risks are

DEVELOPMENT OF A STANDARDIZED QUESTIONNAIRE TO REPORT MECHANISMS OF FALL-RELATED INJURIES IN SPORT CLIMBING

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INTRODUCTION: Sport climbing is rapidly growing in popularity. While falls are frequent and mostly harmless given the recommended positioning during a fall, the most severe and very severe injuries in sport climbing have been caused by a fall. However, the respective contribution of fall mechanisms to the burden of fall-related injury (FRI) in sport climbing is little understood. In case of FRI, mechanisms are primarily asked to the climber and the belayer by sport climbing responsible or rescue teams, but no standardized tool exists to report the fall mechanisms that led to injury. The main purpose of this study was thus to develop a reliable standardized self-report tool of fall mechanisms.

METHODS: Fall mechanisms were compiled from a previous empirical study (1). A total of 40 fall mechanisms were divided into three fall temporalities dimensions: 1) the reasons that lead to the fall (FR; n=12); 2) the climber's or belayer's behaviors during the fall (FB; n=19); 3) the details concerning the end of the fall (FE; n=9). A questionnaire was developed with four boxes. The first three boxes included items representing FE, FB and FE. The last box included the location of the body hit in case of collision during the fall. A pilot study was conducted between January, 30th, 2023 and February, 13th, 2023 in a french sport climbing gym to assess the internal validity of the tool. A researcher observed climbers ascents, and in case of a fall, reported FE, FB and FE using the developed questionnaire. The same questionnaire was subsequently filled by the climber and the belayer without having prior knowledge of the exact content of the questionnaire. The (i) researcher and climbers and (ii) researcher and belayers levels of agreement were compared using Gwet's AC1 agreement coefficient, overall and by fall temporalities (2).

RESULTS: A total of 50 falls were recorded. The overall agreement between researcher and climber was very good (0.88, 95% CI=0.86-0.89). The researcher and climber had a very good level of agreement for fall reasons (0.89, 95% CI=0.85-0.92), fall behaviors (0.81, 95% CI=0.77-0.85) and fall end (0.90, 95% CI=0.85-0.94). A very good level of agreement was also found concerning the location of the body that hit the wall (0.97, 95% CI=0.95-0.99).

The overall agreement between researcher and belayer was very good (0.89, 95% CI=0.87-0.81). The researcher and climber had a very good level of agreement for fall reasons (0.89, 95% CI=0.85-0.93), fall behaviors (0.84, 95% CI=0.80-0.87) and fall end (0.92, 95% CI=0.88-0.96). A very good level of agreement was also found concerning the location of the body that hit the wall (0.96, 95% CI=0.94-0.98).

CONCLUSION: The level of agreement of fall mechanisms reported by the researcher, the climbers and the belayers were very good. This standardized questionnaire could be used to report fall mechanisms that led to an injury in sport climbing. Further studies are needed to compare its validity according to the climbers' level of experience and climbing

MUSCLE OXYGEN SATURATION AS A DIGITAL BIOMARKER TO GUIDE THE RETURN TO PLAY OF ATHLETES FOLLOWING ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION

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INTRODUCTION: Return to play (RTP) protocols for anterior cruciate ligament (ACL) injuries involve full motion, strength, psychological readiness, GPS monitoring, isokinetic testing, and functional testing. However, current RTP criteria lack ob-

jective, internal, and continuous data necessary to complement current assessments. The majority of evidence suggests > 9 months is required to regain neuromuscular function and allow for appropriate osseointegration and vascularization of the neoligament into the native environment. Monitoring muscle oxygen saturation (SmO2) levels utilizing wearable sensors enables the collection of objective and internal data to monitor oxygen delivery and consumption in surgical and contralateral limbs during the RTP process. Crum et al. validated the reliability of the SmO2 sensor at low to moderate exercises among 10 healthy cyclists. Statistical analysis showed strong correlations of r=0.842-0.993 for the Spearman's Rank-Order Correlation and r=0.773-0.992 for the Intraclass Correlation between the trials of all participants [1]. We hypothesize that muscle atrophy in the surgical leg following ACL reconstruction (ACLR) results in changes in SmO2.

METHODS: Currently ongoing is a multi-arm IRB approved study assessing SmO2 levels in the legs of healthy subjects aged 14-22 years (arm 1, n=50) and aged matched patients after ACLR (arm 2, n=50). A standardized workout was created for testing at 6, 9, and 12 -months post ACLR. Sensors are placed on the vastus medialis bilaterally to record SmO2 throughout the study duration. Healthy patients undergo testing once, while surgical patients undergo the testing at 6, 9, and 12 -months post-operatively.

RESULTS: At present, continuous SmO2 data has been collected on seven healthy subjects and nine patients. The healthy cohort shows no difference in SmO2 levels between the two limbs. Results of the longitudinal trial for ACL patients show the convergence of SmO2 levels during air bike interval sprints, 1-minute air bike sprint, and isometric squat hold exercises over the 6, 9, and 12 -month time periods. ACLR SmO2 levels at the 12 -month trials resemble the healthy cohort.

CONCLUSION: The change in SmO2 in ACLR patients is likely due to a combination of altered hemoglobin-oxygen unbinding, altered blood delivery, detraining, and muscle atrophy. These changes in SmO2 in the ACLR subjects correlate with improvement in other RTP testing. SmO2 data offer complementary objective data in RTP criteria. Future work will measure key biomarker and physiological data along with patient reported outcome measures on this critical age group. This data will enable an integrative algorithm that physicians and physical therapists can employ to gauge athlete readiness following ACLR with broader implications to other musculoskeletal injuries.

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Statistics and Analyses

THE RELATIONSHIP BETWEEN THE AMOUNT OF KNOWLEDGE IN SAILING COMPETITIONS AND THE FACTORS OF GENDER, AGE, COMPETITIVE AGE, POSITION, AND BOAT TYPE

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INTRODUCTION: In Sailing competitions, decision-making is more important, which is based not only on a correct assessment of the situation but also on a great deal of correct knowledge. However, how do sailing competitors acquire the correct amount of knowledge? It would be interesting to know whether it is acquired simply by reading books or it is naturally acquired through the experience of sailing a boat under various conditions. Therefore, this study examines the relationship between the amount of knowledge required for sailing competitions and the factors of gender, age, competitive age, position, and boat type.

METHODS: The knowledge required for sailing competitions is assumed to be: (1) Outfitting (56 items); (2) Sailing (28 items); (3) Racing (16 items); (4) Strategies (10 items); (5) Tactics (14 items); (6) Weather (19 items); and (7) Safety (5 items). Corresponding to these factors, a total of 149 written tests were administered to 165 participants in the 74th National Athletic Meet Sailing Competition in Japan. Apart from that, a) Gender, b) Age, c) Competitive years, d) Boat type, and e) Position were also asked. Multiple regression analysis was performed on the data obtained with dummy transformations for a) Gender, d) Boat type, and e) Position. In addition, explanatory variables were selected using the forward-backward variable selection method.

RESULTS: As a result of variable selection, a regression equation consisting of b) Age, d) Boat type, and e) Position was chosen, with the multiple correlation coefficient of .259 (F0=3.61, df=[3, 151], p=0.0147), which was a significant correlation at the 5% level. The regression coefficients were 0.038 for Age, 0.848 for Position (skipper; fixed at 0.0 for crew), -1.306 for Boat type (single-seater; fixed at 0 for two-seater), and the constant term was 11.535. The regression coefficient for Boat type was significant at the 1% level (p=0.005). In other words, Boat type contributed the most to the acquisition of sailing knowledge, followed by Age and Position.

CONCLUSION: First of all, the results indicating that two-seater boats contribute the most to the acquisition of sailing knowledge compared to one-person boats can be explained by the fact that participants in two-person boats are more competitive and more knowledgeable than those in one-person boats. Second, it is thought that older participants acquire more sailing knowledge than younger ones possibly because they are able to acquire knowledge in a shorter period of time and in a more theoretical way, due to their higher level of comprehension. Third, skippers contribute the most to the acquisition of sailing knowledge as opposed to their crews because skippers hold the rudder and steer the boat.

Boat type contributed the most to the acquisition of sailing knowledge, followed by Age and Position.

LONGITUDINAL CHANGES IN BASKETBALL DRIBBLING SKILLS BY SPORTS EVENT USING LINEAR MIXED MODEL

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INTRODUCTION: Skill tests are used also in PE basketball classes of Physical Education majors to measure basic skills. However, it is possible that each of the students in the Physical Education majors specializes in sports events other than basketball, and this may affect the measurements of the skill tests. At the same time, it may affect their effectiveness in PE classes. For example, those who specialize in basketball or similar sports events would be less effective in the PE class, while those who do not would be more effective. Therefore, this study examines longitudinal changes in dribbling skills. However, since there are those who have experience in the same sports event practice similar to each other while considering these associations, this study aimed to examine the associations using a linear mixed model.

METHODS: 244 students of Physical Education major (71 male and 73 female students) taking basketball PE classes at F-University were asked to perform the basketball dribbling skill test twice each. Subjects dribble in a zigzag manner between 12 chairs (= 2 rows of 6 chairs) arranged with 6 feet apart, and the time required is measured. Then, the change over a six-month period by the following sports event group is examined: "Basketball," "Ball games other than basketball," "Non-ball games," "No affiliation," and "Faculty other than physical education." Since these individual repetitions (individuals), sports events (SE), and groups of sports events (GSE) are nested, their association was analyzed using a linear mixed model with these as random effects and with timing (before and after the class), gender, and their interaction as fixed effects.

RESULTS: The results of the deviance analysis for the models with only random effects (Null model, AIC=4521.9) and the model including gender and time as fixed effects (Full model, AIC=4442.3) showed significant goodness of fit (Chi-squared =85.54, df=3, $p<0.001$). Furthermore, the likelihood ratio test was used to select independent variables, and a model was selected that excluded the fixed effects of the interaction between time and gender and the random effect of the slope of the GSE (Selected model, AIC=4439.1). The intraclass correlation coefficients for the random effects were the highest for the individual intercept at 0.591 and the interaction (slope) between time and individuals at 0.541, followed by the intercept for the GSE at 0.389 but were the lowest for the SE intercept at 0.184 and its interaction with a time at 0.177. In other words, the development of dribbling skills was largely influenced by individuals and GSE, with little influence among the SE. For the fixed effects, the partial regression coefficients for males and time were -2.70 and -1.56, respectively, and the interaction effect between males and time was not significant.

CONCLUSION: Males were originally better in dribbling skills than girls, and the overall effect of the classes was uniformly effective for both genders.

COMPARISON OF ATTACK INDICATORS OF NÕMME KALJU FOOTBALL CLUB IN THE PREMIUM LEAGUE IN SEASONS 2018 AND 2021

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INTRODUCTION: In football, attack indicators can help to explain the reasons why one team is more successful than another. The aim of the current study was to compare the seasons of 2018 and 2021 of Nõmme Kalju FC who plays in the Premium League of Estonia and to find which differences in attack indicators caused the weaker results of the team during the second season.

METHODS: In the second, 2021 season, the team lost more points and finished at a lower position in the table. A total of 68 league games were analysed. The analysis included the following parameters: goals scored, total number of passes, percentage of precise passes, key passes, number of precise key passes, centrings, percentage of precise centrings, kicks towards the goal, precise kicks to the goal, situations created for scoring a goal, standard situations, goals scored from standard situations, percentage of possessing the ball, number of position attacks, goals scored from position attacks, number of counter-attacks, goals scored from counter-attacks.

RESULTS: In the 2018 season, the number of goals, the number of precise kicks, and number of kicks towards the goal by the team was statistically significantly greater than in the 2021 season. In the 2018 season, the number of centrings by the team was statistically significantly greater than in the 2021 season, but no statistically significant difference was found in the indicators of pass and possession of the ball. The comparison of attack types revealed statistically significant differences in favour of the 2018 season in both standard situations and counterattacks.

CONCLUSION: The reason why fewer centrings were performed in the 2021 season might be that during attack the team could not possess the ball on the opponent's side long enough. A study conducted in the English Premier League revealed that if a team performed more centrings, this did not bring about an increase in the percentage of wins [2]. The reason why the indicators in standard situations and counterattacks were lower in 2021 may have depended on the tactics of the game – too one-sided, misunderstandings between players during attack, timing of passes and openings. A study of goals scored from counterattacks revealed that teams that were at higher positions in the table performed more counterattacks and scored more goals from them [1]. It can be concluded that the differences in standard situations and counterattacks between the two seasons can help to explain the reason why Nõmme Kalju FC lost too many games in the 2021 season and finished at a lower position.

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POS-PANDEMIC ERA INQUIRY TENDENCY FOR SUBSTANCES PROHIBITED IN SPORTS: DATA ANALYSIS OF TAIWANESE ANTI-DOPING SERVICES.

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INTRODUCTION: World Anti-Doping Agency (WADA) updates its prohibited list(1) annually according to the latest research and reports, making it difficult for sports and medical professionals to keep track of all the latest information and memorized which healthcare products contain substances prohibited in sports. To assist Taiwanese athletes and people concerned, anti-doping authorities in Taiwan provide services utilizing website search tools, APP, and online professional consultation. Analysis data collected from these services allow us to identify the population in need and the types of issues or substances that athletes may encounter in daily life, improving the efficiency of sports-prohibited substance misuse prevention.

METHODS: The study collects over 30,000 data from the search history of anti-doping APP and inquiries submitted for prohibited substances consultation from 2021 to 2022 which contain the identity (i.e. occupation or relationship to athlete) of anonymous users. The prohibited substances in the data were categorized according to WADA's prohibited list(1) and routes of administration. The information on the users' population and healthcare products was also calculated and categorized.

RESULTS: The majority of users are athletes (44.0%), much more than any other group in the user population (all below 20%). For healthcare products in the database, 60.4% are western medicine (21.9% containing prohibited substances), 28.2% are traditional Chinese medicines (35.9% contain prohibited substances), and 11.4% are nutritional supplements (58.3% high risk of containing prohibited substances). Prohibited substances in modern medicine include S1 anabolic agents (1.6%), S2 peptide hormones (0.5%), S3 beta-2 agonists (6.7%), S4 metabolic modulators (1.7%), S5 diuretics (3.1%), S6 stimulants (52.4%), S7 narcotics (4.9%), S9 glucocorticoids (25.3%), P1 beta-blockers (3.8%); prohibited substances in traditional Chinese medicines include S3 beta-2 agonists (44.4%), S6 stimulants (51.4%), S8 cannabinoids (4.2%).

CONCLUSION: Athletes are the population most likely to utilize anti-doping services to search for information about whether healthcare products contain substances prohibited in sports. Approximately 50% of prohibited substances in inquiries are from category S6, this might contribute to that substances listed in this category are often used for the treatment of common cold and Covid-19 symptoms. Inquiries about traditional Chinese medicines and nutritional supplements products have a higher percentage containing prohibited substances than western medicines. This may be attributed to the complexity of the composition, manufacturing process, and source material within products of the above two categories.

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ANALYSIS OF THE COMPETITION PATTERN OF CHINESE COLLEGE STUDENTS TAEKWONDO COMPETITION IN 2022

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INTRODUCTION: Taking the winning data of Chinese college students taekwondo competition in 2022 as a sample, this paper analyzes and summarizes the geographical distribution of the winning schools, the proportion of winning gender, the difficulty of winning the small events, and the participation proportion of each group, and explores the current competitive pattern of Chinese college students taekwondo competition, with a view to providing a certain reference basis for the future development of Chinese college students taekwondo project from a macro perspective.

METHODS: Literature Method, Mathematical Statistics method, Logical Analysis Method

RESULTS: 1. The competition difficulty of individual project is higher than that of group project

2.The competition difficulty of grade Poomsae is higher than that of Dan Poomsae

3. The award-winning degree of economically developed regions is higher than that of other regions

4. The winning ratio of men and women is similar

CONCLUSION: The popularity of taekwondo in Chinese universities is very high. A total of 129 universities in 24 provinces participated in the 2022 Chinese college student taekwondo competition. The participants are mainly from South China, Central China and East China. The degree of regional economic development is related to the number of participants and the level of athletes skills.

ADDITIONAL MEASURES IMPROVE HRV BASED VENTILATORY THRESHOLD ESTIMATION ACCURACY COMPARED TO STATE-OF-THE-ART DFA-A1 ALGORITHM

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INTRODUCTION: Short-term Detrended Fluctuation Analysis scaling exponent (DFA-a1), a parameter of non-linear heart rate variability (HRV) analysis, has been used to determine organismic transition zones (aerobic and anaerobic threshold) during exercise. DFA-a1 has shown good agreement with traditionally used ventilatory thresholds (VT1 and VT2) (1). We hypothesized by adding meaningful measures to the DFA-a1 algorithm we could improve threshold determination.

METHODS: Physically active individuals (n=64, age range 20-50) performed an incremental cycle ergometer cardiopulmonary exercise test (CPET) with inter-beat interval (RR) measurements. Kubios VT estimation algorithm (VT-algorithm) is based on instantaneous values or heart rate (HR) in relation to individual HR reserve, respiratory rate (RF), and fractal behavior of HRV measured by DFA-a1. HR reserve was obtained by subtracting a fixed 60 bpm resting HR from the maximal HR achieved during the CPET. The RF was derived from beat-to-beat RR data. DFA-a1 and Kubios VT-algorithm were used to evaluate HR and oxygen uptake (VO2) on ventilatory thresholds (VT1 and VT2). The true VTs were evaluated from the CPET by an exercise physiology specialist.

RESULTS: On average the VO2 at the true, DFA-a1, and VT-algorithm derived ventilatory thresholds were 1.74, 2.00 and 1.89 l/min (VT1) and 2.40, 2.41 and 2.40 l/min (VT2), respectively. Correspondingly, average HRs at the true, DFA-a1, and VT-algorithm thresholds were 141, 151 and 142 bpm (VT1) and 169, 168 and 170 bpm (VT2), respectively. When compared to the true thresholds, the error (bias ± standard deviation of error) of the DFA-a1 thresholds were -0.26±0.41 l/min or -10±16 bpm at VT1 and 0.00±0.34 l/min or 1±10 bpm at VT2, whereas the error of the VT-algorithm were -0.15±0.28 l/min or -1±11 bpm at VT1 and 0.01±0.20 l/min or -1±7 bpm at VT2.

CONCLUSION: HRV based VT determination algorithms provide an accurate estimation of ventilatory thresholds to get an insight into training zones, internal loading, and metabolic transitions during exercise without laboratory equipment. The Kubios VT-algorithm, which considers instantaneous HR and RF in addition to DFA-a1, provided higher accuracy for VO2 and HR values for both VT1 and VT2. Our findings suggest that inclusion of instantaneous HR and RF values in the VT estimation minimizes the limitations of the DFA-a1, which include instability of the estimate and possible need to individually adjust the DFA-a1 threshold values based on training status. However, using Kubios VT-algorithm is currently limited only to post-session evaluation and does not give insights to evaluation of systemic internal loading during exercise.

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COMPARISON OF GAME VARIABLES IN THE MAIN EUROPEAN RINK HOCKEY LEAGUES

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INTRODUCTION: Performance analysis appears to be widely accepted by players, coaches and sports scientists as useful feedback in the coaching process to achieve better results (Liu et al., 2016). Rink hockey, also known as roller hockey or hardball hockey, is not an exception, and, lately, the number of studies about this sport has grown considerably (Arboix-Alió et al., 2023). However, although it has been studied in other sports, there are few data regarding the comparison of game variables according to the main European rink hockey leagues. Therefore, the aim of this study was to compare the rink hockey game variables in the three top national championships of Spain, Portugal and Italy.

METHODS: A sample of 1,665 matches corresponding to the Spanish League: OK Liga (n = 654), Portuguese League: Primeira Divisao (n = 497), and Italian League: Serie A1 (n = 514) played between the 2018-2019 and 2020-2021 seasons was analyzed. Comparisons were made using an analysis of the variance (ANOVA) followed by Bonferronis post hoc multiple comparison tests. Additionally, the t-Student test was used to compare each variable according to match location.

RESULTS: Results showed that OK Liga was the championship with the fewest goals per game and Serie A1 was the championship with higher goals ($p = 0.001$, $\eta p2 = 0.217$). In Primeira Divisao there were more individual set-pieces (penalties and free direct hits), team fouls and cards, and a higher percentage of individual set-pieces' goals with respect to total goals. In the three championships, the performance variables associated with the victory (total goals, goals from individual set-pieces, team fouls and cards received) were favorable to home teams.

CONCLUSION: The analysis of the match variables can provide valuable information to help coaches and practitioners to better understand the rink hockey game dynamics. Additionally, these findings could help staff teams to prepare training sessions based on the specificity of a particular competition or simulate different scenarios.

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PHYSICAL QUALITIES AND THEIR RELATIONSHIP TO MATCH PERFORMANCE IN FEMALE YOUTH BASKETBALL PLAYERS.

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INTRODUCTION: Basketball is a physically demanding sport known for intermittent high intensity efforts in a combination of movements like jumping, sprinting, repeated accelerations, and decelerations in different directions (1). The concept of evaluating and predicting future match performance is central to planning and prescribing individualized training programs (2).

Purpose

The purpose of the present study was to identify the physiological variables that are of significance for basketball players' performance capacity during basketball games.

METHODS: Thirty-six female basketball players (age: 17.2 ± 0.9 years; body height: 1.80 ± 0.06 m and body weight: 72.5 ± 5.9 kg) were tested according to a test battery called Fysprofilen (https://fysprofilen.se/sv/default.aspx). Physical tests were conducted at the end of the precompetitive phase. Match performance was assessed by analyzing the four initial games of the regular season and by calculating the effectivity score for each player. Data were analyzed with the use of Principal Component Analysis (PCA) and Partial Least Squares Projection to Latent Structures (PLS).

RESULTS: No significant relationships were observed between physical qualities and basketball match performance. Goodness of fit (R2Y) explained 29% of the variance in match performance. Goodness of prediction, judged via cross-validation, (Q2Y= 0.12) indicated that physical characteristics and physical test results had poor predictive ability on future performance in female youth basketball players.

CONCLUSION: Performance on the basketball court is dependent on physical, technical, tactical, and psychological factors (3,4). The model's poor predictive ability highlights the importance of treating players' physical qualities cautiously especially when it comes to predicting match performance.

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NEURAL CORRELATES OF SPORT-SPECIFIC SPATIAL ANTICIPATION: A SYSTEMATIC REVIEW FOR FUTURE APPLICATION OF NEUROPHYSIOLOGICAL METHODS WITH ENHANCED ECOLOGICAL VALIDITY

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INTRODUCTION: In sports, the anticipation of actions is essential and correlates with sports performance (Nadin, 2015). Experts outstanding ability to anticipate is based on long-term motor training that influences the human brain (Makris, 2014). To date, the neural correlates that explain the underlying processes contributing to successful anticipation in sports reveal inconsistencies (Smith, 2016). Therefore, this systematic review aims to examine the feasibility of quantifying sport-specific spatial anticipation (SSSA) via different neurophysiological methods, to elaborate on specific markers and brain areas reflecting anticipation processes, and to develop methodological adaptations regarding future research and analysis.

METHODS: A literature search was performed in PubMed/MEDLINE, Web of Science, and PsycINFO published until December 2021. Included were neurophysiological studies quantifying the neural activity of expert athletes and control participants during a video-based SSSA task recorded from the first-person perspective. Quality evaluation was assessed using the quality assessment tool provided by the National Institutes of Health.

RESULTS: The review includes ten studies involving 370 participants. Average methodological quality is rated as fair. Selected methodological approaches comprise transcranial magnetic stimulation (TMS), functional magnetic resonance imaging (fMRI), and electroencephalography (EEG) in five different sports. All studies reveal expertise-related neural alterations during SSSA associated with the action observation network (AON) and adaptational performance monitoring processes. However, results vary in significance, causing some methods to be more appropriate for quantifying SSSA than others. In addition, there are deviations between experimental task demands and the requirements of natural environments.

CONCLUSION: This review indicates expertise-related neural alterations during SSSA extend beyond brain regions of the AON and are best quantified via fMRI and EEG. However, due to the restrictions on subjects' mobility during neurophysiological assessments along with simplified motor responses, it is questionable whether these approaches can reflect real-world scenarios (Mann et al., 2013). Based on included studies and recent research in exercise neuroscience (Chang et

al., 2022), methodological considerations for future research are proposed, including the integration of mobile EEG and time-frequency analysis for quantifying SSSA.

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IN SEARCH OF THE SIGNATURE OF PERCEPTUAL-MOTOR EXPERTISE IN 4X100 M RELAY

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INTRODUCTION: The 4x100 m relay is a very demanding sport as performance depends on the ability of athletes to run at the highest possible speed of course, but also and above all to pass the baton at a high speed in a constrained space. The coordination between runners is one of the main determinants of performance and requires highly developed anticipation skills in athletes. Indeed, success presupposes for the receiver to pick-up information early on their running partner to be able to initiate their race at the right time. In this context, the go-mark's placement on the ground is supposed to help receivers to initiate their run at the right time (i.e., when the partner passes over of the go-mark). The ambition of the present study is twofold. The first one is to better understand the perceptual-motor mechanisms allowing athletes to successfully perform this highly constrained synchronization task. The second one is to analyze the way expertise shapes the implemented mechanisms.

METHODS: The participants were equipped with a virtual reality headset to be immersed in a virtual stadium at the receiver's position. Three groups were formed according to their level of expertise: beginner, intermediate (regional level) and expert (national/international level). They were instructed to initiate their race when the avatar of their partner, who could arrive in a straight line or in a bend, passed over the go-mark. They performed 3 blocks of 10 trials (5 trials per condition). Their perceptual-motor strategies have been characterized according to several levels of analysis: the timing error, the temporal sequence of remarkable events (athletes preparatory movement initiation, end of taking information on the avatar, initiation of the race...) and the information sampling strategies employed.

RESULTS: The results revealed that the strategies implemented depended on the level of expertise: the timing error was lower for experts and performance was more stable. Interestingly, the time sequence of the remarkable events was more efficient for the experts, reflecting the importance of the movement preceding the initiation of the race in the process of anticipation. In the same way, the analysis of the eye tracking data also revealed specific strategies for taking information according to the level of expertise, with experts spending more time scrutinizing the most information-rich areas.

CONCLUSION: Taken together, these results provide a first insight regarding the effect of expertise on athletes anticipatory behavior during the initiation of the race while approaching the partner. Even if new studies are necessary to provide more information about the involved mechanisms, our study already underlines the close links between perception and action in the anticipation process of experts and the extreme sophistication of the implemented mechanisms.

PERFORMANCE EVALUATION OF THE 2022 FIFA WORLD CUP TEAMS USING THE MEASURE OF SPATIAL ENTROPY OF SUCCESSFUL PASSES

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INTRODUCTION: In recent years, network science has received increasing attention from the research community to analyze players' performance in team sports. Most studies have focused on analyzing the passing network using various measures of network centrality while ignoring the spatial distribution of passes. The concept of spatial entropy is defined as a measure of the distribution of different elements within a grid area, and it is a direct measure of the level of complexity or disorder of spatial structure. The aim of this study is to evaluate passing performance of players from different positions at the 2022 FIFA World Cup through the measure of spatial entropy.

METHODS: First, the event data of all 64 matches during the 2022 FIFA World Cup provided by Opta are processed to extract the spatial coordinates of 55887 successful passes. Next, the average spatial entropy of successful pass coordinates is calculated separately for goalkeepers, defenders, midfielders, and forwards. Here, we calculate the spatial entropy by dividing the average nearest neighbor distance by the expected average nearest neighbor distance. The average nearest neighbor distance is the average of the distances of all successful passing points on the pitch and other successful passing points that are closest to each other. The expected average nearest neighbor distance is equal to half of the square root of the area of the pitch divided by the number of successful passes.

RESULTS: The average values of spatial entropy of successful pass coordinates are 0.32, 0.77, 0.79 and 0.78 for goalkeepers, defenders, midfielders and forwards respectively. Among all teams, Senegal presents the highest spatial entropy of 0.73 per game and Spain has the lowest value of 0.52. Serbian goalkeepers show the highest average spatial entropy of

0.56, and Saudi Arabia has the highest value of 1.10 for defenders. Brazilian midfielders own the highest average spatial entropy of 0.95; while Japan, which upsets Spain and eliminates Germany, has the highest average spatial entropy of 1.16 for its forwards.

CONCLUSION: The novel findings of this study are that, in the 2022 FIFA World Cup, (I)the goalkeeper passes have the least value of spatial entropy, which is consistent with the finding of a previous study on 2017-2018 La Liga; (II) the defender, midfielder and forward passes have similar values of spatial entropy, mainly because they are all highly involved in the games and have greater randomness in their range of movement on the pitch; and (III) the Spain team has the least average value of spatial entropy of successful passes among all teams, which may be related to the fact that they have the highest number of passes per game. In the following study, we will focus on the effect of spatial entropy of players' pass coordinates on other match behaviors and even the outcomes of games.

PERFORMANCE PROFILES & PEAK AGE OF ADOLESCENT TRIPLE JUMP CONTESTANTS AT YOUTH OLYMPIC GAMES

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INTRODUCTION: A decade ago the summer edition of the world-spanning under 18 yrs of age (u18) competition, the Youth Olympic Games (YOG) were introduced. In recent years there is a rising scientific interest regarding the nonlinear and highly variable developmental trajectory of performance in adolescent athletes due to the individual biological adaptations as a result of growth, maturation, training load & strain, and aging. Aim is to quantify age of peak performance (APP) and improvements over the preceding years of athletic career (AC) in former YOG athletics contestants in the complex movement and physically demanding triple jump (TJ) according to athlete performance level, sex, and age group.

METHODS: Data were extracted from a renowned database (www.worldathletics.org) through 10/2021. Competition results of 29 female TJw & 31 male TJm qualifiers & medallists at YOG (2010, 2014) and their performance profiles of legally achieved outdoor season bests were empirically analysed. Comparisons of selected age groups & peers, AC duration and last performance, personal best (PB) and APP as well as participation & success at further champs were made.

RESULTS: Contestants achieved YOG results of 85.7±3.0% (TJw) & 86.9±4.1% (TJm) relative to world's u18 best; meanwhile PB developed to 84.1±3.6% (TJw: 12.32-14.35m) & 86.8±5.1% (TJm: 13.97-17.18m) relative to actual world record. APP of YOG competitors is sig. lower (Kruskal-Wallis r=0.50-1.04) compared to peers & all-time best athletes ($X2(4) = 81.65$ (TJw) & 40.04 (TJm), $p \leq 0.001$)), but not sig. different between sex. The average annual improvements were +1.5-6.3% in u18 followed by an increase rate levelling off at -2.0% to +2.0% in juniors (u20 & u23) to seniors (= mostly performance plateau or decline). The attrition rate until 2021 was 68% (22 TJw & 19 TJm). Of the remaining 32%, only 4 athletes achieved medal success in world junior champs, 5 athletes were contestants in senior world champs & Olympic Games so far.

CONCLUSION: Accompanying the accumulation of adolescent competitions one observes a clear shift of APP to younger age (80-86% in u20) as well as shorter AC in YOG TJ contestants and therefore a need of a deeper knowledge on possibilities/limits of adaptation & training in adolescent TJ athletes. Jump performance in elite TJ is determined by the balance among velocity, force and movement technique which requires patience to continually adapt. Derived findings should provide further approaches on long-term, more holistic development pathways and strategic training planning (less is more; quality prior quantity) with enough attention on the biological domain (e.g. load & recovery, adaptation time, and enhanced vulnerability to injury/illness during biological maturation). Identification & documentation of qualitative factors (nature & nurture) should strengthen a viable, flexible, healthy & sustainable pathway from adolescent to senior TJ success.

TEXT NETWORK ANALYSIS USING RESEARCH KEYWORDS IN FOOTBALL ARTICLES BETWEEN 1948 AND 2022

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Text network analysis using research keywords in football articles between 1948 and 2022

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INTRODUCTION: Football is the sports enjoyed and loved by the world's largest population and has become a culture beyond sports. There have been many peoples efforts in various fields before football developed. Among them, many researchers in the academic field have conducted various research for the development of football for a long time. This study aimed to identify research topics in football papers and analyze changes of research trends by periods.

METHODS: The used research was collected from 'Web of Science' and a total of 36,256 football articles between 1948 and 2022 were analyzed. The used keywords went through refining process such as using only nouns, synonym, thesaurus, independent word, etc. for network analysis. Cyrams Netminer 4.0 software was used for the network analysis. Centrality analysis was conducted by extracting only words corresponding to the top 2% of the research main topics, and degree centrality and eigenvector centrality were calculated.

RESULTS: The most frequently mentioned research keywords were 'injury', 'performance', 'club' and 'training'. The keyword 'performance' showed the highest degree centrality(0.294) and 'world' and 'cup' showed the highest eigenvector centrality. The 7 clusters were formed regardless of ranking from centrality analysis(modularity=0.662) and each cluster could be

understood as 'performance', 'analysis', 'injury', 'training', 'research sample', 'experiment' and 'exercise' respectively. As of 2010, the keyword with the highest degree centrality value changed from 'injury'(prior to 2000 and 2000s) to 'performance'(2010s and 2020s). Meanwhile, the keyword with the highest eigenvector degree value changed from 'injury'(prior to 2000) and 'world'(2000s) to 'cup'(2010s and 2020s).

CONCLUSION: The number of published football papers rapidly increased every year. The majorities of football research papers were physical injury related to knees, ankles, ligaments and experimental from university in the past, whilst recently many papers related to applied football field such as performance, analysis, clubs and World Cup have been published. This paper is meaningful in that it could be a basic data by grasping the trends of all football articles published over the last 75 years.

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PACING PATTERNS IN THE LAST DECADE OF WORLD ROWING CHAMPS AND OLYMPIC GAMES

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INTRODUCTION: Pacing strategies in rowing are the varied strategies which rowers use to distribute their energy and efforts throughout 2000 meters. The Olympic distance lasting between 5'30"-7'30" (Boillet, 2022). Rowing competitions are 6-line elimination races with boats navigating backwards so an early lead allows the leader to monitor the progress of opponents (Astridge 2022). Given this particularity the most common rowing pacing patterns is parabolic (Muehlbauer, 2011) described as reversed Jshaped (Mentzoni, 2021). Taking this into consideration we examinate the last decade of rowing to identify the common pacing and tactics as an important info for coaches and rowers.

METHODS: Rowing times of each 500m sector of the 6 Finalist boats (1-6th) of each modality were registered from World Rowing Championships (WR) (2010-2022) and Olympic Games (2012-2020).

RESULTS: Mean rowing times at finals for single sculls were (men (M): 1:40,16; 1:43,84; 1:44,15; 1:42,32 & women (W) 1:51,24; 1:54,58, 1:55,30, 1:55,04) for doubles scull (M: 1:32,7; 1:35,6; 1;35,9; 1:34,1 & W 1:42,4; 1:45,5; 1:45,8; 1:44,5), lightweight double scull (M: 1:35,4; 1:38,1; 1:39,0; 1:37,2 & W: 1:45,8; 1:49,0; 1;48,6; 1:46,5), pairs (M: 1:35,9; 1:39,8; 1:40,0; 1:38,9 & W: 1:45,9; 1:49,8; 1:49,7; 1:48,3) fours (M: 1:29,0, 1:31,9, 1:32,6, 1:30,4 & W: 1:37,1, 1:41,2, 1:42,1, 1:39,3) quads (M 1:26,4, 1:28,6, 1:29,1, 1:27,4 W 1:36,1, 1:39,3, 1:39,7, 1:38,0) & eights (M 1:21,4, 1:24,0, 1:24,6, 1:22,4 W 1:30,2 1:32,8, 1:33,4, 1:31,7).

CONCLUSION: Results shown that the most common pacing strategy for each modality at the WR & Olympic Finals was the J-shaped as mentioned before, being the first 500m of the race the fastest one, and the last 500m the second. Central sectors (2n and 3rd 500m) showed similar times having the ability to maintain this speed during the whole race will produce a more even rowing times as happened in Tokyo 2021 (Kleshnev, 2021).

TACTICAL ANALYSIS IN OLYMPIC WRESTLING: A MARKOV CHAIN APPROACH

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INTRODUCTION: In sport, the concept of tactics has been defined by several authors as the actions taken by players to adapt to dynamically changing match situations. The delicate competitive balance between two athletes is broken as soon as the former scores a point. This change in the status of the fight inevitably leads to changes in the tactics, style of play and psychological state of the athletes [1]. Therefore, the objective of the study was to develop a tactical model of wrestling matches in order to determine the probability of the outcome as a function of a given score, the time remaining before the end of the match and the associated co-variables throughout a match.

METHODS: The score, time, weight class, round of competition and wrestling style were automatically annotated from 5280 bouts from the international wrestling circuit. In order to determine the probability of evolution and outcome of the fight, a multi-state Markov model was calculated. The transition intensities were calculated from the Nelson-Aalen estimator. The evolution probabilities of the fight were calculated at each moment of the fight thanks to the Aalen-Johansen estimator.

RESULTS: The model developed makes it possible to understand the mechanisms of score transitions during a fight. It also allow to estimate outcome of fight according to the current score. All the probabilities of score changes and combat outcomes were calculated for each possible score difference and grouped into a matrix. Taking the example of a 4-point gap, regardless of the style of wrestling, this advantage lead the fight towards victory (40%). And this tend to be accentuated if this gap occurs late in the fight (90% in the last minute).

CONCLUSION: This work presented a Markov chain approach for better understand the tactical evolution of a wrestling match. Although the results are promising, we see opportunities for several improvements, though the majority can only be implemented with a more detailed dataset. In the near future, we will be able to add the techniques associated with each point scored as well as the area on the combat surface. The current model will be able to evolve towards a semi-Markovian model inhomogeneous in time [2], taking into account the time spent in a state, and parametric by testing several laws a priori.

Keywords : score; wrestling; markov chain; time; performance; tactics

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PERFORMANCE ESTIMATION BASED ON BIOMETRIC PARAMETERS

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INTRODUCTION: Estimating individual sporting potential is a decision aid for staff and federations, especially in rowing. One way to estimate the performance is to estimate the relationship between age and performance. Several equations were designed to model this relationship. Dan H. Moore [1] proposed in 1975 the Moore's equation and more recently G. Berthelot [2] and al. published in 2019 an integrative modeling approach to the age-performance relationship (IMAP), but these approaches use only age to estimate performance. We aim to include biometric parameters like weight in the age-performance relationship in rowing to improve the accuracy of the estimation of athletic potential.

METHODS: The results and weight of French athletes aged 14 to 68 years in 2000-meters ergometric tests from 2002 to 2023 for men and women were used. The best performance by age for men and women was modeled using least squares method with the Moore's equation with an added coefficient specific to the weight representing its impact on performance. The adjusted R-squared of the Moore's equation and its weight-aware version were compared in order to determine whether or not the addition of weight in performance estimation is relevant.

RESULTS: For men, the adjusted R-squared is 0.9024 for the Moore's equation considering the weight against 0.8942 for the Moore's equation. The estimated peak age is 23.7 years for the weight adjusted equation against 23 years. For women, the Moore's equation taking into account the weight has an adjusted R-squared of 0.7221 against 0.7220. 19.30 years is the estimated peak age for the Moore's equation considering the weight against 20.32 years for the other one.

CONCLUSION: For men, adding weight to the Moore's equation increases the adjusted R-squared. For the women, the adjusted R-squared of both equations are similar to each other. The addition of weight reduced the uncertainty in the estimation of men ergometric test results.

References:

[1] Moore, « A Study of Age Group Track and Field Records to Relate Age and Running Speed »;

[2] Berthelot et al., « An Integrative Modeling Approach to the Age-Performance Relationship in Mammals at the Cellular Scale ».

Training and Testing

THE EFFECTS OF SHORT-TERM HIGH-INTENSITY INTERVAL TRAINING VS. GENERAL INTERVAL TRAINING IN RUGBY PLAYERS

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INTRODUCTION: High-intensity interval training (HIIT) is one of the training methods which designed to optimize the athletic performance through variety exercise type with high exercise intensity, less recovery time (interval), and several bouts. It has been found varying HIIT doses were effective, but there is no indication of the different effects between the short term HIIT and general interval training. The purpose of this study was to investigate the different effects of short-term HIIT and general interval training on speed, power, agility, and endurance of rugby players.

METHODS: Thirty-two trained male college rugby players (age: 20.66 ± 1.63 years; height: 174.69 ± 5.41 cm; body mass: 79.41 ± 13.15 kg) participated in this study. Written informed consent was obtained from all the subjects before the experiment begin. The subjects were randomly divided into the HIIT group (HG, n=18) and general interval training group (GG, n=14), respectively. The HG took twice a week of high-intensity interval training for 3 weeks and the GG took the general interval training as the original schedule. The Yo-Yo IR2 test, counter-movement jump, 30 m sprint and T test of subjects were measured before (pretest) and after (post test) training, and after the tapering phase which will be the fourth week from the begin of training (retest). Two-way mixed-design ANOVA and LSD post-hoc procedures was used in this study. Significance was set at $P < .05$.

RESULTS: According to the analysis results of speed, there is no difference both in main effects [group: $F(1, 30) = 1.430$, $p = .241$, ES = .048; time: $F(1, 49) = 1.263$, $p = .267$, ES = .042)] and interaction effects [$F(1, 49) = 2.617$, $p = .112$, ES = .087]. We found similar result in power, there is no difference both in main effects [group: $F(1, 30) = .508$, $p = .481$, ES = .017; time: $F(2, 60) = .844$, $p = .435$, ES = .028)] and interaction effects [$F(2, 60) = .786$, $p = .460$, ES = .026]. The results of agility showed that significant difference were observed in time factor ($F(2, 60) = 52.563$, $p < .001$, ES = .653). Post-hoc test revealed the results of post test (10.38 ± 0.54 s) is better than retest (10.68 ± 0.59 sec), and retest is better than pretest (11.39 ± 0.58 sec). Significant effect was found in the interaction of results in endurance [$F(1, 44) = 6.198$, $p = .017$, ES = .207], and the simple

interaction effect showed the results of pretest (1595.56 ± 250.32 m) and retest (1687.78 ± 323.88 m) are both better than post test (1492.22 ± 218.35 m) in HG.

CONCLUSION: we conclude that there is no significant difference in short term training effects between HIIT with general interval training. Moreover, both two types of short term interval training can only maintain the exercise ability in this study. While HIIT is adopted as a training session, the training-induced fatigue should be considered. However, the advantages of HIIT in time saving and high intensity, which could be the option of tapering strategy.

COMPARASION OF PHYSIOLOGY CHARACTERISTICS OF DIFFERENCE POSITION IN ELITE MALE HANDBALL PLAYERS

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INTRODUCTION: Handball players have several field positions, but the physical abilities of players in different positions may vary and therefore need to be treated differently.

METHODS: 25 elite male handball players (age:22.6±3.7, height: 191.3±6.4cm, weight: 90.9±13.2kg) participated in the study, tested twelve physiological and physical fitness indexes of the players, and compared the differences between different position(goalkeeper, pivot, back and wing) by ANOVA with Bonferroni post-hoc test

RESULTS: There were no difference with height, weight, vertical jump height, 30m sprint, YoYo test, pull-up, 60°·s-1 isokinetic muscle strength test in different position ($p > 0.05$). There were group differences in the 1RM squat and bench press ($p < 0.05$).

CONCLUSION: No difference in height, weight, speed, endurance, explosive power, slow isometric muscle strength between position handball players and there is a difference between the maximum strength of deep squat and bench press. Practitioners can use the result as a reference for training, but should also be aware of the small sample size in this study.

A NOVEL FORMULA USING ENERGY CONTRIBUTIONS TO CALCULATE PURE MAXIMUM RATE OF LACTATE PRODUCTION (PNLA.MAX) DURING AN ALL-OUT ANAEROBIC CYCLING TEST

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INTRODUCTION: The aim of this study was to compare previous calculating formulas of maximal lactate produced rate (□La.max) and a novel formula of pure □La.max (P□La.max) during a 15-s maximal sprint cycling test (MSCT) and to analyse their correlations.

METHODS: Thirty male national-level track cyclists participated in this study (n = 30). They performed a 15-s MSCT in which anaerobic power output (peak watt; Wpeak and mean watt; Wmean), peak and mean oxygen uptakes (V̇O2peak and V̇O2mean), and maximal blood lactate concentrations (Lamax) were measured. These variables were utilised for different calculations of □La.max and three energy contributions (phosphagen contribution; WPCr, glycolytic contribution; WGly, and oxidative contribution; WOxi). P□La.max calculation considered ΔLa−, timespan until Wpeak (tPCr−peak), and contributed timespan of the oxidative system (tOxi). Other □La.max values without tOxi were calculated using decreased time by 3.5% from Wpeak (tPCr −3.5%) and tPCr−peak.

RESULTS: Absolute (kJ) and relative (%) WPCr indicated higher levels compared to WGly and WOxi. Values of WGly in kJ and % were significantly higher than WOxi ($p < 0.0001$, respectively). The value of □La.max (tPCr −3.5%) was significantly higher than P□La.max and □La.max (tPCr−peak) (0.97 ± 0.18, 0.88 ± 0.13, and 0.85 ± 0.12, respectively; $p < 0.0001$) while □La.max (tPCr−peak) was lower than P□La.max ($p < 0.0001$, respectively). A very high association between P□La.max and □La.max (tPCr−peak) was observed ($r = 0.99$; $R2 = 0.98$). This was higher than the relationship between P□La.max and □La.max (tPCr −3.5%) ($r = 0.87$; $R2 = 0.77$). □La.max (tPCr−peak), P□La.max, and □La.max (tPCr −3.5%) correlated with absolute Wmean and WGly (vs. Wmean: r = 0.48, 0.45, and 0.43; vs. WGly: r = 0.73, 0.70, and 0.61, respectively).

CONCLUSION: P□La.max as a novel calculation of □La.max provides more detailed insights into interindividual differences in energy and glycolytic demands than □La.max (tPCr−peak) and □La.max (tPCr −3.5%). In particular, because WOxi and WPCr can differ remarkably between elite cyclists, implementing those values in P□La.max can therefore establish more optimized individual responses for elite track cyclists.

RELIABILITY OF A NOVEL INDOOR GPS TECHNOLOGY DURING A BASKETBALL EXERCISE SIMULATION TEST

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INTRODUCTION: Exercise tests used to assess acute and chronic athletic performance need to closely simulate the movement characteristics of players during the actual game or match. Such tests also need to have adequate reliability to ensure changes in performance can be appropriately identified. Therefore, the aim of this study was to investigate the measurement reliability of movement characteristics during a simulated basketball exercise simulation test using novel indoor GPS technology (VX Sport, Omni, Wellington New Zealand).

METHODS: Eighteen regional or national representative basketball athletes (13 males; 20.4 ± 1.3 yr, 185.8 ± 27.5 cm, 87.7 ± 8.0 kg and 5 females; 20.4 ± 1.5 yr, 175.5 ± 7.5 cm, 75.2 ± 6.0 kg mean ± SD) performed two trials (7-8 days apart) of

the basketball exercise simulation test (BEST) on a FIBA-sized basketball court with VXSport Omni devices inserted into custom-made pockets located between thoracic vertebrae T1-T4 in the back of the VXSport Smartvests. Initially, each player completed a standardised movement sequence on an outside field to allow the VXSport unit to calibrate for the players gait cycles and movement patterns before moving inside to the basketball court. Measures taken included total distance and relative distance covered during the test, maximal speed, total number of sprints, total number of jumps, total number of accelerations/decelerations as well as high-intensity accelerations/decelerations (> 3m/s2) and average heart rate. The test-retest reliability was determined by using the typical (standard) error, coefficient of variation (CV) and intraclass correlation coefficient (ICC).

RESULTS: All movement parameters showed reasonably high between-trial ICCs ranging from 0.77 to 0.98. Total distance covered during the test, total number of sprints, total number of jumps, total number of accelerations/decelerations and average heart rate all exhibited low CVs (≤5%), while relative distance, maximal speed, and total number of sprints over 15 km/h had slightly higher CVs (5.8, 7.0, 7.2%). Total number of high-intensity accelerations and decelerations had high CVs (17.8 and 15.6% respectively).

CONCLUSION: The novel finding of this study was that the VXSport Omni unit showed adequate reliability for most movement characteristics measured indoors during an on-court basketball simulation test. This suggests that using GPS units with added micro-technology (accelerometers, gyroscopes, and inertia sensor) can reliably measure most simple movement characteristics in basketball players on indoor courts where satellite coverage is unavailable.

HEART RATE VARIABILITY AND ITS ASSOCIATION WITH TRAINING AND MATCH LOAD IN FEMALE SOCCER PLAYERS

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INTRODUCTION: Identifying fatigue and overtraining would be helpful for coaches and athletes as the training load could be modified accordingly. It is, therefore, imperative to have reliable and valid indicators of players' adaptation to training and competitive load. There are several scientifically validated tools currently available for this purpose. Accordingly, the measurement of resting or post-exercise HR variability (HRV) has been suggested to indicate both positive and negative adaptations to training and it can be indicative of the physiological stress and fatigue levels during and after training or matches. Hence, we conducted this pilot study to (i) analyse changes in HRV as indicated by the root mean square of successive differences (rMSSD) during four microcycles of competition and (ii) observe the relationship of HRV with training and match load.

METHODS: Data from nine female soccer players (age 21±6.18 years, height 164.33±5.52 cm, weight 53.79±6.40 kg) was analysed for this study. Resting HRV (rMSSD in ms) was measured daily upon waking using the validated HRV4Training app, while the training load was acquired after each training and match. The session RPE method was used for quantifying training load, which involves multiplying the athlete's RPE (on a 1–10 scale) by the duration of the session (in minutes). The Spearman rank test (rho) was used to assess the relationship of HRV with training and match load measures.

RESULTS: No significant changes in HRV were identified between the four microcycles of competition. In addition, results indicated significant moderate associations in HRV between MD (match day) and MD-3 (three days before match) (r =0.41) as well as MD and MD-4 (four days before match) (r =0.44). HRV of MD-1 and MD-2 were also significantly correlated (r = 0.62). Lastly, the HRV of MD-4 was significantly correlated with MD-3 (r =0.55). Regarding the training load, MD-3 and MD-4 were significantly positively associated (r =0.51), while significant negative associations were indicated between the training load of MD and MD-2 (r =-0.34), MD-1 and MD-2 (r =-0.61) as well as MD-2 and MD-5 (r =-0.76). Lastly, no significant associations were indicated between HRV and training load despite the aforementioned associations.

CONCLUSION: The results indicate that HRV is sensitive to changes in stress or fatigue, but in general, athletes should be considering HRV in relative terms and not as an outcome. Therefore, the goal should be to maintain a stable HRV and look at relative changes over time so that they can balance stressors, regardless of the absolute values of HRV. Conclusively, evaluating HRV during training and match days can aid in better planning of the training load as well as avoiding negative chronic responses, but the interpretation of the HRV should be done with caution especially considering the great variability of rMSSD values that are obtained through the apps and wearables.

A COMPARISON OF OVERHAND AND SIDE-HAND THROW TECHNIQUES IN HANDBALL THROW: EXPLORING THE EFFECT OF PHYSICAL CONSTITUTION AND STRENGTH ON THROWING PERFORMANCE

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Introduction

The overhand throw is widely used to assess the throwing ability in handball throw, which is part of a physical fitness test in Japan. However, individuals with limited physical constitution or strength may struggle to perform the proper kinematic chain known as the "whip-like motion" properly and grip the ball, leading to reduced overhand throwing distance. This underscores the limitations of assessing throwing ability solely through the overhand throw. This study explores the side-hand throw as an alternative throwing technique and classifies throwers based on their performance using both techniques. Additionally, comparisons will be made between groups in terms of physical constitution and strength.

Methods

Thirty-nine college students participated in this study. Each participant performed two trials of handball throws using both side-hand and overhand throwing techniques, and the best results were used for analysis. The order of the techniques was randomized. Physical constitution and strength were measured using following variables: height, weight, arm span, shoe size, hand length, hand width, arm length, leg length, grip strength, and standing long jump. Participants were classified using cluster analysis based on the ratio of side-hand to overhand throw performance. An unpaired t-test was used to compare the measurement variables, and Cohen's d was calculated. The significance level was set at $p < 0.05$.

Results

Two groups of throwers were identified: one group had significantly lower overhand throw records compared to side-hand throw (SHT), and the other group showed little difference in their throwing records between the two techniques (OHT). The OHT group had significantly higher records for both overhand throw and weight compared to the SHT group. Although there were no significant differences between the groups, the effect sizes for grip strength of both hands were approximately medium (right: $d = 0.47$, left: $d = 0.55$).

Discussion

The results of this study suggest that individuals who struggle with overhand throw can still achieve some distance with side-hand throw. Although only weight showed significant differences, it is an indicator of muscle strength and the effect sizes for grip strength of both hands, a measure of muscle strength, were approximately medium. Previous research has found a relationship between muscle strength and ball speed in baseball pitching (1). These studies suggest muscle strength affects the overhand throw performance. In side-hand throw, participants can throw the ball without using "whip-like motion" and gripping the ball, making the motion simpler than overhand throw and less reliant on physical attributes. These findings indicate that individuals may benefit from a throwing technique that takes into account their physical constitution and strength.

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PHYSICAL FITNESS COMPARISON BETWEEN PROFESSIONAL SOCCER PLAYERS AND U17 ELITE YOUTH

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INTRODUCTION: According to the literature, the success rate of a youth footballer, already at the highest youth level, becoming a professional soccer player is minimal. However, general athleticism is undeniably a major factor in a successful transition to senior soccer. Therefore, comparing these youth athletes athleticism to those already at the highest standards would provide an inside into the fitness parameters needed.

METHODS: Fifty-two professional male football players (pro) (age =27.37 ± 5.57 years) and forty-four youth players (age =16.20 ± 0.80 years) performed a series of laboratory tests to assess anthropometry, lower body strength, cardiovascular endurance, lactate curve profiling and leaping ability.

RESULTS: Independent t-tests demonstrated that the pros were significantly taller 179.77 ± 6.72 cm and heavier 77.11± 6.54 kg than the youth 175.97 ± 5.84cm and 66.98 ± 6.19 kg, respectively. The 7-site skinfold method demonstrated no significant difference in body fat percentage (BF%) (10.5±3.28 pro vs 9.83±3.01 youth). The remaining sites were not significantly different. Pros demonstrated greater leaping ability on both the squat jump (39.62±3.83 vs 33.68±4.73cm) and the countermovement jump (42.52±3.84 vs 36.86±4.73cm). The quadriceps and hamstrings strength measured on the isokinetic device at a speed of 60 degrees /sec demonstrated that both muscle groups were significantly higher in pros. The pro group ran significantly longer on the incremental running test (18.08±1.83 vs 17.19±1.86 min). Mixed design ANOVA was used to evaluate the aerobic fitness characteristics within the pro and youth groups and between them at each of the increments. The Greenhouse-Geisser analysis demonstrated that the was a significant effect of within-group lactate values ($F(5, 125) = 723.3$, $p<0.001$, $\eta2=0.92$) and a significant interaction of playing standards ($F(5, 125) = 3.30$, $p<0.05$, $\eta2=0.05$). The pairwise comparison demonstrated that after the first running increment, the youth experienced significantly greater production of lactates in all the remaining increments. Similarly the VO2 values had a significant within group VO2 values ($F(5, 125) = 722.59$, $p<0.001$, $\eta2=0.91$) and a significant interaction of playing standards ($F(5, 125) = 3.23$, $p<0.05$, $\eta2=0.04$). The pairwise comparison demonstrated that the youth experienced significantly greater VO2 values in all the remaining increments. Thus, the VO2 max of the youth was significantly higher, 61.12±5.57 ml/kg/min, than the pros, 55.32±6.76 ml/kg/min.

CONCLUSION: The findings of this study demonstrated the superiority of pro footballers compared to youth U17 in all laboratory fitness parameters. The results indicated that cardiovascular fitness depended mainly on lactate kinetics rather than the VO2 max when comparing the two groups. Furthermore, the most notable difference is lower body strength. Practitioners could use the results in developing targeted programs that would enhance the chances of a successful transition to senior soccer.

ACUTE PHYSIOLOGICAL RESPONSES TO HYPEROXIC HIGH-INTENSITY INTERVAL EXERCISE IN HORSES

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INTRODUCTION: High-intensity interval training in hyperoxia has been proposed to enhance exercise performance and aerobic capacity, but its potential efficacy and mechanism are unclear. Therefore, the aim of this study was to determine the effect of breathing hyperoxic gas during high-intensity interval exercise and moderate-intensity continuous exercise in horses.

METHODS: In a randomized crossover study design, seven trained Thoroughbred horses performed four distance-matched treadmill exercise protocols: 1) moderate-intensity continuous exercise in normoxia (FIO2 = 0.21, 6 min at 70%VO2max; N-MICT), 2) high-intensity interval exercise in normoxia (FIO2 = 0.21, 6 × 30 s at 100%VO2max with 30 s recovery; N-HIIT), 3) moderate-intensity continuous exercise in hyperoxia (FIO2 = 0.30, 6 min at 70%VO2max; H-MICT), and 4) high-intensity interval exercise in hyperoxia (FIO2 = 0.30, 6 × 30 s at 100%VO2max with 30 s recovery; H-HIIT). Arterial blood samples were collected during exercise to measure blood gases and plasma lactate concentration. Heart rate during exercise was also recorded. Data are expressed as mean ± SE, and effect of the protocol was analyzed using mixed models ($P < 0.05$).

RESULTS: At the end of exercise, arterial O2 saturation (SaO2) in H-MICT (95.6 ± 0.1%), H-HIIT (95.1 ± 0.2%) and N-MICT (92.4 ± 0.7%) was significantly higher than that in N-HIIT (86.5 ± 1.6%) ($P < 0.0001$). Arterial O2 partial pressure (PaO2) in H-MICT (158.2 ± 1.6 Torr) and H-HIIT (155.1 ± 2.9 Torr) was significantly higher than that in N-MICT (95.1 ± 1.9 Torr) and N-HIIT (89.3 ± 1.3 Torr) ($P < 0.0001$). Heart rate and plasma lactate concentration in N-HIIT (216 ± 3 bpm, 23.6 ± 2.6 mmol/l, respectively) and H-HIIT (214 ± 2 bpm, 19.5 ± 2.6 mmol/l) were significantly higher than those in N-MICT (198 ± 4 bpm, 9.5 ± 2.1 mmol/l) and H-MICT (202 ± 4 bpm, 12.0 ± 2.5 mmol/l) (heart rate, $P = 0.0009$; lactate, $P = 0.0003$). Arterial pH in N-HIIT (7.183 ± 0.032) and H-HIIT (7.195 ± 0.031) was significantly lower than that in N-MICT (7.354 ± 0.021) and H-MICT (7.299 ± 0.031) ($P = 0.0002$).

CONCLUSION: Heart rate, plasma lactate concentration, and arterial pH were not affected by inspired O2 concentration, while SaO2 and PaO2 were maintained even in high-intensity interval exercise when breathing hyperoxic gas. These results suggest that hyperoxic high-intensity interval exercise can enhance O2 delivery to skeletal muscle and can lead to additional stimulus to mitochondrial oxidative capacity.

MULTIFACTORIAL INDIVIDUALISED PROGRAMME FOR HAMSTRING MUSCLE INJURY RISK REDUCTION IN PROFESSIONAL FOOTBALL: A PROSPECTIVE COHORT STUDY

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INTRODUCTION: The aim of this prospective cohort intervention study was to test whether an innovative hamstring injury risk reduction program could further reduce the risk of hamstring muscle injuries (HMI) in professional football settings with ongoing risk reduction efforts.

METHODS: HMI and player exposure were registered prospectively during the two seasons (2019 & 2021) in 5 Finnish premier football league teams. The 2019 season was used as a control (n = 90), while the intervention was conducted in the 2021 season (n = 87). Questionnaires for the coaching staff were also used to better understand the differences between the 2019 and 2021 seasons in terms of HMI risk reduction strategies. Cox regression hazard ratio (HR) was used as the primary analysis to compare seasons, which was adjusted for age, team, team position, body mass, height, and history of HMI. Secondary analysis included adjusting for program compliance.

RESULTS: The seasons were similar in nature, including non-significant differences in match exposure, age, and previous HMI. A total of 20 index HMI were registered during the control 2019 season (average injury per team: 4.8, range: 4-5, injury burden: 15.1) and 16 index HMI during the intervention season (average injury per team: 3.2, range: 1-6, injury burden: 14.5). Average compliance of the intervention program was 50% (CI95%: 38-62). Cox regression analysis showed a non-significant trend toward increased risk of hamstring injuries during the intervention season (HR: 1.35, CI95: 0.68 – 2.66, $p = 0.39$). However, when controlling for total compliance, there was a non-significant trend toward the intervention season reducing the risk of injury (HR: 0.52, CI95%: 0.05 – 5.33, $p = 0.58$). Furthermore, players showing reductions in maximal theoretical horizontal force or knee flexor force between pre-season and mid-season screening measurements had a significantly higher risk of sustaining an HMI later in the season (Risk Ratio: 5.6 – 12.1, $p < 0.05$).

CONCLUSION: The innovative multifactorial and individualized injury risk program was not successful in further reducing HMI risk in a professional football setting with ongoing risk reduction protocols. The program remained feasible as it didn't increase risk, while future research should explore whether increased compliance in a multifactorial and individualized approach can improve the HMI risk outcome.

FATIGUE IN A SHUTTLE REPEATED SPRINT-RUNNING TEST IN MALE AND FEMALE STUDENTS IN A SCHOOL SETTING: A COMPARISON BETWEEN CALCULATION METHODS

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INTRODUCTION: It has been shown that 62% of high school students seem to prefer mainly team sports during physical education classes [1]. Repeated sprint ability (RSA) is an important determinant of performance in team sports, and is readily assessed by the shuttle repeated sprint running test [2, 3]. Fatigue in this test may be assessed by different methods, e.g., by calculating the fatigue index (FI), the percent sprint decrement (Sdec) or the slope of performance decrement over the six sprints [4,5]. The aim of the present study was to examine the relationships between FI, Sdec and slope during a shuttle repeated sprint-running test in male and female students in a school setting.

METHODS: Twenty-six adolescent students performed six 30 m sprints with a change in direction of 180o at 15 m, indoors on a non-slippery court. Performance time of each sprint was measured by a timing gate which was set at the start (which was also the end of each sprint). The following methods of fatigue calculation were used: (a) Fatigue index (FI%)=((fastest time – slowest time) x fastest time -1) ·x 100 , (b) percent sprint decrement (Sdec%) = 1 – (Total time x (6 x minimum time)-1) and (c) (slope of the individual performance time decrement over the six sprints using linear regression x fastest time -1)x100. Significance was set at $P<0.05$.

RESULTS: The two-way ANOVA (sex x sprint repetition) showed a significant main effect for sprint repetitions during the shuttle repeated sprint running test ($p<0.01$). Tukey's post hoc tests indicated that performance time in both male and female students significantly increased as sprints progressed (1st vs. 3rd till 6th, 2nd vs. 4th till 6th, 3rd vs. 5th and 6th, 4th vs. 6th). Also, males had significantly faster times than females ($p<0.01$) at every corresponding sprint. The correlation coefficient of the linear regression used to calculate the slope of performance decrement was $r = 0.90 \pm 0.08$. All fatigue indices were similar for males and females (FI%: -11.5% ± 5.0% and -15.1% ± 4.3%, p=0.07; Sdec%: -5.6% ± 2.2% and -7.3% ± 2.2%, p=0.08; slope: 2.1 ± 1.0 and 2.9 ± 1% per sprint, p=0.059). Slope was strongly correlated with fatigue index and Sdec in males (FI: r = -0.97 and Sdec: r = -0.89; $p<0.05$) and females (FI: r = -0.96 and Sdec: r = -0.86; $p<0.05$).

CONCLUSION: The slope of individual sprint time curve was strongly correlated with the FI and Sdec in both males and females and could be used as an alternative index to determine the level of the RSA of individuals.

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EVALUATING HANDBALL THROWING USING OBSERVATIONAL STANDARDS FOR SOFTBALL THROWING

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INTRODUCTION: Overhand throws are a crucial skill in various sports, and observational standards have been established to evaluate the movements. In Japan, overhand throws in either softball or handball are evaluated, however, only observational standards for softball throws exist. The aim of this study was to determine the feasibility of evaluating handball throws using the observational standards for softball throws.

METHODS: Forty male collegiate students participated and performed overhand throws with a handball. The throws were recorded by two high speed cameras at 120 fps, placed on the right side and backward against the throwing direction. The video was repeatedly observed and evaluated based on the observational standards of softball throwing four movements (step length, backswing action, throwing arm kinetic chain, and free arm leading movement) on a three-point scale (3: excellent, 2: fair, 1: poor) by two evaluators [1]. Pearsons product-rate correlation coefficient was used to determine the relationship between the handball throw record and the total evaluation score. Multiple regression analysis, using the stepwise method, was performed with the handball throwing record as the dependent variable and the evaluation results of each movement as independent variables to determine the impact of each movement.

RESULTS: A significant positive correlation was found between the handball throw record and total score of the four movements ($r = 0.75$, $p < 0.01$). The results of multiple regression analysis showed that the throwing arm kinetic chain ($\beta = 0.44$, $p < 0.01$) and free arm leading movement ($\beta = 0.56$, $p < 0.01$) had a significant impact on the record ($R^2 = 0.70$, $p < 0.01$), while step length and backswing action were excluded.

CONCLUSION: The findings indicate that the throwing arm kinetic chain and free arm leading movement are valid standards for evaluating handball throwing by observation, similarly to softball throwing [2]. However, step length and backswing action may not be significant factors in handball throwing. In softball throwing, stepping with the foot initiates the transfer of weight and kinetic energy, while backswing action prepares the throw [2]. The handball, with its larger diameter and mass compared to softball, may have resulted in some participants prioritizing their grip on the ball given their hand size and grip strength, causing a deviation from stepping or backswing compared to softball throwing. Neverthe-

less, the effective use of kinematic chain and free arm leading motion allowed for successful handball throws. Therefore, it can be concluded that the critical preparatory movements in handball throwing differ from those in softball throwing, as determined by observational evaluation.

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THE EFFECTS OF DARK CHOCOLATE SUPPLEMENTATION ON RATE OF PERCEIVED EXERTION AND FATIGUE INDEX DURING ANAEROBIC SPRINT TEST

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INTRODUCTION: Studies have revealed that diet rich in flavanols have positive effects on cardiovascular health. Dark chocolate (DC) contains high amounts of flavanols due to high levels of epicatechin present that promotes availability and activity of nitric oxide (Patel, Brouncer & Spendiff, 2015). The increase in nitric oxide has shown to decrease oxygen cost during exercise and thus improving cardiovascular health (Engler & Engler, 2004). To investigate the effects of DC on anaerobic performance and OMNI rate of perceived exertion (RPE) in running-based anaerobic sprint test (RAST).

METHODS: Ten healthy participants (age: 23.8 ± 1.21 years; height: 1.74 ± 5.78 m; weight: 73.91 ± 9.18 kg; body fat percentage: 19.18 ± 6.17 %; lean muscle mass: 77.95 ± 6.16 %) volunteered for this study. Their anthropometric measurements were recorded, and body composition measured via dual-energy X-ray absorptiometry (DEXA) machine. Participants were randomly assigned to DC trial and white chocolate trial (WC); and consumed 300ml each of DC milk and plain milk mixed with 5-7 WC flavor drops respectively. They completed other trial (DC or WC) after a 7-day wash-out period. The RAST was conducted, and participants had to perform six 35m sprints with 10s passive recovery between each sprint. Timings gates were used to measure the time taken. RPE was recorded after 2nd, 4th and 6th sprint stages and Fatigue Index (FI) were recorded at the end of each RAST test.

RESULTS: Significant differences was indicated for both trials for 4th stage RPE ($t(9) = -2.54$, $p = 0.03$, $r = 0.64$, DC: 5.4 ± 1.3 vs. WC: 6.5 ± 1.2)); FI in 1st RAST ($t(9) = -2.73$, $p = 0.02$, $r = 0.01$, DC: 34.40 ±8.71 vs. WC: 39.60 ± 2.89)). Positive significant correlations were revealed between trials for FI in 1st RAST: (DC: 34.40 ± 8.71 vs. WC: 39.60 ± 9.14, $p = 0.02$, $r = 0.67$); FI in 2nd RAST: (DC: 35.61 ± 9.14 vs. WC: 40.58 ± 11.92, $p = 0.03$, $r = 0.69$). Results revealed negative significant correlation within trial for DC FI and 4th stage RPE for 1st RAST (DC FI: 34.40 ± 8.71 vs. DC RPE: 5.40 ± 1.35, $p = 0.04$, $r = -0.65$); positive significant correlation between WC FI 2nd RAST and WC 2nd RAST 2nd stage RPE (WC FI 2nd RAST: 40.58 ± 11.92 vs. WC 2nd RAST 2nd stage RPE: 5.30 ± 0.67, $p = 0.02$, $r = 0.71$).

CONCLUSION: Results indicate that pre-consumption of DC before exercise significantly may have reduced FI and RPE during anaerobic exercise for certain stages during the RAST. Furthermore, athletes and sports enthusiasts may consider consuming DC as a safe ergogenic aid to help improve anaerobic performance. RPE may be used to regulate intensity for anaerobic performance. Further studies need to be conducted to ascertain similar results.

EFFECTS OF ENDURANCE TRAINING ON ATHLETIC RECORDS AND ANAEROBIC POWER PRODUCTION CAPACITY IN JAPANESE LONG-DISTANCE RUNNERS.

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INTRODUCTION: Previous studies have reported the importance of improving aerobic capacity in improving the athletic records of long-distance athletes [1]. Recently, the athletic record is affected by the running speed in the last spurt. For this reason, not only aerobic capacity but also anaerobic capacity is considered important factor for long-distance runners. Changes in maximal anaerobic power and middle power and their effects on athletic records have not been examined by endurance training throughout one year. Therefore, the purpose of this study was to examine the change of athletic record and anaerobic power generation capacity throughout the year in Japanese long-distance runners.

METHODS: The subjects were 18 male collegiate long-distance runners (age: 19.6±1.1yrs, Height: 170.0±4.7cm, Weight: 56.0±4.8kg). In this study, the athletic records in 5,000m, 10,000m and 20km were researched throughout season1 and season2(one year after season 1). The maximal anaerobic power (MAP), middle power (MP) and middle power to peak power ratio (MP/PP ratio) in each season as an anaerobic power generation capacity were measured by cycling ergometer (Power max VII), respectively. The change ratio of measurement parameters was calculated in all subjects. Subjects were classified by athletic record based by 10,000m athletic record faster (AG) and slower (BG) than 30:30 in season 1.

RESULTS: As a results, the athletic record of 5,000m was improved both AG and BG. In 10,000m, BG only observed improve the athletic record. However, improve the athletic record of AG and BG were not observed in 20km. The change ratio of athletic record in BG (5,000m: 2.2±1.7%, 10,000m: 1.5±0.8%, 20km: 2.5±3.8%) was showed high value than that of AG (5,000m: 1.1±1.7%, 10,000m: 0.3±1.3%, 20km: 1.4±3.0%). MAP and MP were not improved in both groups. In addition, MP/PP ratio in season2 was showed significantly higher than that of season1 in BG. The change ratio of MP/PP ratio was observed significantly higher BG (MAP: -6.2±9.2%, MP: -4.7±7.5%, MP/PP ratio: 4.5±3.3%) than AG (MAP: -1.5±5.2%, MP: 2.9±9.4%, MP/PP ratio: 1.1±6.5%).

CONCLUSION: In this study, it was cleared that endurance training in long-distance runners fails to produce high value for MAP and MP as in previous study [2]. However, MP/PP ratio in BG was improved by endurance training throughout one year. From these results, it might be considered that improve the MP/PP ratio reflect to improve the athletic record for long-distance runners who have not yet reached a high level.

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EFFECTS OF DRY-LAND STRENGTH TRAINING SESSION ON SWIMMING PERFORMANCE THE FOLLOWING DAY

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INTRODUCTION: Strength endurance (SE) or maximum strength (MS) training may affect subsequent in-water performance of competitive swimmers. Any effect on performance may be dependent on the time available for recovery. The aim of the study was to examine the effect of dry-land SE and MS training sessions on the following day swimming performance.

METHODS: Eight national level competitive swimmers (age 18.6 ± 2.9 years) performed in a random order: i) SE (2x15-20 repetitions, 50% of 1-repetition maximum), ii) MS training (2x5 repetitions, 85% of 1-repetition maximum), iii) a control condition (CON: no dry-land training) in an afternoon session (18:00 – 18:40 p.m.). Each dry-land session was followed by 90 minutes of in-water swimming training (19:00 – 20:30 p.m.). Upper body and lower body muscles performance was evaluated via a 3 kg medicine ball throw and countermovement jump (CMJ), free countermovement jump (FCMJ) and squat jump (SJ), before and after each dry-land training session and 12 hours later in the next morning, before a 100-m front crawl performance test at 8:30 a.m. Performance time, arm-stroke rate (SR), arm-stroke length (SL) were measured in the 100-m test. Blood lactate concentration (BL) was measured at the start and the end of the 100-m test and heart rate (HR) and rating of perceived exertion (RPE) were measured at the end of the test.

RESULTS: Performance time and biomechanical variables (SR, SL) as well as physiological response (BL, HR) in the 100-m test were no different between conditions (time, MS: 64.70 ± 7.35, SE: 63.81 ± 7.29, CON: 64.52 ± 7.71 s, p=0.57). CMJ was higher in SE compared to MS, and SJ was higher in SE compared to CON condition ($p<0.05$). FCMJ was no different between conditions. Jump height in all types of jumps was not changed before and after dry-land sessions and before the 100-m test in all conditions ($p>0.05$). Medicine ball throw was lower in MS compared to CON before the 100-m test (MS: 4.44 ± 1.11 vs. CON: 4.66 ± 1.21 m, p=0.01).

CONCLUSION: Performance time and biomechanical variables in a 100-m test, are not affected by dry-land maximum strength or strength endurance training performed 12 hours earlier. Upper but not lower body explosive power may be affected by dry-land MS training completed 12 hours earlier without affecting swimming performance. Swimmers may apply dry-land SE or MS training 12 hours prior to 100-m swimming race without any negative effect on performance.

EFFECTS OF REDUCED CONCURRENT TRAINING FREQUENCY ON MUSCLE HYPERTROPHY, MUSCLE STRENGTH AND AEROBIC POWER

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INTRODUCTION: Systematic resistance training combined with high intensity interval bicycling (i.e. concurrent training) results in muscle mass and strength increases together with increases in aerobic power, especially in unaccustomed individuals [1]. However, many trainees need to reduce their training frequency for certain periods of time due to injuries or other personal/professional reasons. Yet, little is known about the effect of reduced concurrent training frequency in protecting the already achieved adaptations with concurrent training [2]. Aim of the study was to compare the effects of concurrent training once per week or once per two weeks, on muscle mass, strength and aerobic power in young females, implemented after 12 weeks of systematic concurrent training.

METHODS: Fourteen young active females (height 1.69±0.06m, body mass 61.1±6kg), unaccustomed to resistance training and intense bicycling, underwent 12 weeks of leg press training [4 sets x 6-8 reps at 80-85% maximum strength (1-RM)], followed by 10 x 1-min high intensity bicycling at 90-100% maximum heart rate, twice per week [1]. Participants were then equally assigned into 2 groups: group G7 continued to train once per week, while group G14 continued to train once every two weeks, for another 12 weeks with the same training intensity and volume used at the last session of the systematic concurrent training period. Leg press 1-RM, quadriceps cross sectional area (qCSA, via ultrasonography) and maximum aerobic power were measured at the initiation of the project (T1), at the end of 12 weeks systematic concurrent training (T2), and after 12 weeks of reduced training frequency (T3). Repeated measures ANOVA with Tuckey post-hoc test was used to explore differences between interventions at $p<0.05$ statistical significance.

RESULTS: The initial training intervention (T1-T2) increased leg press 1-RM and qCSA by 29.9±11.3%, and 12.2±5.5%, $p<0.01$, respectively. Leg press 1-RM was not decreased between T2-T3 for the G7 (-1.1±1.7%, $P>0.05$), but it was reduced for the G14 (-4.3±3.4%, $p<0.05$). Yet, G14 group had higher leg press strength at T3 compared to T1 ($p<0.05$). Quadriceps CSA decreased similarly for both groups between T2-T3 (G7: -5.9±3.8%; G14: -4.7±2.5%, $p<0.01$), yet it remained higher than the initial qCSA at T1 for both groups ($p<0.05$). Aerobic power was increased by 20.6±10.7% ($p<0.01$), between T1-T2, while it remained unchanged for G7 ($p>0.05$), and it was decreased for G14 (-4.7±2.5%, $p<0.01$), between T2-T3.

CONCLUSION: These results suggest that performance improvements achieved with systematic concurrent training may be partly preserved for up to 12 weeks by performing at least one training session every two weeks. For this to occur training intensity and volume should be the same as the one used at the last training session of the systematic training period.

1. Spiliopoulou et al. (2018) 2. Sousa et al. (2019)

A STUDY OF PHYSICAL FITNESS TEST ITEMS FOR EFFECTIVE USE IN SOCCER COACHING - FOCUSING ON PHYSICAL FITNESS TESTS INCLUDING REACTION COMPONENTS

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INTRODUCTION: Although the use of scientifically-based methods for sports training and practice is actively promoted, the most familiar and simple scientific approach to instruction is to quantify the physical strength and ability of the athlete via physical fitness tests. However, it is difficult to clearly define and quantify competitive skill in a soccer competition, and determining the most appropriate test for physical strength can be challenging. According to a questionnaire survey of Japanese university soccer teams, approximately half of the teams did not undergo physical fitness tests (Fukushi et al., 2015). The purpose of this study was to identify and propose physical fitness tests that can be utilized in instructional settings in soccer competitions. We conducted physical fitness tests on a university soccer team and compared the results between two groups of players: those who participated in official matches and those who did not. The association between the physical fitness test results and competitive performance was analyzed, with particular focus on a physical fitness test that includes a reaction component.

METHODS: Subjects were 67 male collegiate soccer players (19.7 ± 1.06 years old). The physical fitness test items were 50-m running (10, 20, 30, 40m transit time), Arrowhead agility test (AAT), Pro agility test (PAT), Reactive Pro agility test (RPAT), 10m x 5 shuttle-run, bounding, standing broad jump, and Yo-Yo intermittent recovery test level 2 (YYIR2). Each test was performed in accordance with the references (Japan Football Association, 2005; Bangsbo and Mohr, 2015; Ministry of Education, Culture, Sports, Science and Technology, 1999; Ariga et al., 2016). For the RAPT, subjects begin running in the direction of alternately lit LEDs placed to the right and left sides of the finish line; time measurement begins when the LED is lit. Unpaired t-tests were used for statistical analysis. Statistical significance was determined as p values less than 5%.

RESULTS: Comparisons between the two groups revealed significant differences ($p<0.05$) in six events: 50-m running (30,40,50m transit time), AAT, RPAT, 10m x 5 shuttle-run, bounding, and YYIR2.

CONCLUSION: Physical fitness elements necessary for soccer players include "sprinting ability" and "agility" (Bangsbo and Mohr, 2015). The 50-m run results in our study revealed no significant differences in the transit time at shorter distances such as at 10 m and 20 m. In addition, no significant differences were found in the PAT for the 20 m total distances. However, significant differences were found in the RPAT results. This suggests that the cognitive functions that contribute to running ability, the ability to respond to sensory information, and the ability to control the body instantly may be expressed differently depending on the levels of competition. Therefore, coaches and recruiters may discover more competitive soccer players by conducting fitness tests that include a reaction component, such as the RPAT.

EFFECT OF CARBON FIBER PLATE EQUIPPED RUNNING SHOES ON LACTATE METABOLISM DURING INCREMENTAL RUNNING TEST

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INTRODUCTION: The purpose of this study was to examine the changes in physiological load in hypoxic environment caused by differences in shoes with and without carbon fiber plates in an elite Japanese distance runner.

METHODS: The Carbon Plated Shoes: Nike-ZoomX Vaporfly Next% 2 (VFN), and the non-carbonated shoes: Nike-ZoomX Pegasus Turbo 2 (PT2) were tested in an elite male distance runner on a 10-step x 3-min incremental running test under normobaric hypoxia (FiO_2=14.4%).

RESULTS: The longest 30-min incremental running test could not be completed in either shoe condition, with a duration of 26 min in PT2 and 28 min 30 sec in VFN. Running speeds at blood lactate concentrations (La) of 2 mmol/L and 4 mmol/L were 242 m/min and 280 m/min, respectively, for PT2 compared to 285 m/min and 308 m/min, respectively, for VFN. The highest value of La occurred at stage 9, when exhaustion was reached in both conditions, at 15.2 mmol/L for PT2 compared to 12.5 mmol/L for VFN. In addition, lower heart rate and higher arterial oxygen saturation were observed in the VFN condition compared to the PT2 condition at the same stage.

CONCLUSION: These results suggest that changes in running shoes with and without carbon fiber plates may alter energy metabolism in the glycolytic system, and therefore, continuous assessment of aerobic capacity by running should be performed using the same running shoes.

MAXIMUM VELOCITY SPRINT TRAINING: A CASE STUDY INVESTIGATING ECCENTRIC HAMSTRING STRENGTH, FASCICLE LENGTH AND FORCE, VELOCITY, AND POWER PROFILING IN SEMI-PROFESSIONAL AUSTRALIAN FOOTBALL.

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INTRODUCTION: Sprint training is viewed as important for hamstring strain injury (HSI) prevention in Australian Rules Football (AF). Eccentric hamstring strength and biceps femoris long head (BFLH) fascicle length are modifiable risk factors for HSI. Maximum velocity sprint training has been viewed as less important than acceleration training for AF. Analysis of the influence of maximum velocity sprinting on force production and work completed shows a significant increase between 80% and 100% of maximum velocity. Therefore, maximum velocity training may provide a conditioning stimulus to the hamstrings that is not replicated in other training methods.

METHODS: One Victorian Football League athlete (age = 19, height = 1.79, mass = 69.4kg) completed pre- and post-testing consisting of a 40-metre sprint, which was also analysed utilising the MySprint application. The 40-metre sprint included a 0-10-metre split to measure acceleration, and a 30-40-metre split to measure maximum speed. This was followed by an eccentric hamstring strength assessment, and an ultrasound scan of the hamstrings. The athlete then completed six weeks of maximum velocity sprint training that aligned with best practice recommendations (weekly volume = 130-210m). In these sessions, a gradual acceleration was utilised to achieve a higher maximum velocity. This consisted of two sessions per week, separated by a minimum 48 hours. A weekly ultrasound was completed 24 hours after the last session of the week. Ethical approval along with informed consent was obtained prior to the commencement of this investigation.

RESULTS: Fascicle length increased by 1.31cm. Acceleration and maximum velocity qualities improved (0.05s and 0.15s, respectively). Eccentric hamstring strength displayed no change (pre = 343N, post = 337N), however, muscle symmetry improved (pre = 21%, post = 11%). The force-velocity-power profile displayed improved peak power (pre = 17.83 w/kg, post = 19.05 w/kg).

CONCLUSION: The volume of sprint training was suitable to improve sprint performance and increase fascicle length in this athlete. The average eccentric hamstring strength remained unchanged, however, this may be because the training load was insufficient to elicit a positive adaptation. Despite completing targeted maximum velocity training, a small increase was observed in acceleration qualities. This is encouraging from a performance perspective. Similarly, the improved Force-Velocity-Power profile is evidence of the potential benefits that results from a maximal sprint, where key determinants of success, such as peak power, peak force, and the ratio of forces can all improve with exposure to a relatively low volume of training. The improvements in fascicle length over a short intervention are further rationale to include maximum speed sprinting as a part of a multifactorial approach to physical preparation and injury prevention. Findings indicate maximum speed sprint training was likely effective in improving sprint performance and muscle architecture.

VALIDITY OF USING PERCEIVED EXERTION TO ASSESS MUSCLE FATIGUE DURING BENCH PRESS EXERCISE

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INTRODUCTION: Muscle fatigue can be perceived as subjective feelings such as fatigue and tiredness [1,2]. The rating of perceived exertion (RPE) is an exercise intensity estimator that combines numbers and verbal [3]. The interdependence between physiological and perceptual responses during exercises indicate that the RPE may be a valid method of assessing muscle fatigue. Velocity loss has been recommended as muscle fatigue indicator for explosive resistance exercises [4], however, the validity might not be justifiable when exercise is performed under non-explosive manner. Therefore, this study's aims are as follows: (1) to examine the validity of using RPE to assess muscle fatigue quantified by new surface electromyography (sEMG) techniques, and (2) to compare the validity of using velocity loss as a fatigue indicator during non-explosive bench press (BP) exercise.

METHODS: Fifteen male athletes underwent different fatigue levels of BP consisting of 30% (L), 60% (M), and 90% (H) volume at 65% of one-repetition maximum. The sEMG signal (Kissei-Com Tech, Japan), RPE, and velocity (Fitronic, Slovenia) were measured throughout trials. Muscle fatigue was quantified by spectral fatigue index (SFI) using sEMG signal [5]. Velocity loss was calculated as the percentage loss in velocity of each condition. RPE was assessed using Borg's CR-10 scale. One-way ANOVA followed by Bonferroni post-hoc test was used to compare between conditions. The relationship between variables was examined using Spearman's correlation analysis. Significance was set at $p < 0.05$.

RESULTS: Significant difference in overall-RPE was observed between L (3.06 ± 1.28), M (5.67 ± 1.35) and H (7.27±1.75) conditions ($p < 0.001$). With regards to average velocity loss, significant difference was observed in L vs. H ($p < 0.001$) and M vs. H ($p < 0.05$) comparisons (L: 12.80 ± 7.82%, M: 20.44 ± 9.91%, H: 28.14 ± 7.22%). Similar results were observed in average SFI (L: 1.08 ± 0.05, M: 1.17 ± 0.08, H: 1.32 ± 0.11, L vs. H: $p < 0.001$, M vs. H: $p < 0.05$). Significant relationship was confirmed in both SFI-RPE ($r = 0.681$, $p < 0.001$) and SFI-velocity loss ($r = 0.510$, $p < 0.001$).

CONCLUSION: The current study has demonstrated that overall-RPE, average velocity loss, and average SFI change correspondingly, indicating that both velocity loss and RPE are effective for assessing overall muscle fatigue levels of non-explosive BP. Further, significant RPE-SFI and velocity loss-SFI correlations were observed, indicating that both RPE and velocity loss changes within the increase of muscle fatigue levels. However, regarding the easy-to-use characteristics of RPE, it could be concluded that RPE is more suitable for muscle fatigue assessment when performing non-explosive BP.

Consequently, both RPE and velocity loss are useful for muscle fatigue assessment, however, RPE is easier to be applicated when performing non-explosive BP exercise.

1. Marcora (2009) 2. Morree (2012) 3. Lagally (2002) 4. Sánchez-Medina (2011) 5. Dimitrov (2006)

THE USE OF ARMS IN WRESTLING KUMITE

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INTRODUCTION: The purpose of wrestling is to take down the opponent. Leg attack is the most important technique to this end and obtain scores (1). The set up is an efficient way to improve the leg attack success rate (2). The situation in which wrestlers push or pull the opponent to execute the set up and leg attacks is defined as kumite. In kumite, wrestlers use arms to gain control over the opponent to break their balance. A wrestler's stance is usually putting one leg about one foot in front of the other. The hand closest to the opponent is called close hand (CH) and the hand furthest is called far hand (FH). Little is known of the role of each arm in kumite, although coaches and athletes would understand its importance. The purpose of this study is to clarify arm use in kumite to improve wrestlers' performance.

METHODS: We conducted a survey using a questionnaire (Google form) and collected responses from 110 collegiate wrestlers. Survey items covered how wrestlers use their CH and LH in kumite by selection and explanation. From the answer options, participants chose from "pull", "push", "stop", and "relax". Additionally, wrestlers responded regarding their competition level. The chi-square test was incorporated to investigate the relationship between arm use and competition level, as well as the opinions related to their CH and LH.

RESULTS: There was no significant association between wrestlers arm use and competition level in CH ($p = 0.321$) and FH ($p = 0.090$). As for each hand placement, pushing is considered important in CH and pulling is important in FH ($p < 0.001$). In explanations regarding CH, there were varied responses such as sensing the opponents movement, measuring the distance to the opponent, and touching the opponent. Explanations concerned with FH, most were related to the pulling movement.

CONCLUSION: This study revealed athletes focus on pulling the opponent with the FH, while pushing the opponent and feeling the opponent's move and response with the CH. Before executing the leg attack, wrestlers try to cause the opponent to lose balance. The most effective, fundamental movement is to push the opponent with the CH. In this case, the opponent usually try to push back because they lose one point if they go outside the mat circle. The attacker can break the opponent's balance by pulling their opponent as they push back. Thus, by sensing the opponents movement and pushing back with the CH, they decide when to pull or relax in response to their opponent. Therefore, it is essential wrestlers and coaches understand the role of each arm when practicing the set up and overall movement in kumite.

(1) Tunnemann and Curby, Inter J of Wrestling Science, 2016

(2) Ito, et al., Arch of Budo, 2019

DIAGNOSTICS OF LOWER EXTREMITY EXPLOSIVE MUSCULAR STRENGTH ON RUNNING SINGLE-LEG VERTICAL JUMP WITH DIFFERENT APPROACH DISTANCES

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INTRODUCTION: Vertical jumping is one of the key forms of movement required to achieve success in athletic performance [1]. Taking the long jump action as an example, the jump process involves maintaining horizontal and vertical speed to produce the most vertical lift and achieve the maximum distance [2]. Although the running single-leg jump (RSJ) is also an explosive jumping method, the action is similar to the high jump or long jump in the starting movement. However, the RSJ actions have received less attention in terms of the explosive muscular strength of the lower extremities [3]. Therefore, the aim in this study was to compare the characteristics of the explosive muscular strength of the lower extremities on the single-leg vertical jump. We observed what distance of jumping helps athletes jumping performance, providing a reference for future training or jumping applications.

METHODS: We recruited eight general athletes. The running distance is set to 1, 3, and 5 m outward from the force plate boundary. For this experiment, we used the dominant foot as the starting test foot to randomly collect data from three successful movements for each distance. The test required the participants to run to the force plate, and then use their maximum strength to perform a vertical jump with one foot, followed by a double foot landing. We used one Kistler force plate to record the ground reaction force data after touchdown to define the instant of landing. The data analysis was mainly based on the IRFD, RFD, RSI, SSI, vertical stiffness and impulse from the moment of landing to the jumping phase. We used repeated measures one-way ANOVA.

RESULTS: We compared the explosive muscular strength of the lower extremities during a running single-leg vertical jump with different approach distances. The results of repeated measures one-way ANOVA showed that the SSI with the 1 m approach run was significantly higher than with 3 (P=.001) and 5 m (P=.003) approaches. The RFD (P=.009) and RSI with the 5 m (P=.006) approach were significantly higher than with the 1 m approach.

CONCLUSION: We performed diagnostics of the lower extremities explosive muscular strength during running single-leg vertical jump with different approach run distances. RSI is used to assess an athletes ability to convert centrifugal to centripetal force during the jumping process. It can also be used to examine the strengths and weaknesses of an athletes

ability to shorten the cycle during movement. The result of this study shows that the 5 m horizontal distance helped increase the muscle efficiency of the SSC and increase jumping performance. Our findings show that the approach run distance influences jump performance [4]. We also found that different approach run distances influence the explosive muscular strength of the lower extremities. These findings can be used to help improve athletic performance.

1. Dobbs et al. (2019) 2. Kakihana & Suzuki (2001) 3. Laffaye et al. (2007) 4. Tai et al. (2018)

THE IMPACT OF BALANCE AND MINDFULNESS TRAINING ON YOUNG BIATHLETES SHOOTING EFFICIENCY

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INTRODUCTION: The purpose of the study was to evaluate the effectiveness of two alternative methods for improving the shooting performance of biathletes. The first relies on motor skills and stresses body balance. Not only does effective postural balance reduce the risk of body imbalance, falls, and associated injuries, but it also enhances motor performance in a variety of sports. The second method is based on the concept of mindfulness and emphasizes psychological competence. Mindfulness is a way of paying attention that involves putting your attention on the present moment and accepting it without judging it. Recent research shows that parts of mindfulness are linked to better shooting performance in competitions. This is because mindfulness and refocusing make you more aware of your surroundings.

METHODS: The 6-week balance training and 6-week Mindfulness Sports Performance Enhancement (MSPE) programs were designed to improve youth biathletes shooting performance. In this study, 16 youth biathletes served as the experimental group, whereas 10 youth biathletes served as the control group. Both categories were covered by National Sports Championship Schools. The tests included functional balance tests, balance tests on force platforms, dry shooting tests with the Scatt shooting system, and a number of psychological inventories and assessments. Also, the quality of the aiming was tested with a video tracking system and laser feedback experiments. After the biathletes did a short, hard workout on a ski ergometer, their performance was also measured after they were tired. The experimental group was separated into a Stability (n=8) group and a Mindfulness (n=8) group, and after the initial measures, they completed different training programs concurrently with their daily practice.

RESULTS: Significant associations existed between posturographic parameters and shooting performance. There were also substantial correlations between shooting ability and the results of tests and questionnaires measuring mindfulness. After the training, the importance of these dependencies was emphasized even more than before. The trials after effort implemented in the experiment did not appreciably alter these characteristics. We were only able to identify a positive trend in the direction of balance and mindfulness improving, but these changes did not reach the level of statistical significance required to be considered significant.

CONCLUSION: The most significant and potentially advantageous result of the research is that it lends support to the theory that maintaining ones physical equilibrium and being mindful of ones surroundings can significantly improve ones shooting accuracy. Our findings should be replicated in subsequent research using the same procedures, but with athletes who are more skilled and with a larger number of participants overall. It is likely that the studys results would be more evident if the training program had been implemented at the beginning of the planning phase.

DOES BIOELECTRICAL IMPEDANCE-BASED BODY COMPOSITION RELATE TO LOWER LIMB ISOMETRIC STRENGTH AND POWER INDEXES IN ALPINE SKIERS?

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INTRODUCTION: Alpine skiing performance depends on several physical factors beyond technical ones, including lower limb strength and power [1]. These features may be, in turn, influenced by intrinsic athletes characteristics, such as body composition [2]. Therefore, this study aimed to assess the relationship between bioelectrical impedance-based body composition and selected lower limb power and strength measures in alpine skiers.

METHODS: Nineteen young alpine skiers (7F / 12 M, age: 17 ± 1 years, BMI: 23 ± 1.6 kg/m2) underwent a foot-to-hand bioelectrical impedance vector analysis (BIVA; BIA 101 BIVA PRO, Akern) body composition assessment, obtaining phase angle (PA) and computing fat mass percentage (%FM) using a validated athletic specific equation [3]. After a warm-up, they completed two countermovement jump (CMJ) trials, and from the highest one, jump height (JH) and jump peak power (JP) were computed [4]. Finally, maximal isometric strength was assessed in both limbs (ForceFrame, Vald), and then summated to obtain the total standing hip flexion (Hflex) and extension (Hext), and lying (with 45° knee angle) hip abduction (Habd) and adduction (Hadd) strength.

After checking outliers and data normality, pairwise Pearson correlation tested the relationship (r coefficient was computed) between body composition and lower limb strength and power-related variables, with α=0.05.

RESULTS: %FM showed significant (p from 0.001 to 0.039) negative correlations with large magnitudes with all power and strength variables (r from -0.58 to -0.70), except for Hext, which revealed a moderate correlation (r=-0.48). Similarly, PA exhibited significant (p from 0.005 to 0.026) positive large correlations with all variables (r from -0.52 to -0.64), except for Hext (p=0.061).

CONCLUSION: Raw (PA) and advanced (%FM) BIVA-based measures showed a significant relationship with the selected lower limb strength and power indexes (JH and JP). In particular, lower percentages of fat mass and higher PA are related

to greater hip isometric strength and jump-related power production. Therefore, our results indicate that body composition assessment should be implemented in alpine ski racers development screening process, as it may influence key physical performance indicators.

1. Turnbull et al. Scand J Med Sci Sports 2009; 19: 146–155

2. Ackland et al. Sports Med 2012,42: 227–249

3. Matias et al. Int J Sports Med 2021,42: 27–32

4. Sayers et al. Med Sci Sports Exerc 1999, 31: 572–577

VALIDITY AND REPEATABILITY OF WALKING TEST IN POLAR PACER GPS WATCH

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INTRODUCTION: Polar introduced a walking test in Pacer-series in April 2022. This Polar Walking Test (PWT) estimates maximal aerobic power (VO2max ml/kg/min) based on a 15-minute fast walk, subject´s demographics (age, height, weight) and distance walked and heart rate during the test. The test is built on the basis on 2-km UKK Walk test, established in 1991. Walking test is targeted to healthy adults who do not participate in competitive sports. In this pre-validation study PWT was validated scientifically against reference measure of VO2max. Repeatability was evaluated based on two repeated tests.

METHODS: Altogether 24 volunteers (13 women and 11 men, mean age 44 and 41 years, mean BMI 25 and 26 kg/m2, mean VO2max 40 and 45 ml/kg/min (range 28-49, 35-52), mean maximal heart rate (HRmax) 183 bpm for both, respectively) participated into study. First, they all did a laboratory test in a maximal walk-run treadmill protocol with breath-by-breath VO2 measurements. After this they performed two walking tests within 2-week period with Pacer guidance on a self-selected route. Firstly, user settings were given to watch. The test started with warm-up and during the test appropriate walking speed was guided using HR, which should exceed 65% of HRmax. As a result, Pacer calculated distance, speed, test HR, VO2max -value and corresponding Fitness level.

RESULTS: The mean walking distances in the first and second test were 1750 and 1780 meters and the mean heart rates 124 and 128 bpm. Predicted VO2max -values were 38 and 39 ml/kg/min in the first and second tests. The mean absolute errors and standard deviations between the laboratory and walk test VO2max were 5.9 (4.8) and 5.8 (4.8) ml/kg/min and absolute %-errors (SD) 13.6 (9.9) and 13.4 (10.4) % in the first and second test. Comparing the first and second test the mean absolute error between the tests in maximal aerobic values were 2.3 (1.4) ml/kg/min and correlation 0.95. There was no difference in two repeated tests in VO2max estimations. However, more (83% in the second test vs 75 % in the first test) subjects were able to reach target HR during the second test resulting to faster walk and longer walking distance. In addition, more subjects (29% in the second and 21% in a first test) had a same Fitness level in the second test.

CONCLUSION: This pre-validation study indicates rather good validity and a small learning effect in Polar Walking Test in Pacer watch, although 9/24 (38%) of the subjects were highly fit and not the ideal target group to the PWT. In UKK Walk Test validation studies the standard errors of estimates to lab VO2max have varied between 3.3 - 5.1 ml/kg/min. Based on pre-validation it can be concluded that a training test and/or at least a supervised Polar Walking Test should be carried out when PWT is used in a scientific study, as recommended in original UKK walking test. For Polar customers Walking test provides a rather good self- test alternative to assess and follow changes in aerobic fitness.

CLASSIFICATION OF SPORTS BASED ON COACHES PERSPECTIVE ON ENVIRONMENTAL, INDIVIDUAL AND TASK REQUIREMENTS: A MACHINE LEARNING SPORTS PROFILE ANALYSIS.

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INTRODUCTION: Well-designed talent programs with a focus on talent identification, orientation, development, and transfer may support the engagement of young individuals in sports and the pursuit of elite performance. To facilitate these processes, a systematic analysis of task, environmental and individual characteristics for each sport is much needed. This study analysed whether unique profiles per sport could be established based upon generic characteristics.

METHODS: By means of a validated survey 1247 qualified coaches from 34 different sports ranked 18 different characteristics on importance to their sports (0-10; not important at all - very important). To discriminate the responses per sport, 1) a Linear Discriminant Analysis (LDA) was carried out, 2) a Machine learning method - Uniform Manifold Approximation and Projection (UMAP) with Catboost classifier - was performed to refine the linear process of classification. Cross-validation was carried out by means of the leave-one-out method. To test the performance of the Catboost classifier-algorithm a Confusion matrix was generated.

RESULTS: Cross-validated LDA showed that 70.2% of the coaches were correctly classified to their sport. Applying the UMAP/Catboost technique increased the accuracy to 75.1%. The Confusion matrix showed the correctly predicted responses per sport ranged from 18.2% (sailing) - 98.2% (soccer). Conclusions: With varying precision, the algorithm was able to classify the different sports by importance of its characteristics.

CONCLUSION: This method enables coaches to construct unique sport profiles for the optimisation of talent identification, orientation, transfer, and development programs by searching for similarities and differences between sports.

ACUTE EFFECTS OF TISSUE FLOSSING VERSUS NEUROMUSCULAR ELECTRICAL STIMULATION OF THE QUADRICEPS FEMORIS MUSCLE ON IMPROVING VERTICAL JUMP PERFORMANCE

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INTRODUCTION: Vertical jump (VJ) is an explosive action and a significant component of sports such as basketball [1], and can be an important determinant of match-winning actions [2]. Current training methods of improving VJ performance, such as resistance [3] or plyometric training [4], are effective but require investment of a significant amount of time. Tissue flossing (TF) and neuromuscular electrical stimulation (NMES) are methods purported to improve functional performance. However, research on their effects of an acute bout on the quadriceps femoris (QF) and VJ performance is lacking. This study compared the acute effects of a bout of either TF or NMES on the QF to improve VJ performance.

METHODS: 20 male basketball players (age 23.45±2.13 y) participated in a randomized crossover study. Participants were subjected to an acute bout of either TF or NMES on two separate sessions, with a washout period of at least 24 hours. For TF, the floss band was applied on the QF of each leg and range-of-motion exercises were performed, with the band removed after two minutes to allow reperfusion of blood to the muscle tissue. For NMES, electrodes were placed on the vastus medialis and lateralis, with stimulation intensity increased to the maximal tolerable levels to achieve the strongest muscle contractions. Countermovement jump (CMJ) height was chosen as the VJ measure and recorded as the pre-test and post-test measure. Three CMJs were performed at 1 min intervals, with the best trial used for data analysis.

RESULTS: Mean CMJ measure differed significantly between conditions, $F(2, 36)=46.83$, $p<.001$, $np2=.722$. Mean CMJ increased from baseline (67.90±6.38 cm) to post-TF (69.71±6.50 cm) by 1.81cm but decreased by 1.13cm post-NMES (66.77±6.43 cm). Post hoc analysis with a Bonferroni adjustment revealed significant differences in CMJ post-TF ($p<.001$) and post-NMES ($p=.003$). For TF, no adverse effects on CMJ were reported, but for NMES, 12 participants showed decreased CMJ and only 2 had increased CMJ performance.

CONCLUSION: The results of this study suggested that TF is a valid intervention for acute VJ performance improvement. Our results were comparable to those of traditional resistance training programs ranging from 6 to 15 weeks [5]. In line with current literature, NMES should be combined with other training methods for potential gains. Comparing the two, TF demonstrated more promising results for acute improvement in VJ. It is likely that there were too many contractions in the NMES protocol, which led to fatigue of the fast twitch muscles and poorer VJ performance. Future studies should investigate the time course effects of these interventions and the optimal NMES parameters to achieve a potentiation effect.

1. Ziv & Lidor (2010) 2. Meylan & Malatesta (2009) 3. Baker (1996) 4. Markovic (2007) 5. Hackett et al. (2016)

EFFECTS OF PAST EXERCISE EXPERIENCE ON COORDINATION ABILITY AND MEASURING TIME OF GRIP STRENGTH

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INTRODUCTION: Previous studies on the coordination ability in grip strength were based on the magnitude of the difference between the target value set based on the maximum value and the grip strength exerted with that value considered as an index [1]. However, no study has taken into account the time required to measure this ability. Therefore, in this study, we measured the difference in the grip strength relative to a target submaximal value and the time needed to measure the grip strength. We also examined the relationship between these values, as well as exercise experience and exercise habits of the subjects.

METHODS: A total of 155 healthy male and female university students (mean age, 18.5 ± 0.8 years) were enrolled. We measured the error in the isometric grip strength measurement for the target value corresponding to 30%, 50%, and 70% of the voluntary maximal grip strength (0.1 kg), and the time (0.1 sec) required for the measurement. The grip strength was measured using the specially altered grip dynamometer, which recorded the grip strength by pressing the switch as fixed and together and measured the time from the start of measurement to pressing the switch. Furthermore, we investigated past exercise experiences retrospectively for all subjects using questionnaires. The subjects were administered a questionnaire about their exercise experience, participation in exercise events, number of exercise sessions per week (day/week), implementation time per session (hours), and exercise intensity (5-Point Likert Scale) for every 6 school-age categories based on the educational stage in Japan. A multilevel model of hypothesized relationships among error in grip strength exhibited for the target value (Grasp error), time of measurement (measuring time), grasp error relative to the measuring time (error time), and questionnaire responses was tested.

RESULTS: Grasp error as a dependent variable had a significant relationship with exercise volume in the pre-school ($P <.01$) and lower grade of elementary school age-groups ($P =.02$). Moreover, exercise volume of pre-school ($P =.04$) and junior high school groups ($P <.01$) had a significant relationship with measuring time as a dependent variable. Error time as a dependent variable showed a significant relationship ($P =.02$) with only the current exercise volume (university student), and the error time increased with decreasing current exercise volume.

CONCLUSION: The results of this study suggest that the simple grading ability of adolescents to grasp exercise may increase by practicing exercise with certain intensity and frequency above a certain intensity. Moreover, current exercise volume was not related with the grading ability to grasp or the time required for measurement.

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THE RELATIONSHIP BETWEEN RATE-DEPENDENT METRICS IN THE ISOMERIC SQUAT AND ISOMETRIC MID-THIGH PULL

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INTRODUCTION: Isometric strength assessments have become a popular means of assessing maximal and rate-dependent strength in athletes. The most common tests of multi-joint isomeric strength include the isometric squat and the isometric mid-thigh pull (IMTP). To date, only a single study has evaluated whether there is a difference between the measures of rate-dependent metrics between these two conditions [1]. It is important to also understand the associations between these metrics to determine if the tests assess similar or different qualities. Thus, the purpose of this study was to assess the association between peak and rate-dependent metrics of the isometric squat and IMTP in semi-professional athletes. We hypothesised that there would be strong associations between the peak and rate-dependent metrics between tests.

METHODS: Twenty-six male (BM=79.5±8.9 kg) and 27 female (BM=65.7±8.3 kg) athletes from an elite junior Australian rules football (17-19 years of age) league performed trials of the isometric squat and IMTP with instructions to push/pull as fast and as hard as possible. Seven metrics were derived from each test: net peak force [N], net force at 100ms, 150ms, and 200ms [N], and net force/net peak force at 100ms, 150ms, and 200ms [%]. The trial with the highest peak force was used for analysis.

RESULTS: There were weak correlations between the metrics of the two isometric tasks (r = 0.22-0.42).

CONCLUSION: The present study determined that there were weak associations between rate-dependent metrics of the IMTP and isometric squat. These findings suggest that the two tests may measure different qualities in junior-level athletes. It is recommended that practitioners approach the interpretation of values across isometric tests independently, as they may contain unique information.

HIGH-CONCENTRATION ARTIFICIAL CARBONATED SPRING LOWER LEGS BATH AFFECTS MUSCLE TISSUE ELASTICITY AND MUSCLE STRENGTH

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INTRODUCTION: Facilitation of the blood supply and oxygen consumption in the muscle by a local immersion of the extremities into high-concentration carbon dioxide water (CO2-water, CO2≥1000ppm) suggests an improvement in muscle performance and flexibility (Yamamoto, 2007). In the present study, we investigated whether the lower legs bath into artificially made high-concentration CO2-water (CO2≥1000 ppm) influences muscle tissue elasticity and muscle strength.

METHODS: The healthy male college students (n=6, 19-24yrs, 170.4±4.7cm, 63.8±9.1kg) participated in this study. The subjects were randomly divided into the tap-water group and the CO2-water group, and a crossover test was conducted. The subjects immersed their lower legs up to below the knee into tap-water or CO2-water at 35 °C for 10 minutes. Subjective thermal sensation (TS) during the lower leg bath were recorded by every two minutes. The medial head of gastrocnemius muscle (MG) dominant muscle hardness was evaluated using ultrasound real-time tissue elastography and maximum isometric plantar flexion and dorsiflexion strength at pre and post lower legs bathing. The strain ratio (SR) between the MG and the subcutaneous adipose tissue of the calf was calculated. In addition, the rate of force development (RFD) was also measured. We compared the variables after the tap water bath and after the CO2 water bath using a paired Students t-test. The significance level was set at $p < 0.05$.

RESULTS: TS in the CO2-water was significantly higher than in the tap-water (tap-water vs. CO2-water at 10 minutes in the bath, -0.50±0.55 vs. 1.17±0.41, $p<0.001$). After the lower leg bath, in the CO2-water compared with the tap-water, SR significantly increased (3.26±1.52 vs. 7.82±3.91, $p<0.05$). Ankle joint peak strength and RFD (0-200ms) were not significantly difference between pre and after tap-water bathing. However, mean right ankle dorsiflexion strength increased significantly more CO2-water than tap-water (14.4±10.0 Nm vs. 15.8±7.3 Nm, $p<0.05$).

CONCLUSION: We reported previously that the muscle blood flow in the immersed part was larger in CO2-water than tap-water of the same temperature. In addition to a local effect of CO2, suppression of muscular sympathetic activity may also contribute to the increase in local blood flow. The facilitation of muscle tissue elasticity shown in this study might be caused by the increased muscle blood flow. The present results suggested that the high-concentration artificial CO2-water lower leg bath improves the muscle elasticity of the immersion part. No significant change in RFD was observed with the lower leg bath. However, muscle strength tended to improve slightly. It was suggested that CO2-water bathing might contribute to muscle strength improvement.

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GENDER DIFFERENCES IN POWER PRODUCED DURING JUMPS IN NON-ATHLETES AND ATHLETES

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INTRODUCTION: Although various tests of explosive strength have been incorporated into physical fitness test batteries for children and adults (e.g., standing long jump, squat jump, countermovement jump, drop jump, jumping sideways, triple hop, single-leg hop, maximal and submaximal hopping), data providing information on age-related changes in test variables in female and male competitive athletes are still lacking. This study investigates gender differences in power produced during jumps in non-athletes and athletes during adolescence.

METHODS: A group of 352 female and male non-athletes aged 6-23 years (~20 in each age category), recruited from schools and universities, was supplemented by 59 competitive aerobic dancers, ballroom dancers, gymnasts, and rock & roll dancers aged 12-18 years. They performed a test of 10-s maximal jumps with hands fixed on their hips. Subjects were instructed to minimize ground contact time and to maximize jump height. Two trials with a 2-min rest period were performed while the better of them was analysed. A FiTRO Jumper consisting of a contact switch mat, which measures contact and flight times during jumps, was used to calculate the power in the concentric phase of take off normalized to body weight.

RESULTS: The power in the concentric phase of take-off was significantly higher in male than female non-athletes from the age of 13 years. While the power increased year on year in males, females reached a plateau from 13 to 17.5 years, and then only slightly increased up to age 23. However, compared to non-athletes, power gradually increased with increasing age in both male and female athletes. There were significant between-gender differences during adolescence, with higher power in favor of males, at 13y (7.6%, p=0.043), 14y (9.2%, p=0.021), 15y (11.5%, p=0.006), 16y (13.5%, p=0.001), 17y (15.2%, p=0.001), and 18+y (16.3%, p=0.001).

CONCLUSION: The power produced during 10-s maximal jumps increased from childhood to adulthood in male non-athletes and athletes. However, its values have reached a plateau during adolescence in female non-athletes, whilst in athletes they increased during this period. These differences in adolescent females may be ascribed to their different amount of muscle mass contributing to power production during jumps. Genetic predispositions (larger proportion of fast-twitch fibers) and adaptation to jumping or hopping exercises in gymnastic and dance sports might have also contributed to greater power in female athletes than non-athletes. Taking these gender differences into account, normative data are needed to classify jump performance in adolescent athletes.

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SELECTED ANTHROPOMETRIC AND PHYSICAL PERFORMANCE PARAMETERS RELATED TO THROWING PERFORMANCE IN YOUTH MALE SHOT PUT ATHLETES

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INTRODUCTION: Anthropometric and physical performance Variables including body mass, height, strength and power are considered crucial parameters in shot put. The purpose of this study was to investigate the characteristics of selected anthropometric and physical performance parameters in throwers for the Fitness assessment and Talent identification.

METHODS: 55 youth elite male shot put athletes (aged 16.15±1.09) from China participated in a total of sixteen Anthropometric and physical performance tests viz Body mass, height, Body mass index, Sit and Reach Flexibility, 30m sprint, 60m sprint, Standing long jump, Standing triple jump, Hexagon Agility Test, Balance cushion One leg stand, The Plank Fitness Test, Pull-Up Test, 2000m rowing ergometer; To avoid the effects of technique, we chose 5kg Overhead Medicine Ball Throw (forwards), 5kg Medicine Ball Throw(backwards) and Standing shot put test(5kg) to assess the throwing ability of athletes. The correlation analysis was made between throwing ability tests and other tests.

RESULTS: 5kg Overhead Medicine Ball Throw (forwards) was correlated with Sit and Reach Flexibility(r=0.688,p=0.000), 30m sprint(r=-0.370,p=0.005), 60m sprint(r=-0.623,p=0.000), 2000m rowing ergometer(r=-0.413,p=0.002), Pull-Up Test(r=0.702,p=0.000), The Plank Fitness Test(r=0.764,p=0.000), Balance cushion One leg stand(r=0.656,p=0.000), Standing long jump(r=0.290,p=0.032) and Standing triple jump(r=0.477,p=0.000). 5kg Medicine Ball Throw(backwards) was correlated with Sit and Reach Flexibility(r=0.704,p=0.000), 60m sprint(r=-0.619,p=0.000), 2000m rowing ergometer(r=-0.373,p=0.005), Pull-Up Test(r=0.722,p=0.000), The Plank Fitness Test(r=0.723,p=0.000), Balance cushion One leg stand(r=0.570,p=0.000) and Standing long jump(r=0.462,p=0.000). Standing shot put test(5kg) was correlated with Sit and Reach Flexibility(r=0.637,p=0.000), 60m sprint(r=0.639,p=0.000), 2000m rowing ergometer(r=-0.373,p=0.005), Pull-Up Test(r=0.755,p=0.000), The Plank Fitness Test(r=0.656,p=0.000), Balance cushion One leg stand(r=0.568,p=0.000), Hexagon Agility Test(r=-0.280,p=0.038) and Standing long jump(r=0.448,p=0.001).

CONCLUSION: The test results show that flexibility, strength, speed, agility, aerobic ability are significantly related to the throwing ability of young shot put athletes. There is no correlation between height, weight, BMI and throwing ability These

findings provide information for coaches that young shot putters need to develop their overall physical ability to promote their speciality. Project 22-23 Supported by the Fundamental Research Funds for the China Institute of Sport Science.

LONGITUDINAL MONITORING OF THE FUNCTIONING ON HORSEBACK OF YOUNG PROFESSIONAL RIDERS IN VOCATIONAL TRAINING

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INTRODUCTION: Horseback riding is a dyad sport. To perform, the rider-horse synergy must be effective since each of the athletes influences the functioning of the other. For his part, the rider must acquire a good functioning i.e. a straight and stable trunk [1,2], fixed wrists and head [2,3] and independence of aids. Acquiring this expertise requires time, technical work and good physical condition. The objective of this study is to follow the evolution of the functioning on horseback of a group of 10 riders in their first year of vocational training.

METHODS: Today, rider's kinematics and kinetics can be easily assessed [4]. Here, 10 professional riders in the first year of vocational training at the IFCE were measured (2 men and 8 women; age=19±0.5 years; weight=57±9 kg; height=167.5±10 cm; handedness: 9 right-handed and 1 left-handed). Riders were equipped with 2 inertial units (Shimmer) on the upper back (sternum) and lower back (L3). Flexion-extension and right-left inclination were calculated. Rein tension and the forces normal to the floor of the stirrups were measured using force sensors (IFCE-CAIPS, 5). Riders performed a standardized sequence of gaits (walk, rising trot, sitting trot and 3-point canter) during 4 sessions: September (T1), December (T2), March (T3) and June (T4). 5 riders change the horse during the year. In parallel with the technical teaching, the riders benefited from general physical preparation (3x45min/week). Differences in functioning between sessions over the entire sequence on horseback was assessed with Friedman test ($p<0.5$).

RESULTS: Stirrups: the average right stirrup forces decrease ($p=0.019$; T1: 2.3±0.7 N/kg; T4: 1.7±0.2 N/kg) while there is no difference in left stirrup forces over the year (T4: 1.7±0.3 N/kg). Reins: no difference in rein tension is observed. Upper back: the standard deviation of the flexion-extension angles decreases ($p=0.0004$; T1: 8.8±1.4°, T4: 6.0±0.9°). The standard deviation of the inclination angles decreases ($p=1.3e-05$; T1: 4.9±0.7°; T4: 3.1±0.5°). Lower back: the standard deviation of the flexion-extension decreases ($p=0.001$; T1: 8.8±1.1°; T4: 6.6±0.9°). Mean inclination decreases ($p=5.3e-05$; T1: -2.1±2.6°; T4: 0.5±1.9°) as the standard deviation ($p=0.0003$; T1: 5.3±1.2°; T4: 3.5±0.4°).

CONCLUSION: Stirrup forces can be a strong expression of the rider's laterality, which symmetrise with technical teaching and physical preparation. Rein tension are not specific to the rider but also depend on the horse and on environmental factors [6]. Regarding the back, better stability is observed in the antero-posterior and lateral axes, acquired thanks to technical teaching and physical preparation. In any case, the acquisition of a good functioning on horseback is a long-term objective which is envisaged as a team (rider, coach and physical trainer) and which depends on technical, physical and environmental factors.

1. Schills (1993) 2. Olivier (2017) 3. Terrada (2006) 4. González (2022) 5. Pycik (2022). 6. Dumbell (2018)

BODY COMPOSITION MONITORING OF YOUNG PROFESSIONAL RIDERS IN VOCATIONAL TRAINING

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INTRODUCTION: The body composition phenotype of an athlete is the result of the interaction between genotype, sport requirements, diet and training program. The variability of the literature values concerning the rider is high, due to a highly variable physiological answer depending on the discipline and to the technology/method used to carry out the measurements. The first objective of the study was to characterize the phenotype of the professional rider at the beginning of his career by a bio-impedancemetry technique. The characterization of this population will constitute a reference. The secondary objective was to study the evolution of body composition and bone density during their first year of training.

METHODS: A group of 10 riders in their first year of vocational training were monitored for body composition and bone density every 6 weeks from October (start of training) to May (first-year exam). The group consisted of 8 girls and 2 boys, reflecting the population of members of this mixed sport. The average age of the group was 19±0.5 years and the minimum level of competition was amateur.The impedance was evaluated by a Z-Metrix® multifrenquency impedancemeter (BioparHom Company, France). The weight (W), fat Mass (FM, %w), muscular mass (MM, %w) and bone mineral content (BMC, kg) were evaluated. Descriptive statistics were calculated at each test and variables were compared between the 7 tests for everyone (Friedman test, $p<0.05$).

RESULTS: The mean height was 167.5±10 cm and the mean weight was 57±9 kg. These values are consistent with the population described in the literature [1]. At the end of the training program, FM was 15±6%W and MM was 37±5%W. The FM value is much lower than the % found in the literature (23.5 - 28.6%). Their activity and the measurement method may explain these differences. The estimated BMC values (2.8±00.3 % MNG or 1.4±0.3 kg) are hardly comparable to the literature data. The equations used are specific to the measurement method [2]. The dispersion at t1 and t7 reflects a stability of body composition and bone mineral content, although there are significant variations per individual that could have been explained by a period of examination, with Covid etc.

1.Douglas (2012) 2.Moreno (2015)

CONCLUSION: This study has shown the feasibility and interest of monitoring the body composition by bio-impedancemetry of professional riders in training, a population which despite their intensive sports activity, are still insufficiently monitored.

A STUDY ON THE IMPACT OF ADDING THREE MAJOR BALLS ON PHYSICAL EDUCATION TEACHING IN JUNIOR MIDDLE SCHOOLS IN WUHAN UNDER THE CONTEXT OF PHYSICAL EDUCATION SECONDARY EXAMINATION REFORM

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INTRODUCTION: The reform of the Physical Education Secondary Examination is not only relevant to the development of students, but also marks the future direction of physical education in schools. The incorporation of the three major balls in the physical education examination not only enables students to develop their physical fitness more comprehensively, but also has the important significance of enhancing the popularity of the three major balls in China, and laying the foundation for the future reserve talents of the three major balls in China.

METHODS: This paper analyses and discusses the current situation of physical education in Wuhan after the reform of physical education secondary examination through questionnaire, literature review, and mathematical statistics. The impact of the reform on the participants, teaching objectives, teaching contents, and teaching methods of physical education will be discussed.

RESULTS: (1) The reform has broadened students'choices, changed the traditional physical education learning mode which focuses only on practicing physical fitness, and increased students'motivation to learn physical education.

(2) Although the reform has put greater pressure on PE teachers, there is an increased emphasis on the work of PE teachers, and social status of PE teachers has improved.

(3) The reform has placed higher demands on PE teachers and school sports venues and equipment. Thus, the resources for teachers of the three major balls in schools are generally uneven, and the lack of football teachers is particularly serious.

(4) The teaching content and method for the three major balls lack variety, and there is a phenomenon of exam-oriented practice of what is tested.

CONCLUSION: (1) Education department should continue the implementation of the three major balls in schools, improve the setting of items and scores for the examination, explore the teaching situation and feedback, promote the construction of selective physical education class system, and ensure the smooth connection of physical education from primary school to junior high school.

(2) Middle schools should strengthen the training of PE teachers and management of three major balls. The recruitment of qualified professionals from universities and outstanding teachers can ensure the balanced development of three major balls. To address the problem of venue and equipment limitations, middle schools can increase funding or arrange for staggered training.

(3) PE teachers themselves should constantly strengthen their professional knowledge and skills, teaching abilities, and their awareness of lifelong learning. Three major balls'teaching should not be limited only to exam content, the teaching content should be optimized, and teaching methods should be innovated.

CAN I SWIM AND TALK COMFORTABLY?

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INTRODUCTION: Subjective methods to measure exercise intensity, such as the Talk Test (TT), have been shown to be practical alternatives of prescribing exercise in healthy individuals and athletes. Despite the TT is widely used in several sport such as cycling and running, no study has yet investigated its conceptual validity in swimming. Therefore, this study aimed to describe the variability of the land and water-based version of the TT.

METHODS: One elite male breaststroker swimmer (age: 24 years; height: 184 cm; weight: 84 kg) participated in the study. Three incremental treadmill running talk test (RTT) and 3 incremental swimming talk test (STT) sessions were performed. RTT consisted of 3-min warm-up with a slope of 1% (fixed for the test), with subsequent speed increase of 1 km/h every 2-min. For the STT, individual target times for each incremental bout were calculated based on the seasonal competitive personal best. STT consisted of 200m incremental bouts with the first bout set at 30s greater than the personal best, whereas all successive bouts' target time were set at 5s less than the previous bout. During each testing session, subject was required to rate his perceived exertion (RPE) on a 0-10 scale. At the end of each stage/bout the subject was also required to recite the Olympic Oath. Immediately after reciting the speech, subject was asked if he "Could speak comfortably" with three possible answers: "Yes", "Not sure" or "No". The last "Yes" answer was coded as last positive (LP), the first "Not sure" as equivocal (EQ) and the first "No" as negative (NEG). RPE values were then associated with LP, EQ and NEG stage for each TT. Tests were stopped if volitional fatigue was reached or "No" was given as answer. The two-standard deviation (SD) band method was used to describe the variability of the LP, EQ and NEG answers between the land- and water-based version of the tests, by using the RTT values as baseline mean and SD.

RESULTS: Significant differences were found between RPE RTT and STT LP values with at least 2 STT sessions (2nd STT: 4.5 AU; 3rd STT: 5.5 AU) over 2 SD of the baseline RTT (LP: 4.2 AU). Trivial significant differences were found for the EQ values,

with all STT sessions (1st and 2nd STT: 5.5 AU; 3rd STT: 6.5 AU) higher than the RTT SD upper limit of 5.4 AU. No significant difference was observed for the NEG, with only one STT session higher than the upper band of the RTT 2 SD (STT NEG: 8.0 AU > RTT 2 SD upper band: 7.5 AU).

CONCLUSION: TT protocol might be applied in swimming for measuring exercise intensity, especially at higher intensities such as the ones above the ventilatory and respiratory compensation thresholds. The higher STT RPE values found might be related to the test specificity, and therefore further studies should evaluate larger and specific samples with different characteristics in order to select the best procedure to adopt in this particular environment.

AN INNOVATIVE BASKETBALL JUMP SHOT PERFORMANCE TEST

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INTRODUCTION: The purpose of this study was to validate An Innovative Basketball Jump Shot Performance Test.

METHODS: The subjects were ten university level male basketball players (aged 18 to 25). Each subject completed two trials of An Innovative Basketball Jump Shot Performance Test. Each week the test was consisting of 15 shot attempts from middle distances on 3 different court locations (4.60 m. away from the basket). Each shot attempt was follow operations and scored. The operations were 1) Step forward the usual 2-step and get the ball out of training assistant hands and jumping with both feet facing the left side towards the basket 2) Dribble the ball once and catch the ball and jump backwards until face approached the basket, landing on the ground with both feet 3) Jump and Shooting. The scoring criteria are as follows: 3 points is the basketball go through the basket no hit on the loop or a backboard, 2 points is basketball hit on the loop or a backboard before go through the basket, 1 point is basketball hit on the loop or a backboard but do not down through the basket and 0 points is basketball no hit on the loop or a backboard and do not down through the basket.

RESULTS: There was a high correlation between 2 trials basketball jump shot scored (intraclass correlation coefficient (ICC) = 0.86, $P < 0.001$).

CONCLUSION: An Innovative Basketball Jump Shot Performance Test appears to be high valid in predicting and scoring jump shot performance.

BILATERAL VARIABILITY IN Q-ANGLE AND LOWER-LIMB PERFORMANCE AMONG DIVISION I BLACK BASKETBALL PLAYERS: SEX DIFFERENCES

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INTRODUCTION: Female basketball players show a higher prevalence of knee injuries compared to males [1, 2]. Increased quadriceps angle (Q-angle) is positively related to knee injuries due to decreased quadriceps strength [3, 4]. Quadriceps' functional performance can be measured via jumping tests [5, 6]. Bilateral variability is an injury predictor due to compensation [7, 8]. Even though Q-angle has been examined worldwide, its bilateral variability is less studied, especially on Black basketballers [9, 10]. The purpose of the study was to examine bilateral variability and the relationship of Q-angle to jumping performance among division I Black basketball players.

METHODS: A licensed Physical Therapist (PT) performed a goniometric Q-angle measurement on fifteen players (Male = 9, Age = 21.2 ± 1.1; Female = 6, Age = 19.5 ± 0.8) and an evaluation of lower-limb performance (via a vertical jump [VJ] and a standing broad jump [SBJ]) according to standard procedures. Paired t-test and independent t-test were performed to determine bilateral variability in Q-angle by sex, while Pearson's r correlation was used to determine the relationship between Q-angle and lower-limb performance. Statistical analyses were performed using Jamovi (v. 2.3.3.0) at $p < .05$.

RESULTS: The average Q-angle for the sample was 9.5 ± 2.3 and 9.3 ± 1.8, for the left and right limbs, respectively. Q-angles were higher for females compared to males (11.8 ± 1.2 vs. 8.0 ± 1.4 and 10.8 ± 1.3 vs. 8.2 ± 1.3 for left and right limbs, respectively). No significant differences were observed between the left and right limbs in males ($t8 = -1.0$, $p = 0.35$), while females' left Q-angle was significantly different from the right Q-angle ($t5 = 2.7$, $p = 0.04$). Significant differences between sex were observed in both left and right Q-angles ($t13 = 5.5$, $p < 0.001$, and $t13 = 3.8$, $p = 0.002$, respectively). The left Q-angle was negatively correlated to VJ ($r = -0.7$, $p = 0.002$) and SBJ ($r = -0.7$, $p = 0.004$), while the right Q-angle was only negatively correlated to SBJ ($r = -0.6$, $p = 0.02$). Only males showed a significant correlation between Q-angles for the left and right limbs ($r = -0.9$, $p = 0.002$).

CONCLUSION: Our quadriceps strength findings provide indirect evidence of the greater risk for knee injuries in Black female basketball players: a) less strength than males and b) variability in-between legs. Investigation of bilateral variability in one-leg strength assessments may add value in terms of knee injury when screening this demographic.

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DETERMINATION OF THE ANAEROBIC THRESHOLD FOR RUNNING FROM CENTER OF MASS VERTICAL DISPLACEMENT

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INTRODUCTION: During incremental treadmill running neuromuscular and metabolic changes, which determine the anaerobic threshold, are associated with changes of specific kinematic parameters. The main objectives of this research were to investigate: 1) the relationship between the amplitude of vertical displacement of the center of mass for lower extremities and pelvis (CMa) and running speed during incremental running, and the possible presence of a nonlinear trend change, or threshold, for CMa (CMTh) with increasing running speed; 2) the relationship between the ventilatory anaerobic threshold (ATh, respiratory compensation point) and the CMTh.

METHODS: Twenty-three PE students were subjected to an all-out incremental treadmill test, with measurement of gas exchange (VO2, VCO2) and kinematic parameters. Independent evaluators defined the ATh (modified V-slope method) and CMTh thresholds. The APAS system (Ariel Dynamics, USA) with surface markers was used to measure the CMa, and the Quark b2 (Cosmed, IT) system for spiroergometry data. Student's t-test, correlation coefficient (r), and limits of agreement (LoA) were used to compare the ATh and CMTh thresholds obtained in the graded exercise test.

RESULTS: In 19 subjects CMTh was determined as the point of stagnation or decrease of the vertical displacement in the sagittal plane of the CM with increasing running speed. In the remaining 4 subjects a shift in the CMa trend was seen at the running speed corresponding to ATh. A strong relationship between ATh and CMTh ($r = 0.83$, $p < 0.01$) was determined. The average values of ATh and CMTh did not differ significantly, although a trend towards somewhat higher values for CMTh was present (LoA = 0.2 ± 2.5 km/h).

CONCLUSION: We conclude that, during graded treadmill running, there is close coupling between trend changes of center of mass vertical displacement and changes in gas exchange parameters that determine the anaerobic (second ventilatory) threshold. The results of the study give the opportunity for development of a new method for anaerobic threshold determination by center of mass measurement during graded treadmill running.

EFFECTS OF NON-DOMINANT SIDE STRENGTH TRAINING ON ATHLETIC PERFORMANCE OF MODERN PENTATHLON ATHLETES

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INTRODUCTION: This study evaluates the changes in the strength of both sides of the lower limbs after stage training through unilateral lower limb resistance strength training intervention with the same load and different movement modes. It explores the impact of non-dominant side strength changes on the related sports performance of modern pentathlon athletes.

METHODS: Fourteen athletes from the Shanghai modern pentathlon training team were selected as subjects for this study. The experimental intervention group was identified based on isokinetic strength test results. The experimental intervention involved seven participants in the experimental intervention group and seven participants in the experimental control group. The control group utilized bilateral load balance training for strength training, while the experimental group used unilateral strength training with both single and bilateral movement modes, maintaining a one-to-one correspondence, and the training load remained consistent. The training was conducted three times a week for a duration of 12 weeks.

RESULTS: (1) Non-dominant knee flexor and extensor strength, non-dominant ankle dorsiflexor strength were significantly correlated with CMJ, SJ, lower extremity relative maximum strength, 2 sets of 14m kendo round trip, 100 m swimming, laser run. (2) After training intervention, the strength of knee flexor and extensor muscle on the non-dominant side and dorsiflexor muscle on the non-dominant side of ankle joint in the experimental group were significantly increased, and the difference between the two sides was significantly decreased ($P < 0.01$), and the Y balance in the experimental group was significantly improved. (3) The maximum power and average power of anaerobic power in the experimental group were significantly increased in 30s, and CMJ, SJ, reaction force, 1RM squat, relative 1RM squat, 30 m run, 3000 m run in the experimental group were significantly increased. The performance indexes of 2 sets of 14m Kendo round trip, 100 m swimming, 200 m swimming and laser running were significantly improved in the experimental group.

CONCLUSION: Our findings suggest that (1) The strength of the non-dominant lower limb may significantly impact the Y balance, sports injury, anaerobic work, speed, strength, and specific sports performance indexes of modern pentathlon athletes. (2) Unilateral body strength training, utilizing both single and bilateral movement modes, can effectively improve the flexion and extension strength of the non-dominant knee joint and the plantar dorsiflexion strength of the ankle joint in modern pentathlon athletes. (3) The improvement in flexor and extensor muscle strength of the knee joint on the non-dominant side, along with dorsiflexor muscle strength of the ankle joint on the non-dominant side, can effectively promote

the development of special strength, speed, anaerobic endurance, aerobic endurance quality, and specific sports performance of modern pentathlon athletes.

THIGH MUSCLE ACTIVITIES DURING BOTH- AND ONE-LEG STAND-UP TESTS FROM DIFFERENT SEAT HEIGHTS

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INTRODUCTION: Both- and one-leg stand-up tests are simple and relatively safe, and are used for evaluating lower limb strength and balance, especially in older persons. The scores were reported to have a linear relationship with the weight bearing index of maximal knee extension isometric strength. However, few studies have investigated thigh muscle activities during stand-up tests. The purpose of this study was to examine thigh muscle activities, assessed using electromyographic (EMG) analyses, during both- and one-leg stand-up tests from seats of different height.

METHODS: Thirteen active young females (age: 21 ± 1 years, height: 159.2 ± 7.1 cm, weight: 52.8 ± 7.1 kg, BMI: 20.8 ± 2.3 kg/m2) participated in this study. Their body composition was measured using bio-impedance analysis, and the thickness of their muscles and fat in the middle of the anterior thigh was assessed using ultrasound B-mode imaging. Their maximal knee extension isometric strength was measured using a strain gage. Seven types of stand-up tests were performed randomly: both-leg stand-up tests from seats 40-, 30-, 20-, and 10-cm high (BL40, BL30, BL20, and BL10, respectively), and one-leg (right side) stand-up tests from seats 40, 30, and 20-cm high (OL40, OL30, and OL20, respectively). During the tests, the EMG activities of the vastus lateralis (VL), rectus femoris (RF), and vastus medialis (VM) of the right thigh were continuously measured. The root mean squares of the EMG values were calculated and normalized to OL20 (i.e., the EMG value during OL20 is 1.00).

RESULTS: There was significant interaction between the three muscles ($p < 0.05$). The mean EMG values in the VL and VM, but not in RF, increased gradually in the following order: BL40, BL30, BL20, BL10, OL40, OL30, and OL20. The EMG values during OL40 were significantly higher than those during BL10 in the VL ($p < 0.001$) and VM ($p < 0.001$). However, those in the RF were not significantly different between BL10 (0.531 ± 0.124) and OL40 (0.507 ± 0.144). The EMG value in the RF was significantly different between OL30 (0.783 ± 0.129) and OL20 (1.000 ± 0.000) ($p < 0.001$), although those in the VL and VM were similar between the two tests (N.S.).

CONCLUSION: These results suggest that, although the scores of stand-up tests were reported to be linearly related to the lower limb strength per body weight, the changes in muscle activity during the tests are different between the thigh muscles, and none of the muscle activities increased linearly from BL40 to OL20.

RELATIONSHIP BETWEEN UNILATERAL JUMP AND DIFFERENT COD ASYMMETRIES IN ACTIVE YOUNG ADULTS

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INTRODUCTION: The repeated execution unilateral jumps and COD actions involve large neuromuscular loads which may lead to asymmetries between limbs (Bishop et al, 2019) and, consequently, to an injury risk. The magnitude and direction of these asymmetries during change of direction (COD) actions have rarely favoured the same direction in sport population (Bishop et al., 2017). Moreover, the relationship between the performance and the asymmetries in different COD angles are not clear (Dos'Santos et al., 2018). Therefore, the main aim of the present study was to evaluate the neuromuscular asymmetries between the lower extremities in active and healthy students during the execution of different changes of direction (180º, 135º and 45º) and unilateral jumps, as well as to determine their directionality according to the behaviour of each extremity in each test.

METHODS: The sample (n = 22, age = 23 ± 1.40 years) of the present study performed two performance tests, the bilateral jump with countermovement (CMJ) and the 10m sprint, and several unilateral tests such as the unilateral jump with countermovement (SLCJ) and three types of changes of direction (COD: 180º, 135º and 45º). To identify differences between limbs, the magnitude of differences between HPL and LPL were assessed with paired sample t-tests. Kappa test (k) were used to establish the directionality of ASI scores and a correlation analysis of all variables was conducted.

RESULTS: Results showed significant differences between the established legs as HPL and LPL in all unilateral tests observed ($p < 0.001$). The Kappa coefficients determined a poor consistency in the directionality of the asymmetries, thus indicating that these rarely favored the same extremity in the respective tasks (kappa = -0.30 to 0.24). The calculated COD deficit values reported a higher magnitude of the asymmetries compared to the one obtained from the total COD times. However, both the magnitude and the directionality in question also differed depending on the change of direction. At the same time, no significant correlation was observed between performance testing and unilateral testing.

CONCLUSION: The present study highlight the lack of consistency towards the magnitude and directionality of the asymmetries, thus highlighting the fluctuation of their behavior depending on the task evaluated. The fact that no direct relationship was found between performance and asymmetries suggests that each motor skill observed should be specifically assessed and trained.

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DEVELOPMENT AND VALIDATION OF A NEW ANTHROPOMETRIC PREDICTIVE EQUATION FOR ESTIMATING FAT MASS IN ELITE MALE SOCCER PLAYERS

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INTRODUCTION: This study aimed i) to develop and validate an anthropometric soccer-specific equation for predicting FM using dual energy X-ray absorptiometry (DXA) as a reference method; ii) to assess the performance of existing soccer-specific predictive equations.

METHODS: Eighty male soccer players (age 24.4 years, BMI 23.7 kg/m2) participating in the first Italian league underwent anthropometric measurements and DXA scan during the in-season period. the participants were divided into development and validation groups. The validation group returned for a second assessment three months later and was included in an analysis of longitudinal validity.

RESULTS: The best developed model was: FM (kg)= -9.905 + (sum of triceps, iliac crest, abdominal, and front thigh skinfolds (mm) × 0.175) + (thigh circumference (cm) × 0.258) - (ethnicity × 1.577) - (age (years) × 0.068), R2=0.73, standard error of estimation (SEE)=1.01 kg, where ethnicity is 1 for black and 0 for white. Cross-sectional validation showed r2 values ranging from 0.71 to 0.72 with SEE equal to 0.80 kg and 0.86 kg for the baseline and the second assessments, respectively. Concordance correlation coefficients (CCC) were 0.84 at baseline and 0.86 at the second visit. The agreement analysis showed no mean bias at any time (p>0.05) and lower 95% limits of agreement (LoA) ranging from -1.5 kg to 1.8 kg. Longitudinal validation demonstrated a high accuracy at both group (r2= 0.80, SEE= 0.37 kg, CCC= 0.90) and individual (mean bias= 0.04 kg, 95%LoA= -0.7 kg to 0.8 kg, r= 0.117) levels.

CONCLUSION: The FM estimated from existing predictive equation differed from DXA for all the cross-sectional and longitudinal assessments, showing less accuracy compared to the new equation. This study presents a new soccer-specific predictive equation based on four skinfolds and a circumference, allowing for a valid and sport-specific assessment of FM across the competitive season.

TRAINING CHARACTERISTICS AND RACE-RELATIVE INTENSITY DISTRIBUTION OF ELITE TEAM PURSUIT CYCLISTS

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INTRODUCTION: The training process involves the systematic planning and execution of exercises to develop athletic qualities and performance. Team pursuit track cyclists require highly developed aerobic, anaerobic, and neuromuscular capacities to repeatedly and extensively produce the required power output to execute the race strategy. This study aimed to profile the general training characteristics of an elite team pursuit cycling squad relative to their own world-record performance power and torque demands.

METHODS: Training data of five male track endurance cyclists (mean ± SD age 21.9 ± 3.52 y; 4.4 ± 0.16 W.kg-1 @ LT2; 6.2 ± 0.28 W.kg-1 @ VO2peak; peak oxygen uptake 68.7 ± 2.99 mL.kg.min-1) were analysed across a 36-week preparation period. Training intensity distribution for power and torque were calculated with reference to the athletes' subsequent world-record performance (3:49.804 min:sec.ms) demands for the 4-km team pursuit (i.e., WR Lead [wheel 1], WR Average [wheel 1-4], WR Follow [wheel 2-4], along with variations in weekly total training volume by activity type, and training gear and pace evolution.

RESULTS: Across 436 ± 16 sessions during the 36-week period, athletes completed 543 ± 37 hours of training activities (e.g., track, road, ergometer, gym), with 11246 ± 1140 km total distance cycled. Seventy percent of on-bike training was performed at low-intensity power output (below LT1), with 7.7% performed at high intensities (above LT2). Torque demands for WR Lead, Average, and Follow were 55, 45, and 39 Nm, respectively. Athletes accumulated 4.4% of on-bike load above WR Lead torque requirements (55 Nm), with a further 4.7% above WR Average (45 Nm) and 5.6% above WR Follow (39 Nm).

CONCLUSION: These data provide valuable insight to the training characteristics of a recent world-record team pursuit squad. The development of anaerobic and neuromuscular capacities was a major component of these athletes' training, which differs from previous descriptive studies of elite team pursuit cyclists. The findings also present novel quantification of race pace-relative intensity distribution for team pursuit power and torque demands, which may have relevance to coaches and practitioners in training prescription. General intensity distribution observed was not dissimilar to those reported in other endurance sports, although there was limited shift toward a polarised distribution in the competition taper.

THE HIGH INTENSITY INTERVAL TRAINING AND VIGOROUS-INTENSITY CONTINUOUS TRAINING PROTOCOLS DURING CYCLEBOXING - PRELIMINARY STUDY FOR MONITORING TRAINING LOAD AND PHYSIOLOGICAL RESPONSES

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INTRODUCTION: Optimal exercise prescription for the effect in high intensity interval training (HIIT) during cycling has been well documented (Buchheit and Laursen 2013, Martland, Mondelli et al. 2020) and those in vigorous-intensity continuous training (VCT) during cycling has also been reported (Gerber, Brand et al. 2014). Cycleboxer is a sports equipment which allow boxing and cycling simultaneously. However, as a new option for strengthening, cardiopulmonary fitness and conditioning, there is no study which adopted specific exercise protocol such as the HIIT and VCT to investigate the training loads and the immediate physiological responses while performing Cycleboxing. Therefore, current study aimed to investigate the relationships between various kinds of external and internal loads with the oxygen consumption.

METHODS: Participants were recruited to perform Cycleboxing with two different prescriptions, namely the HIIT and VCT. The HIIT prescriptions included 2 min exercise and 1 min resting intervals for 6 sets and the VCT prescriptions included first 25 minutes vigorous intensity and last 10 minutes vigorous-to-high intensity for a total of 35 minutes. During cycleboxing, the participants wore Polar H10 heart rate belt (Büttelborn, GER) on the chest, breathing mask, non-invasive Muscle Oxygen Monitors(MOXY, Fortiori Design LLC, Hutchinson, MN, USA) on the upper limb (biceps humerus) and lower limb (vastus lateralis), the inertial sensor on the upper arm, forearm and thigh. External load and internal training loads such as heart rate, oxygen uptake, SmO2, EMG, blood lactic acid, power, and RPE were monitored during training.

RESULTS: The multiple linear regression model of HIIT showed better coefficient of determination (R2=0.964), with SmO2_VL being the best followed by the Power as predictors for VO2, compared with the determination (R2=0.332), with SmO2_VL being the best followed by the SmO2Bl_diff and by Power as predictors for VO2.

CONCLUSION: Compared with the SmO2 measured in VCT prescriptions, SmO2 measured in HIIT showed better coefficient of determination, suggesting a better explanatory were reached in shorter interval training than in longer endurance training. And this predicting capacity was related to local body parts, gender, and athletic level.

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ACUTE EFFECTS OF JAW CLENCHING WHILE WEARING A CUSTOMIZED BITE-ALIGNING MOUTHGUARD ON MUSCLE ACTIVITY AND FORCE PRODUCTION DURING MAXIMAL UPPER BODY ISOMETRIC STRENGTH

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INTRODUCTION: Beyond the preventive role of wearing bite-aligning mouthguards (MG), recent research has investigated its neuromuscular effects and the possible benefits in different parameters such as muscular strength, power or muscle activation (Allen et al., 2018; Ebben et al., 2008; Schulze & Busse, 2019). The reason for these positive effects may be associated to the phenomenon called concurrent activation potentiation (CAP). This raising mechanism may be promoted by a remote voluntary contraction (RVC) of the mandible muscles (Ebben et al., 2008). It has been reported that the use of these devices promote a better temporomandibular repositioning and a more powerful occlusion, which may magnify the effects of the RVC (Maurer et al., 2018). Thus the aim of the present study is to investigate the effects of jaw clenching while wearing a customized MG on masticatory and prime movers muscle activation as well as on force production during maximal upper body isometric tests.

METHODS: Twelve highly trained rink-hockey athletes participated in the study. A randomized, repeated measures within study design was carried out to compare the acute effects of three experimental conditions: jaw clenching while wearing MG (MG), jaw clenching without MG (JAW) and non-jaw clenching (NON-JAW). Conditions were randomly distributed to avoid the influence of fatigue and the test learning effects. Participants performed three different isometric force tests following the next order: handgrip test (HG), bench press (BP) test and biceps curl (BC).

RESULTS: Statistical analyses revealed a significant higher force production ($p < 0.05$) in all tests for MG conditions with respect to NON-JAW. When comparing JAW and NON-JAW conditions an increased peak force was found in handgrip ($p = 0.045$) and bench press ($p = 0.018$) but not in biceps curl ($p = 0.562$). When comparing MG and JAW conditions, no differences were observed in any force output. In terms of muscle activity, significant differences were found in the agonist muscles of the handgrip test for MG with respect to NON-JAW ($p = 0.031$ - 0.046), whereas no differences were observed when comparing MG and JAW conditions.

CONCLUSION: The present study demonstrated that jaw clenching, with and without MG, is a good strategy to increase the upper body isometric strength compared to NON-JAW condition. A higher isometric force production was observed in all tests for MG with respect to NON-JAW conditions. When comparing JAW and NON-JAW conditions, this improvement was only observed in two of the three tests. The non-significant differences found in force production neither in muscle

activity between JAW and MG conditions, speculated that these ergogenic effects might be attributed to the jaw clenching, even though the use or non-use of MG.

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INFLUENCE OF SEVERE COLD METEOROLOGICAL CONDITIONS ON HUMAN CORE TEMPERATURE DURING MARATHON EXERCISE

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INTRODUCTION: As an extreme sport, marathon is conducted outdoors under a variety of meteorological conditions. It is significantly affected by meteorological conditions, which brings higher sports risks. Marathon participation in extreme severe cold environment may lead to hypothermia and impair life and health, but over the past years there are few quantitative studies on the relationship between meteorological conditions and human hypothermia in marathon exercise. The study was aimed at quantitatively investigate the influence of severe cold meteorological conditions on the time of hypothermia in marathon.

METHODS: From the perspective of heat transfer and according to the characteristics of human body in marathon exercise, this study established the algorithm of internal heat transfer of human body and the heat transfer process between human body and the surrounding environment, and iterated, simulated and calculated the hypothermia process of human body in marathon exercise under the condition of low temperature and cold weather.

RESULTS: In marathon exercise, when there was only low temperature weather, hypothermia never happened when the ambient temperature exceeded -2°C.When low temperature and rainfall weather existed at the same time, assuming that the ambient temperature was 4°Cand the rain temperature was 0°C, the time of fatal hypothermia was about 18-45min when the rainfall was in the range of 0.5-1.75mm/h. Assuming that the ambient temperature was 4°Cand the rainfall was 1.25mm/h, the time of fatal hypothermia was about 20-40min when the rain temperature was in the range of 0-3°C. When low temperature, rainfall and strong wind weather existed at the same time, assuming that the ambient temperature was 4°C, the rain temperature was 0°Cand the rainfall was 1.25mm/h, the ambient wind speed varies in the range of 1-15 m/s, the time for fatal hypothermia of human body is about 20min.

CONCLUSION: Rainfall is the most important meteorological factor affecting hypothermia during marathon, then low temperature takes the second place and strong wind takes the third place. In the future outdoor marathon, special attention should be paid to the prevention of the risk of hypothermia when low temperature, rainfall and strong wind occur at the same time.

EXTERNAL LOAD ANALYSIS IN DIFFERENT FOOTBALL PITCH DIMENSIONS

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INTRODUCTION: Monitoring training loads is essential for more effective training planning and operationalization, allowing the coach to know the training exercises effects (1). It is important for a relevant monitoring of the training load, that the variables to be analyzed consider the specific football game characteristics (2). The game of football is characterized by complexity (3), in which players develop synergies at different times of the game, in which high intensity strengths are relevant to determine the results of the game (4). In this sense, knowledge about training tasks that promote optimal stimulation according to the football players age is fundamental to football coaches (5). The aim of this study was to comparatively analyze the variable external load distance traveled (m) and the distance in high-speed running - HSR (>21 km), high acceleration - Hac (>3m/s2) and high deceleration - Hdec (>-3m/s2), manipulating the pitch size in GK+10x10+GK games.

METHODS: Considering the official football playing area, the analyzed games were performed on 1/2 pitch, 3/4 pitch and the total pitch size. The study included 20 young U-17 players (age: 16.1±0.76 yrs; heigh: 1.73±0.03 m; weigh: 61.81±3.54 kg). The data were collected using WIMU devices that were placed on the back of the trunk with vests specific for this purpose. Data analysis was performed through descriptive statistics, and the comparison between games was made using Anova One-Way. Effect size (ES) was also calculated using Eta-square ($\eta p2$).

RESULTS: The results showed that there are statistically significant differences ($p<0.001$) in the HSR variable between the 1/2 (14.98±14.34 m), 3/4 (27.64±19.27 m) and total pitch size (74.00±62.68 m). It has been observed that pitch size manipulation has an ES on the HSR (ES=0.31). Regarding the variables distance covered, no significant differences ($p>0.05$) were found between Hac and Hdec in the three games analyzed, (ES<0.06).

CONCLUSION: The used game formats are not promoters of differences in distance and distance covered in Hac and Hdec. It is also clear that for players to register HSR values it is necessary that the pitch size is greater than 3/4 official football pitch dimensions.

CROSSOVER EFFECT OF STATIC STETCHING TRAINING ON ANKLE DORSIFLEXION IN ADOLESCENT FEMALE ATHLETES

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INTRODUCTION: The mechanisms underlying stretch-induced joint range of motion (ROM) increases have been attributed to peripheral (muscle and tendon) and central (neural) components. Whereas several studies documented that central neural factors affect the stretched muscle groups, there is some evidence that static stretching also increases ROM in the contralateral non-stretched muscles (1). Thus, the aim of this study was to examine the crossover effect of static stretching training on ankle dorsiflexion in adolescent athletes.

METHODS: Twenty-one adolescent female volleyball athletes (age: 13.5 ± 1.4 years, height: 159.8 ± 7.0, body mass: 53.7 ± 7.6 kg) participated in this study. Static stretching of the plantar flexors of one leg (STR) was performed five times per week for 12 weeks in addition to volleyball training, while the contralateral leg served as control (CON). Total duration of stretching per session increased from 540 s to (week 1) to 900 s (week 12). At baseline, week 3, 6, 9, 12 and after 3 weeks of detraining, ankle angle was measured at rest and at maximum dorsiflexion using video analysis with the athletes performing wall calf stretching.

RESULTS: Resting ankle angle did not differ between legs at baseline ($p = 1.000$). Ankle dorsiflexion of the STR leg increased from baseline by 12% (week 6) to 20.1% (week 12) ($p < 0.001$) and this improvement was maintained during detraining ($p = 1.000$). Similarly, ankle dorsiflexion of the CON leg increased from baseline by 6% (week 9) to 11% (week 12) ($p < 0.001$) and was maintained during detraining ($p = 1.000$). Between legs difference in ankle angle was 28% at week 3 ($p = 0.019$) and increased to 55% at week 12 ($p <0 .001$), while it was maintained during detraining ($p < 0.001$).

CONCLUSION: Ankle dorsiflexion angle increased in both legs with a larger increase in the STR than the CON. Contralateral increases in ROM after stretching training may be attributed to central neural adaptations (2), similar to cross-education effects reported in strength training studies (3). The larger increase observed in the STR compared to CON may indicate the contribution of morphological changes of the plantar flexors to ROM increases.

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THE EFFECT OF INTERMITTENT PALM COOLING ON AEROBIC ENDURANCE PERFORMANCE FOR DIVISION II FOOTBALL PLAYERS – PILOT STUDY

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INTRODUCTION: Three surfaces of the human body are known to possess high thermo-sensitivity, the face, the bottom of the feet, and the palms (1). Each site comprises glabrous skin and is known to significantly aid in releasing metabolic heat through vasodilation (2). Recent evidence suggests that controlled palm cooling may have an ergogenic effect on performance (2). This study aimed to investigate the effect of intermittent palm cooling on football-specific aerobic endurance test (Yo-Yo IRT1).

METHODS: Fifteen male collegiate football players (age 21 ± 2.4) volunteered to participate in the study. The study was conducted over two separate training sessions (S1, S2) using a cross-over approach with subjects randomly assigned to either the cooling [C] or non-cooling [NC] condition for S1 and crossing over for S2. For S1 and S2, we recorded temperature (˚C), humidity (%), and barometric pressure (mmHg); (S1: 19˚ C, 52.2 %, 766.8 mmHg and S2: 25.4˚ C, 57.7%, 761.7 mmHg). The test consisted of repeated 2 x 20-m shuttle runs back and forth between a starting point, turning point and finish line. The running speed was controlled by timed audio feedback. A 10-second active recovery break between bouts was provided, where the subjects walked 2 x 5 meters and then returned to the starting line. During recovery, the players in the C condition submerged each hand into a separate cooler with water kept at 8˚ - 15˚ C while the NC condition did the recovery walk. The water temperature was monitored using the Physitemp BAT-12 Microprobe Thermometer. Descriptive and inferential statistics were calculated for Yo-Yo IRT1 performance using Jamovi 2.3.16. To determine if the cooling intervention impacted Yo-Yo IRT1 performance, a paired t-test was used with an alpha of ($p \leq 0.05$.)

RESULTS: The overall distance across conditions on the Yo-Yo IRT1 was 1733 ± 237m. The average distance for the Yo-Yo IRT1 for the C condition was 1712 ± 223.8m and the NC condition was 1754.7 ± 255.6m. The paired t-test analyses between the C and NC conditions identified a mean difference of -42.7m (95% CI -159.72m to 74.39m) which was not statistically significant $p=0.447$).

CONCLUSION: To our knowledge, this is the first investigation into the effect of palm cooling on endurance performance of football players. The overall distance is comparable to that seen in male amateur football players (3). With respect to the impact of palm cooling on Yo-Yo IRT1 performance, we observed no effect on football-specific aerobic endurance. This may be due to session variations in temperature and humidity which could mediate the effects of intermittent cooling. It is also possible the magnitude and/or duration of cooling was insufficient to have an effect. Future assessment of the ergogenic effects of intermittent cooling is warranted and should account for these issues.

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MAXIMIZING PHYSICAL PERFORMANCE WITH STRENGTH TRAINING DURING THE COMPETITIVE SEASON FOR ICE HOCKEY PLAYERS: FAVORABLE EFFECTS OF 40% VELOCITY LOSS

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INTRODUCTION: Recent studies have explored the impact of velocity-based strength training (VBST) on athletes and have indicated that applying velocity losses of 10-20% can result in neuromuscular adaptations while minimizing neuromuscular fatigue (1). However, during the in-season period, athletes typically engage in a greater volume of high-velocity, power-based movements as part of their sport-specific training regime. This raises the question of whether a different, more fatiguing training stimulus would be advantageous. To the best of our knowledge, the effects of VBST during the competitive season have not yet been investigated. The aim of this study was therefore to compare the effect of 20% vs. 40% velocity loss protocols during the back squat exercise in semi-professional ice hockey players during the in-season period.

METHODS: A total of 24 ice hockey players were randomly assigned to either a 20% velocity loss (VL20: 8 male and 4 female, 17.1±1.5 yrs, 176.6±10.4 cm, 77.8±14.7 kg) or a 40% velocity loss group (VL40: 7 male and 5 female, 16.9±0.9 yrs, 173.3±10.3 cm, 70.0±11.4 kg). Participants underwent a biweekly VBST program with three sets of back squats per session during their competitive season, for a duration of 5 weeks (female team) or 8 weeks (male team). Physical performance, including 1-repetition maximum [1RM] back squat, leg press maximal strength and -power, 30-m on and off ice sprint, and countermovement jump (CMJ), as well as muscle thickness of vastus lateralis (ultrasonography) were assessed at pre- and post-intervention periods.

RESULTS: The VL40 group performed an average of 11±2, 10±2 and 9±2 repetitions in sets 1-3 per session of back squat, compared to 8±2, 7±2, and 7±2 repetitions in VL20 (all $p<0.01$).

The VL40 group showed significantly greater improvements in leg press maximal strength (2.2±5.7% vs. -4.1±4.4% for VL20, $p<0.001$) and -power (2.6±5.3% vs. -1.5±4.3% for VL20, $p=0.05$) than the VL20 group. No other significant group differences were observed, but both VL40 and VL20 protocols led to increases in back squat 1RM (11.1±7.9% and 6.3±6.0%, respectively) and muscle thickness (3.6±3.7% for VL40 and 2.0±1.8% for VL20, both $p<0.001$). Only the VL40 group exhibited a significant improvement in CMJ compared to baseline (2.8±3.0%, $p=0.046$), whereas the VL20 group did not show a significant change (0.1±4.7%, $p=0.688$).

CONCLUSION: Both VBST protocols proved effective in preserving or enhancing muscle size, -strength, and -power among semi-professional ice hockey players during the competitive season. Nonetheless, our results suggest that the 40% velocity loss protocol may be more favorable for achieving strength and power gains than the 20% protocol in-season. Further studies are needed to explore in-season velocity loss protocols that employ equal training volume, to discern whether the results are attributed to velocity loss per se or training volume.

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EFFECT OF TIME-OF-DAY AND TWO TYPES OF PARTIAL SLEEP DEPRIVATION ON FEMALE SOCCER PLAYERS' SPECIFIC PERFORMANCE

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INTRODUCTION: In general, the sleep of athletes is not optimal (e.g., habitual short sleep (<7 hours/night) and poor sleep quality [1]). Many critical athletic performance factors have been found to be negatively impacted by sleep deprivation [2]. However, athletes' sleep and performance is sex-linked [3], and, in reality, athletes encounter much more situations in which they are only partially sleep deprived. Therefore, this study aimed to investigate the effect of time-of-day and two types of partial sleep deprivation (PSD) on female soccer players' performance.

METHODS: 18 active female collegiate soccer players (19.3 ± 1.6 yrs, 165 ± 6 cm, 58 ± 7 kg, healthy sleepers, no extreme chronotypes) performed three sessions of soccer-specific performance tests. Following the baseline session, players were separated into two PSD groups; 9 participants were deprived of ~3.5h sleep in the beginning (PSDB) of the night, while the sleep of the other 9 participants was similarly deprived, but at the end of the night (PSDE). Subsequently, two other performance sessions were conducted in the morning and afternoon following on the PSD. Outcome measurements include specific fitness tests [countermovement jump (CMJ), 30-m sprint (30-m), T-test and YoYo IRTL 1(YOYO)] and skill tests [Loughborough Soccer Shooting and Passing Test (LSST and LSPT)]. Data were analyzed using a mixed ANOVA analysis in SPSS. Significance was set at $p < 0.05$.

RESULTS: A significant main effect of time was found in CMJ ($p<0.001$), T-test ($p=0.035$) and YOYO ($p<0.001$). These performances all significantly declined in the morning and afternoon following on PSD. A significant interaction effect was present in 30-m ($p=0.035$). In PSDB, 30-m performance was slower in the morning than baseline ($p=0.04$) and the afternoon ($p=0.02$). However, in the PSDE group, there were no differences across time. All aspects of LSPT [i.e., Original ($p=0.014$), Penalty ($p=0.005$) and Performance ($p=0.002$)] significantly deteriorated due to sleep deprivation, independently from

PSD-group. Regarding LSST performance, Sequence time (p=0.001) and Null shots (p=0.045) were impaired in time. In addition, Speed of shots was faster in PSDE than in PSDB, showing a main effect of group (p=0.032).

CONCLUSION: Female soccer players' upper body power, agility and aerobic endurance were negatively affected by PSD in the morning and afternoon following on the PSD, independently from the type of PSD. Passing skill and shooting performance were impaired by PSD and time-of-day. The findings of this study have practical implications for coaches to optimize performance in situations of PSD.

DEVELOPMENT OF NEW REACTION AGILITY TEST IN TENNIS

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INTRODUCTION: Tennis is an intermittent physically demanding sport with many high-intensity acceleration, and deceleration actions with four directional changes in an average point, where a player runs an average of 3 m per shot [1]. Players have to react rapidly to the opponent's shots and efficiently change their position in all directions to reach and return the ball [2]. Therefore, successful performance in tennis requires well-developed change-of-direction speed (CODS) and reaction agility (RAG) that is dependent on perceptual and decision-making skills [1,2]. However, there is an evident lack of tennis-specific agility tests. Recently, tennis-specific RAG test was developed, but it enabled only testing in two directions, left (L) and right (R), without sprinting forward (F) [3]. Thus, the aim of this study was to examine the reliability and validity of newly developed tennis-specific test (T-RAG) with three movement options (L, R and F).

METHODS: The study included 18 regional-level, male and female youth tennis players (age: 14.5 ± 1.5 years; body height: 1.69 ± 0.08m; body mass: 57.8 ± 10,9kg). Variables included pre-planned T-CODS, and three protocols of non-planned T-RAG (e.g. F, L, R, F). For the T-RAG test, the participants had to execute "split step" across the infrared (IR) line, which initiates the timing and lit one of the three LEDs placed inside the cones (L, F, R). Then players had to assess which cone was lit, run towards it, hit the hanging ball with the racquet. The ball was placed at the specially constructed stand 1.2m above the respective cone and 4m distant from the starting line. Afterwards they sprinted back across the IR line. For the T-CODS, the participants did the test in pre-planned regime (e.g. L, F, R, L). Each test was performed three times.

RESULTS: Both the relative and absolute reliability were good for the T-CODS (ICC = 0.80; CV = 5.8%) and T-RAG (ICC = 0.92 to 0.94; CV = 6.7 – 7.0%). The T-CODS and T-RAG shared 52–66% of the common variance.

CONCLUSION: This study confirmed the high reliability of the three-directional tennis-specific tests of RAG and CODS in youth players which is in line with previous studies [2,3]. However, T-RAG showed better relative reliability compared to T-CODS, which can be explained by larger between-participants variability in T-RAG than in the T-CODS. When the variability is high, it is easier to maintain consistently the ranking order in test-retest measurements [4]. The percentage of shared common variance between T-RAG and T-CODS was higher than in the previous studies, which can be attributed to the lower playing level of participants who could lack movement proficiency when rapidly changing direction in response to external stimuli compared to their older counterparts. The tennis coaches should be aware that the development of RAG, perceptual and decision making abilities is warranted in youth players.

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SEX-SPECIFIC DIFFERENCES IN EXERCISE INDUCED MODULATION OF CARDIAC AUTONOMIC ACTIVITY IN PATIENTS WITH MAJOR DEPRESSION

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INTRODUCTION: As both depressive symptoms and cardiac autonomic regulation are influenced by sex [1], the aim of this pilot study was to evaluate possible exercise related, sex-specific differences in cardiac autonomic activity (HRV) and perceived exertion (RPE) in female (FDP) and male (MDP) patients with major depression during a moderate intensity 2km walking test (2kmWT).

METHODS: n=10 female (FDP; age: 30±15yrs, BMI: 24.3±6.1kg/m2) and n=10 male (MDP; age: 31±10yrs, BMI: 24.2±2.6kg/m2) patients with moderate to severe major depression (QUIDS: MDP: 15.2±7.1 vs. FDP: 18.2±4.3; p=0.27, d=0.51) performed a 2kmWT (Walking index: WI in a.u.), while data on walking speed (WS in km/h) and rating of perceived exertion (RPE) were assessed every 400m. In addition, heart rate (HR in bpm) and linear (SDNN in ms, RMSSD in ms) and non-linear (DFAa1) indices of 5min-HRV were analyzed before (REST), during the last 5min of 2kmWT (EXE) and after 5min of recovery (REC).

RESULTS: Both sexes showed similar, rather low values of WI (MDP: 78.3±24.8a.u. vs. FDP: 79.8±13.3a.u., p=0.87, d=-0.08) and comparable HR (MDP: 149±18bpm vs. FDP: 154±30bpm, p=0.67, d=0.19) and RPE (MDP: 12.6±2.3 vs. FDP: 13.2±2.5, p=0.58, d=0.25) at the end of 2kmWT, while FDP reached lower WS (MDP: 7.4±0.7km/h vs. FDP: 6.7±0.9km/h, p=0.07, d=-0.87). For both sexes the linear HRV indices SDNN (MDP: 27.8±12.3ms vs. FDP: 25.7±13.6ms, p=0.72, d=-0.17) and RMSSD (MDP: 16.4±8.8ms vs. FDP: 17.1±9.0ms, p=0.85, d=0.08) were similar during REST, strongly diminished during EXE (SDNN: MDP: 3.3±2.1ms vs. FDP: 3.2±1.4ms, p=0.86, d=-0.07; RMSSD: MDP: 2.9±1.6ms vs. FDP: 3.7±1.9ms, p=0.36, d=0.42) and showed a comparable vagal reactivation in REC (SDNN: MDP: 16.6±11.9ms vs. FDP: 13.0±6.8ms, p=0.41, d=-0.38; RMSSD: MDP: 8.4±6.0ms vs. FDP: 7.6±5.0ms, p=0.75, d=-0.19). In contrast, non-linear DFAa1 was lower in FDP compared to MDP during REST (MDP: 1.49±0.12 vs. FDP: 1.36±0.17, p=0.07, d=-0.86) and EXE conditions (MDP: 0.99±0.43 vs. FDP: 0.69±0.21,

p=0.07, d=-0.88), while both sexes regained a similar recovery level during REC (MDP: 1.57±0.28 vs. FDP: 1.55±0.22, p=0.82, d=-0.10).

CONCLUSION: In depressed patients the general exercise induced autonomic perturbation shows a similar pattern of vagal suppression and reactivation in both sexes. In contrast, correlation properties of DFAa1 reveal subtle sex-specific differences in complex regulation during rest and exercise. This may point towards a more severe exercise induced organismic stress [2] in female patients. Whether this effect might influence exercise perception and should be considered in sex-specific exercise prescription in major depression remains to be further elucidated.

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PHYSICAL PERFORMANCE IN PARALYMPIC WHEELCHAIR RUGBY ATHLETES FROM CUNDINAMARCA-COLOMBIA.

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INTRODUCTION: In wheelchair rugby, players use an offensive or defensive wheelchair depending on their position on the field and their level of disability. The performance of wheelchair rugby players is related to several paramenters, degree of disability, physical ability, time of experience, type of wheelchair, which are related to sport performance. The objective of this study is to analyze the physical performance of wheelchair rugby athletes from Cundinamarca-Colombia.

METHODS: Eleven people belonging to the wheelchair rugby league of Cundinamarca-Colombia were tested for physical and technical performance, ball handling, blocking performance, 20-meter speed, long-distance passing, Illinois agility test, 40-meter test, up and backs.

RESULTS: Age 37.4 (10.2), Peak speeds of the first 2 pushes (acceleration phase) were significantly higher with the defensive wheelchair than with the offensive wheelchair ($p < 0.05$ and $p < 0.03$). Mean and peak sprint velocity were significantly greater ($p < 0.04$ and $p < 0.06$, respectively) with the defensive wheelchair. In ball handling 8.36 (3.07) sec, blocking performance 29.67 (7.16) effective.

CONCLUSION: The performance was lower with the offensive wheelchair than with the defensive one, suggesting the frequent finding that the higher performance of defensive players compared to offensive ones, the technical variables are aperfecioamento elements for a development with more effective in the matches potentiating better performance for wheelchair rugby.

COMPARISON BETWEEN SPATIOTEMPORAL STRIDE CHARACTERISTICS DURING RAMP VERSUS STEADY STATE RUNNING TESTS

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INTRODUCTION: Ramp incremental (RI) tests have two major benefits over step tests (ST): their shorter duration (especially at high intensity) and the possibility of assessing metabolic demand over a wide range of speeds as long as the delay to reach a steady state is considered (1, 2). On the other hand, being able to measure the running spatiotemporal characteristics in parallel to the metabolic responses remains an interesting and more complete approach. However, on a treadmill, the spatiotemporal parameters of the stride can evolve over a constant load (3). This case-study aims to compare spatiotemporal stride characteristics at the end of metabolic steady-state steps (ST) versus during the RI at the same speed.

METHODS: An elite runner (10 km run time: 29'05, VO2 max: 80.4 mL.min-1.kg -1) performed a treadmill test (1% gradient) consisting of two stages: 6 min at 15 km.h-1 (moderate intensity domain) and 10 min at 18.5 km.h-1 (heavy). After a 5-min active and 5-min passive recovery, a ramp test (4 minutes at 9 km.h-1 and then + 0.1 km.h-1 / 6 seconds) was performed. Flight time (FT), contact time (CT), stride length (SL) and frequency (SF) were collected throughout the test using an optical measurement system (OptoJump). Vertical (KV) and leg stiffness (KL) as well as duty factor (DF) were determined as proposed by Morin et al. (4). These metrics were compared between the last two minutes during steps [ST], and at the same speed during ramp incremental test [RI] (6 seconds) at 15 and 18.5 km.h-1.

RESULTS: At 15 km/h, CT (ST: 221.4 ± 4.4, RI: 216.3 ± 4.7 ms) and DF (ST: 64.1 ± 1.43, RI: 61.8 ± 1.27%) were superior in the step condition. FT (ST: 124.1 ± 6.4, RI: 133.7 ± 5.0 ms), KV (ST: 19.6 ± 1.1, RI: 21.1 ± 1.2 Kn.m-1) and KL (ST: 7.09 ± 0.4, RI: 7.69 ± 0.5 Kn.m-1) were superior during the ramp incremental condition. On the other hand, SL (ST: 1.44 ± 0.03, RI: 1.45 ± 0.02 m) and SF (ST: 2.90 ± 0.05, RI: 2.86 ± 0.03 Hz), were very similar between the two modalities. For all variables, the relative difference between RI and ST was greatly reduced at 18.5 km.h-1 compared to 15 km.h-1.

CONCLUSION: Spatiotemporal stride characteristics transiently measured during ramp incremental test are closer to those adopted during a steady-state run at 18.5 km.h-1 than at 15 km.h-1 for this elite runner. At 15 km.h-1, the athlete was more aerial and presented higher stiffness values in RI than in ST. These differences were lower at 18.5 km.h-1. The transition from moderate to heavy intensity domain may contributes to these observations, reducing the athletes ability to run at the same speed using varied stride patterns. Furthermore, the ability of a ramp test to translate mechanical characteristics over a wide range of speeds appears relevant to be evaluated in a larger population.

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VARIATION IN ENERGY COST IN SWIMMING : HOW MUCH IS USED ACCORDING TO THE STROKE FREQUENCY VARIATION

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INTRODUCTION: The successful performer is able to adapt his/her behavior to dynamically shifting environments that characterize sport competition. Regarding motor coordination in cyclic locomotion tasks and particularly in swimming, speed and movement frequency appeared as key constraints[1]. Moreover, competition analysis showed that stroke frequency can really vary within and between laps[2]. This study aimed to examine swimmers' energy cost (C) of locomotion in front crawl when facing different task constraint such as stroke frequency.

METHODS: 17 swimmers (14 men (age 19.8 ± 1.4yrs) and 3 women (age 19.7 ± 1.2yrs) performed as fast as possible a 6x50m front crawl with the first trial with the spontaneous stroke rate (SSR) over 50 m. The second 50 m was performed with an audible metronome to impose SSR. The third to sixth 50 m were randomly performed with the audible metronome set to -6, -3, +3 and +6 cycles/min in comparison to SSR. The energy cost of locomotion was assessed by measuring oxygen consumption and blood lactate. Rating of Perceived Exertion (RPE) was obtained after each trial. For the statistical analysis, multiple logistic regression was used to evaluate if C and success in trial with variation of stroke frequency (identical time and respect of imposed SSR) were associated.

RESULTS: Success in trial with variation of stroke frequency revealed that the C (OR = 1.15, $p < 0.05$) was a significant predictor. Further, RPE was not a statistically significant factor.

CONCLUSION: In this present study, swimmers showed a modification of energy cost in order to satisfy the task demand. When manipulating swimming stroke frequency with dominance for speed, different metabolic pathways could emerge, confirming that this parameter act as a main constraint of the energy system.

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TEST – RETEST RELIABILITY OF A 3-MINUTE ALL-OUT 15-METER SHUTTLE RUNNING TEST

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INTRODUCTION: Critical running speed (CS) is the fastest sustainable speed whilst D' is a finite distance above CS, and these parameters can predict performance and inform training (1). A 3-min all-out running test can determine CS and D' (1). Studies have developed 3-min all-out shuttle running tests involving changes of direction (COD) for relevance to team sport players. However, these tests were: not suitable for simultaneously testing a team of players (2), or did not use COD frequencies similar to those expected in team sport (3), or did not convert CS and D' to critical metabolic power (CPmet) and W' to account for accelerations that occur with COD. Further, no studies have assessed test – retest reliability of their 3-min all-out tests. This study assessed the reliability of a 3-min all-out shuttle running test suitable for simultaneously testing a whole team of players, with a COD frequency (COD every 15 m) similar to team-sport activity, and considered speed and metabolic power metrics.

METHODS: 11 English Premier League Academy soccer players (Age 13.6 ± 0.5 years) performed a 3-min all-out shuttle-run test on 3 separate occasions, with consecutive sessions separated by a week. All participants completed the test together. The 3-min all-out test involved running back and forth between two parallel lines set 15 m apart. Running speeds and distances were measured via a GPS unit (STATSports Viper) sampling at 10 Hz. Metabolic power and work were determined from running speed and acceleration using the equations of de Prampero (4). CS and CPmet were average speed and metabolic power in the last 30 s. D' and W' were the areas below the speed-time and work-time curves above CS and CPmet respectively. Between test coefficient of variation (CV) and bi-variate correlation coefficients were determined.

RESULTS: CVs between test 1 and 2 were 6% (CS), 17% (D'), 10% (CPmet), and 17% (W'). Between tests 2 and 3, CVs improved and were 4% (CS), 11% (D'), 8% (CPmet), and 8% (W'). Bivariate correlation coefficients between test 1 and 2 were weak-moderate (0.38-0.52) for all variables. Correlation coefficients improved between test 2 and 3 (0.4-0.61).

CONCLUSION: This 3-min all-out test provided acceptably low CVs in CS, D', CPmet, and D' between test 2 and 3, but not between 1 and 2, suggesting coaches should familiarise their athletes with the test at least once to ensure reliable measurements. Whilst correlation coefficients were higher between test 2 and 3 than test 1 and 2, they remained weak-moderate for all variables, which may be due to low between-participant variability in the variables recorded. This test can

be reliably completed by a whole team of players simultaneously, and utilises COD frequencies that are similar to team sport activity.

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IS MAXIMAL POWER IMPAIRMENT AT THE END OF SEVERE-INTENSITY CYCLING EXERCISE DEPENDENT ON THE INTENSITY OF THE TRIAL?

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INTRODUCTION: In cycling, force-velocity and power-velocity profiling (i.e. maximal force [Fmax], power [Pmax] and velocity [Vmax]) is commonly used to assess the maximal lower limbs capabilities during sprinting (1). These variables have been shown to evolve after completing different fatiguing tasks, like repeated sprint efforts (2) or road race cycling (3). How these parameters evolve when assessed immediately after completing different constant-load cycling exercises (CLCE) to failure in the severe-intensity domain and aiming at depleting the same amount of work above critical power (i.e., [W']) , is unknown. The aim of this study is to investigate how the magnitude of severe CLCE performed to failure influences Fmax, Pmax and Vmax measured at the end of these bouts.

METHODS: One male trained triathlete (age, 29 yr; height, 186 cm; body mass, 67 kg; VO2peak: 73.9 ml.min.-1.kg -1) was tested on 5 occasions on a cycle ergometer, with 48h-rest between the visits. The first visit consisted of a ramp-incremental test to failure (25 W.min-1) achieved at peak power output (POpeak). The next four visits implied performing CLCE to failure into the severe-intensity domain. Immediately after failure, a 5-second all-out sprint was performed. Seven cycle-averaged couples of force and velocity values were obtained for each of the four sprints and effective torque- and power-pedal rate relationships were fitted using linear and quadratic regression models to determine Fmax, Pmax and Vmax indexes.

RESULTS: The participant achieved a POpeak of 405 W. The durations of the severe CLCE were 169, 311, 529 and 767 s. The model that produces the smallest combined SEE of critical power ([CP]) and W' gives the following estimates of these parameters: 314W (SEE: 0,9%) and 15,5 kJ (SEE: 5,3%) respectively. Coefficients of determination of the four linear and quadratic relationships were high ($R^2 \approx 0,95$-$0,99$ and $R^2 \approx 0,86$-$0,98$). Fmax, Pmax and Vmax values ranged between 165-172 N·m, 679-812 W and 155-188 rpm, respectively. Vmax and Pmax linearly decreased ($r^2 = 0,99$ and $0,94$) with the increase of the magnitude of the severe CLCE performed to failure (expressed in W) whereas no relationship exists with Fmax.

CONCLUSION: Maximal power impairment at the end of severe CLCE performed to failure seems to be related to the magnitude of the intensity maintained to failure, rather than the quantity of W' depleted. Moreover, this impairment appears to be due to the decrease of Vmax rather than Fmax. Force-velocity and power-velocity profiling could be relevant to use at the end of fatiguing tasks. Nonetheless, future studies need to be done to confirm these findings with a larger population.

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